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SOCIAL SUSTAINABILITY IN PUBLIC-WORKS PROCUREMENT

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AA	AccountAbility Framework Standard
AC	Award Criteria
AECID	Agencia Española de Cooperación Internacional para el Desarrollo (Spanish Agency for International Development Cooperation)
CA	Correspondence Analysis
CC	Contingency Coefficient
CEEQUAL	Civil Engineering Environmental Quality Assessment and Award Scheme
CIRIA	Construction Industry Research and Information Association
CMR	Construction Manager at Risk
CM/GC	Construction Manager as General Contractor
CPV	Common Procurement Vocabulary
CS	Certification System
DB	Design-Bid
DBB	Design-Bid-Build
DEA	Data envelopment analysis
DEA-BOD	Data Envelopment Analysis - Benefit of the Doubt
DVFA	Society of Investment Professionals in Germany
ESC	English-Speaking Country
EU	European Union
FHWA	Federal Highway Administration
G1	Human rights group
G2	Corporate social responsibility group
G3	Social commitment in the project
GRI	Global Reporting Initiative
IDOT	Illinois Department of Transportation
IHRB	Institute for Human Rights and Business
IIRC	International Integrated Reporting Council
ILO	International Labor Organization
IPD	Integrated project delivery
ISI	Institute for Sustainable Infrastructure
ISO	International Organization for Standardization
MNE	Multinational Enterprise
NCHRP	National Cooperative Highway Research Program
NTG	Northern Territory Government
OECD	Organization for Economic Cooperation and Development

OHSAS	Occupational Health and Safety Assessment Series
PPP	Public-Private Partnerships
RFQ	Request for Qualifications
SA	Social Accountability
SASB	Sustainability Accounting Standard Board
SC	Selection Criteria
SDG	Sustainable Development Goals
SME	Small and Medium-Sized Enterprise
SPAG	Social Procurement Action Group
SSC	Spanish-Speaking Country
TS&CPC	Technical specifications and contract performance clauses
UK	United Kingdom
UNCSD	United Nations Conference on Sustainable Development
UNEP	United Nations Environment Programme
UNSPSC	United Nations Standard Products and Services Code
USA	United States of America
WCED	World Commission on Environment and Development
WH&S	Workplace Health and Safety
WH&SMP	Workplace Health and Safety Management Plan
WIPO	World Intellectual Property Organization

ABSTRACT

Public procurement has been claimed as the key element to drive the integration of the three dimensions of sustainability (economic, environmental, and social) in the construction industry. However, important drawbacks are hindering the effective and efficient implementation of social sustainability in public-works procurement. Currently, a lack of knowledge exists about how social sustainability is considered in the construction industry. There is also a lack of consistent, clear, and practical definitions about what is social sustainability in the construction industry, what factors should be used to define it, and how social sustainability in this industry should be measured and assessed. Based on this, scientific literature highlights the need to study how social sustainability could be implemented more effectively in the construction industry through public procurement, claiming the need for developing a methodology to assist agencies in the effective inclusion and objective assessment of social criteria in public-works procurement.

According to these needs, two research questions are defined. On the one hand, this research seeks to characterize the current scenario regarding the inclusion of social sustainability within public-works procurement at the international level. To that end, the analysis of 451 tendering documents from ten countries is performed in order to: determine how public-works procurement procedures and project delivery methods are considered at the international level; identify the main social sustainability criteria; study how these criteria are defined depending on the stage of the tendering procedure; and, identify the variables that influence the implementation of social sustainability criteria in public-works procurement. On the other hand, this research analyses how the integration of social sustainability criteria in public-works procurement should be improved to overcome the current scenario. The indicators that should be used to assess the social sustainability criteria in public procurement of civil engineering construction projects are established; and a methodology is developed to improve and strengthen the correct implementation of the social criteria in public-works procurement at the international level, specifying where the social criteria should be included depending on the procurement procedure.

This study has established a specific scope for each research question. To characterize the inclusion of social sustainability criteria in public-works procurement, the scope has been defined considering an international approach; and every stage of the infrastructure life cycle of building and civil engineering projects covered. To integrate the social criteria in public-works procurement, the methodology focused only on the construction stage of civil engineering projects.

The characterization of the current scenario concluded that there is a lack of understanding regarding how to quantify social indicators; more significant efforts are needed to increase the number of social categories in procurement procedures; and, a strong dependence of the national context on the inclusion of social criteria in public procurement exists, emphasizing the consideration of location-dependent aspects in the development of methodologies to assess social sustainability in public procurement. Based on this, the development of a holistic methodology to include social criteria in public procurement of civil engineering construction projects was addressed. This work highlighted that, in order to guarantee their effective implementation, three groups of social criteria should be differentiated: 1) human rights; 2) corporate social responsibility; and, 3) social commitment in the project. A methodological approach was established for each of these groups. Regarding the human rights criteria, the aim is guaranteeing that every procurement procedure ensures that the construction companies involved in the process know and comply with each one of these criteria. The result is based on the definition of a human rights declaration that offerors have to submit in their bids to be admissible for assessment in the procurement procedure. The corporate social responsibility criteria seek to assess the corporate social features of each company that participates in the tendering procedure, focusing on the entire company in the country where the project is procured. The result is the definition of a composite indicator consisting of quantitative, reliable, and verifiable indicators, to guarantee the robustness of the methodology, and weights whose definition seeks to minimize the social weaknesses of each country over time. Finally, the social commitment in the project group aims to assess the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of the project. The result is the definition of a composite indicator in which both the definition of each indicator and their level of importance (weights) are able to adapt to the project characteristics. Finally, a practical guide is presented, gathering a flexible yet robust methodology to implement social criteria in public procurement, able to adapt to the social changing conditions of each country. This guide specifies where to include each group of social criteria in the procurement procedure of civil engineering construction projects, and how to guarantee their objective assessment.

RESUMEN

La contratacion pública ha sido destacada como el elemento clave para impulsar las tres principales dimensiones de la sostenibilidad (económica, ambiental y social) en la industria de la construcción. Sin embargo, a pesar de los esfuerzos llevados a cabo por las administraciones públicas a nivel internacional, en la actualidad, existen importantes limitaciones que están obstaculizando la implementación efectiva y eficiente de la sostenibilidad social en la contratación de obra pública. Las limitaciones más importantes son: la falta de conocimiento sobre cómo implementarla en el sector de la construcción; la escasez de definiciones claras, consistentes y prácticas sobre qué es la sostenibilidad social para esta industria; y, la necesidad de determinar los criterios sociales a tener en cuenta, así como el mejor método para evaluarlos y medirlos. En base a esto, la literatura científica destaca la necesidad de estudiar cómo la sostenibilidad social podría implementarse de manera más efectiva en la industria de la construcción a través de la contratación pública, y alega la necesidad de desarrollar una metodología que ayude a las administraciones públicas en la implantación de dichos criterios, al mismo tiempo que se garantiza su evaluación objetiva.

A la vista de estos antecedentes, el presente trabajo propone dos preguntas de investigación. Por un lado, esta investigación busca caracterizar la situación actual respecto a la inclusión de la sostenibilidad social en la contratación de obra pública a nivel internacional. Para ello, se analizan 451 licitaciones procedentes de diez países con el objeto de estudiar el uso de estrategias de contratación y estrategias de licitación a nivel internacional, identificar los principales criterios de sostenibilidad social, estudiar cómo se definen estos criterios según la etapa de la licitación y determinar las variables que influyen en la implementación de dichos criterios en la contratación de obra pública. Por otro lado, esta investigación analiza cómo debería mejorarse la integración de los criterios de sostenibilidad social en la contratación pública respecto al escenario actual. Por tanto, se establecen los indicadores que deberían utilizarse para evaluar la sostenibilidad social en la contratación pública de obras de ingeniería civil; y se desarrolla una metodología que favorezca la correcta implementación de dichos criterios a nivel internacional, especificando dónde deberían ser incluidos según la estrategia de licitación.

Este estudio define un alcance específico para cada pregunta de investigación. En lo que respecta a la caracterización de la sostenibilidad social en la contratación de obra pública, se busca un alcance internacional que cubra cada etapa del ciclo de vida de la infraestructura. En dicho estudio se analizan licitaciones relativas a proyectos tanto de edificación como de ingeniería civil. Por otra parte, a la hora de desarrollar la

metodología para integrar los criterios sociales en la contratación de obra pública, el alcance se limita únicamente a la etapa de construcción de proyectos de ingeniería civil.

El estudio de la caracterización del escenario actual concluyó que existe una falta de comprensión sobre cómo hacer que los indicadores sociales sean cuantificables; se necesitan mayores esfuerzos para aumentar el número de categorías sociales en las estrategias de licitación; y, existe una fuerte dependencia del contexto nacional en la inclusión de criterios sociales en la contratación pública, lo que destaca la necesidad de considerar aspectos dependientes de la ubicación en el desarrollo de metodologías para evaluar la sostenibilidad social en la contratación pública. En base a estos resultados, se abordó el desarrollo de una metodología holística para incluir los criterios sociales en la contratación pública de obras de ingeniería civil. Este trabajo destaca que para garantizar una efectiva implementación de los criterios de sostenibilidad social se deben diferenciar tres grupos: 1) derechos fundamentales; 2) responsabilidad social corporativa; y, 3) compromiso social en el proyecto. Se definió un enfoque metodológico para cada uno de ellos. Con respecto a los derechos fundamentales, el objetivo es garantizar que cada procedimiento de adquisición garantice que las empresas de construcción involucradas en el proceso conozcan y cumplan con cada uno de estos criterios. El resultado se basa en la definición de una declaración de derechos fundamentales que los oferentes deben presentar en sus ofertas para ser admitidos para su evaluación. Los criterios de responsabilidad social corporativa buscan evaluar las características sociales corporativas de cada compañía que participa en el proceso de licitación, analizando toda la compañía en el país donde se licita el proyecto. El resultado es la definición de un indicador compuesto que, para garantizar la solidez de la metodología, consta de indicadores cuantitativos, confiables y verificables, y ponderaciones cuya definición se establece con el objeto de minimizar las debilidades sociales de cada país a lo largo del tiempo. Finalmente, el compromiso social en el proyecto pretende evaluar el compromiso social que las empresas de construcción involucradas en el proceso de adquisición pretenden lograr durante el desarrollo del proyecto. El resultado es la definición de un indicador compuesto en el que tanto la definición de cada indicador como su nivel de importancia (ponderaciones) pueden adaptarse a las características del proyecto. Finalmente, dichos resultados se engloban en una guía práctica en la que se presenta una metodología flexible y robusta que, siendo capaz de adaptarse a las condiciones sociales cambiantes de cada país, favorece la implementación de criterios sociales en la contratación pública. Esta guía especifica dónde incluir cada grupo de criterios sociales en el procedimiento de adquisición de obras de ingeniería civil, y el método para evaluarlos de un modo objetivo.

RESUM

La contractació pública ha sigut destacada com l'element clau per a impulsar les tres principals dimensions de la sostenibilitat (econòmica, ambiental i social) en la indústria de la construcció. No obstant, a pesar dels esforços duts a terme per les administracions públiques a nivell internacional, en l'actualitat, hi ha importants limitacions que estan obstaculitzant la implementació efectiva i eficient de la sostenibilitat social en la contractació d'obra pública. Les limitacions més importants són: la falta de coneixement sobre com implementar-la en el sector de la construcció; l'escassetat de definicions clares, consistents i pràctiques sobre què és la sostenibilitat social per a esta indústria; i, la necessitat de determinar els criteris socials a tindre en compte, així com el millor mètode per a avaluar-los i mesurar-los. Basant-se en açò, la literatura científica destaca la necessitat d'estudiar com la sostenibilitat social podria implementar-se de manera més efectiva en la indústria de la construcció a través de la contractació pública, i al·lega la necessitat de desenrotllar una metodologia que ajude a les administracions públiques en la implantació d'estos criteris, alhora que es garantix la seua avaluació objectiva.

A la vista d'estos antecedents, el present treball proposa dos preguntes d'investigació. D'una banda, esta investigació busca caracteritzar la situació actual respecte a la inclusió de la sostenibilitat social en la contractació d'obra pública a nivell internacional. Per a això, s'analitzen 451 licitacions procedents de deu països amb l'objecte d'estudiar l'ús d'estratègies de contractació i estratègies de licitació a nivell internacional, identificar els principals criteris de sostenibilitat social, estudiar com es definixen estos criteris segons l'etapa de la licitació i determinar les variables que influïxen en la implementació d'estos criteris en la contractació d'obra pública. D'altra banda, esta investigació analitza com hauria de millorar-se la integració dels criteris de sostenibilitat social en la contractació pública respecte a l'escenari actual. Per tant, s'establixen els indicadors que haurien d'utilitzar-se per a avaluar la sostenibilitat social en la contractació pública d'obres d'enginyeria civil; i es desenrotlla una metodologia que afavorisca la correcta implementació dels criteris a nivell internacional, especificant on haurien de ser inclosos segons l'estratègia de licitació.

Este estudi definix un abast específic per a cada pregunta d'investigació. Pel que fa a la caracterització de la sostenibilitat social en la contractació d'obra pública, es busca un abast internacional que cobrisca cada etapa del cicle de vida de la infraestructura. En el estudi s'analitzen licitacions relatives a projectes tant d'edificació com d'enginyeria civil. D'altra banda, a l'hora de desenrotllar la metodologia per a integrar els criteris socials en la contractació d'obra pública, l'abast es limita únicament a l'etapa de construcció de projectes d'enginyeria civil.

L'estudi de la caracterització de l'escenari actual va concloure que hi ha una falta de comprensió sobre com fer que els indicadors socials siguen quantificables; es necessiten majors esforços per a augmentar el nombre de categories socials en les estratègies de licitació; i, hi ha una forta dependència del context nacional en la inclusió de criteris socials en la contractació pública, la qual cosa destaca la necessitat de considerar aspectes dependents de la ubicació en el desenrotllament de metodologies per a avaluar la sostenibilitat social en la contractació pública. Basant-se en estos resultats, es va abordar el desenrotllament d'una metodologia holística per a incloure els criteris socials en la contractació pública d'obres d'enginyeria civil. Este treball va destacar que per a garantir una efectiva implementació dels criteris de sostenibilitat social, s'han de diferenciar tres grups: 1) drets fonamentals; 2) responsabilitat social corporativa; i, 3) compromís social en el projecte. Es va definir un enfocament metodològic per a cada un d'ells. Respecte als drets fonamentals, l'objectiu és garantir que cada procediment d'adquisició garantisca que les empreses de construcció involucrades en el procés coneguen i complisquen amb cada un d'estos criteris. El resultat es basa en la definició d'una declaració de drets fonamentals que els oferents han de presentar en les seues ofertes per a ser admesos per a la seua avaluació. Els criteris de responsabilitat social corporativa busquen avaluar les característiques socials corporatives de cada companyia que participa en el procés de licitació, analitzant tota la companyia en el país on es licita el projecte. El resultat és la definició d'un indicador compost que, per a garantir la solidesa de la metodologia, consta d'indicadors quantitatius, confiables i verificables, i ponderacions que s'establixen amb l'objecte de minimitzar les debilitats socials de cada país al llarg del temps. Finalment, el compromís social en el projecte pretén avaluar el compromís social que les empreses de construcció involucrades en el procés d'adquisició pretenen aconseguir durant el desenrotllament del projecte. El resultat és la definició d'un indicador compost en el que tant la definició de cada indicador com el seu nivell d'importància (ponderacions) poden adaptar-se a les característiques del projecte. Finalment, els resultats s'engloben en una guia pràctica en què es presenta una metodologia flexible i robusta que, sent capaç d'adaptar-se a les condicions socials canviants de cada país, afavorix la implementació de criteris socials en la contractació pública. Esta guia especifica on incloure cada grup de criteris socials en el procediment d'adquisició d'obres d'enginyeria civil, i el mètode per a avaluar-los d'una manera objectiva.

CHAPTER 1

INTRODUCTION

1.1. Background

Sustainability was described by WCED (1987, p. 27) as the desire to carry out activities to meet "the needs of the present without compromising the ability of future generations". The United Nations (2005) established that sustainability should be framed and understood, at least, within a three-dimensional framework: environmental, social and economic. This three-dimensional framework can also be identified as the three principles or the three pillars of sustainability, as well as the triple bottom line of sustainability (Sourani and Sohail 2011). Environmental sustainability refers to the long-term commitment to respect the natural environment (Illankoon et al. 2017). Social sustainability aims to secure people's social-cultural and spiritual needs in an equitable way, promoting human morality, relationships, and institutions (Petersen and Kadefors 2016). Finally, economic sustainability "seeks to maximize the flow of income that could be generated while at least maintaining the stock of assets that yield this income" (Illankoon et al. 2016, p. 2).

The construction industry is a crucial sector for the economic development of countries. This sector is strongly associated with regional and national economies (Burke and King 2015), and it is notably responsible for maintaining stable economic growth and employment and encouraging social progress (Hall and Purchase 2006). However, the construction industry is also one of the largest users of resources, and it produces significant impacts on the living and working environment (Chang et al. 2015). For this reason, numerous authors such as Ugwu and Haupt (2007), Illankoon et al. (2017), etc. have claimed the importance of enhancing sustainability in the construction industry.

Sustainability in the construction industry should be about achieving a win-win outcome for contributing to the improvement of the environment and the advancement of the society, while construction companies gain competitive advantages and economic benefits (Shen et al. 2010). Nevertheless, construction firms are mainly focused on cost, schedule, and quality to maintain competitiveness. Although they would need to respond to the sustainability challenges and become socially and environmentally responsible corporations, limited attention is being addressed to empower sustainability practices in construction firms, hindering the transformation of the industry toward sustainability (Lu and Zhang 2016; Afzal et al. 2017). Based on this, numerous authors have claimed the role of public procurement to drive the integration of sustainability initiatives into construction practices (Adetunji et al. 2003; Sierra et al. 2018a). Public procurement in the construction industry represents large volumes of public spending each year around the world (Kahlenborn et al. 2011); thus, public procurement has the potential to influence the market in terms of sustainability, encouraging public procurers to combine economic, environmental and social aspects in their purchasing activities (Walker et al. 2012).

1.2. Problem statement

To encourage sustainability in public procurement, environmental and social policies have been implemented in many countries around the world (Andrecka 2017). Procurers are fostered to include both social and environmental criteria in tendering procedures in order to guarantee a sustainable performance during the infrastructure life cycle, ensuring respect for social needs and developing sustainable practices that minimize the environmental impact, optimize the natural resources, encourage the use of recycled materials and reduce the generation of waste (Testa et al. 2016a).

However, important barriers, such as the lack of knowledge about how to consider sustainability criteria in procurement procedures (Carter and Fortune 2007; Testa et al. 2016b), and the lack of objective methods to assess (Ruparathna and Hewage 2015a) and monitor these sustainability criteria (Wright 2015), are hindering the effective and efficient implementation of sustainability in the construction public procurement (Walker and Brammer 2009; Sourani and Sohail 2011; Testa et al. 2016a). These facts are aggravated if the analysis is focused on social sustainability (Burke and King 2015; Pan 2015; Ruparathna and Hewage 2015a; Sierra et al. 2017a).

Social sustainability has been characterized as being a key element in the construction industry, boosting the interaction between stakeholders to address the needs of current and future populations and communities (Valdes-Vasquez and Klotz 2013). However, one of the significant present drawbacks of construction procurement practices is to misinterpret the triple bottom line of sustainability, since the social issues are underestimated and overshadowed by the economic and the environmental dimensions (Loosemore 2016). Additionally, there is currently no understanding of what social sustainability means for the construction industry and how it can be engaged more effectively (Abdel-Raheem and Ramsbottom 2016). Thus, this scenario makes the social issues challenging to consider in sustainable construction and, most importantly, to apply them and measure them quantitatively in public construction procurement.

1.3. Knowledge gap

Walker et al. (2012) and Roman (2017) argued that scholars need to do more in terms of analyzing and informing management and professional communities about areas such as public procurement, sustainability, and factors encouraging sustainable practices. But most studies that have examined sustainability in construction projects have been mainly focused on the environmental aspects rather than the social and economic ones (Whang and Kim 2015; Abdel-Raheem and Ramsbottom 2016).

The literature associated with the study of the social dimension in public construction procurement is scarce (Akenroye, 2013; Ruparathna and Hewage, 2015; Loosemore, 2016). Most of the research, which has assessed the inclusion of sustainability criteria in tendering documents of the construction industry, has been centered mainly on environmental criteria; some of these studies are: Faith-Ell et al. (2006), Xia et al. (2014a), Testa et al. (2016b), and Fuentes-Bargues et al. (2017). However, the research that referred to social criteria is very limited, and only authors such as Ruparathna and Hewage (2015) and Hueskes et al. (2017) have analyzed the inclusion of social sustainability criteria in tendering documents of the construction industry. Moreover, these have mainly focused on specific sectors of specific countries (Brammer and Walker 2011); and, even though Adham and Siwar (2012) claimed that the barriers that are hindering the effective implementation of the social sustainability in public procurement depends on socio-economic, demographic or cultural aspects, few contributions in the literature review are in-depth studies that compare the inclusion of sustainability criteria in different countries (Petersen and Kadefors 2016).

Regarding the existing theoretical framework to assess sustainability, Eizenberg and Jabareen (2017) claimed that there is a lack of theoretical and empirical studies regarding social sustainability, and Xiahou et al. (2018) stated that a systematic framework for evaluating the social performance of construction projects is absent in the industry. Additionally, because of the relatively limited literature on social sustainability in the construction industry, there is generally a lack of agreement as to which indicators should be used; therefore, social sustainability is the most challenging sustainability facet to assess (Popovic et al. 2018).

These facts entail the need for increasing the scientific literature that examines, analyzes, and facilitates the effective implementation of social sustainability in construction procurement. In this way, an increase of consideration and practice of social sustainability at the different stages of construction projects may be boosted (Abdel-Raheem and Ramsbottom 2016). Consequently, two knowledge gaps have been identified. On the one hand, there is currently a lack of knowledge about: how social sustainability is considered in the construction industry, the significance of the role played by procurers in institutionalizing sustainable practices in social procurement within the construction industry, and how social procurement policies are implemented and embedded in daily procurement practices among procurement professionals worldwide (McCrudden 2004; Walker and Brammer 2012). On the other hand, nowadays, important limitations exist to integrate social issues in each construction contract, mainly due to the fact that: there is a lack of coherence, clear and practical definitions about what is social sustainability in the construction industry; what factors should be used to define it; and how social sustainability in this industry should be measured and assessed (Barraket and Weissman 2009; Landorf 2011; Sutherland et al. 2015; Kadam and Devalkar 2016; Loosemore 2016; Sierra et al. 2018b). Based on these two knowledge gaps, the need for developing a methodology to assist agencies in the effective inclusion and objective assessment of social criteria in public-works procurement is highlighted. In order to satisfy this need, the research questions and research goals of this dissertation are established.

1.4. Research questions and goals

To find an answer regarding the identified knowledge gaps, two Research Questions (RQ) have been defined:

- RQ1: What is the current scenario of inclusion of social sustainability within public-works procurement at the international level?
- RQ2: How can the integration of social sustainability criteria in public-works procurement be improved to overcome the current scenario?

To achieve these research questions, this research proposes the following specific Objectives (O):

- O1: Analyzing how public-works procurement procedures and project delivery methods are considered at the international level.
- O2: Identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined depending on the stage of the tendering procedure where these are considered.

- O3: Assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures.

- O4: Defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures.

- O5: Determining a methodology to include the social sustainability criteria in public-works procurement procedures.

- O6: Identifying the stage of the public-works procurement procedures to include the social sustainability criteria.

The specific objectives O1, O2, and O3 seek to respond to Research Question 1 (RQ1); whereas O4, O5, and O6 seek to answer Research Question 2 (RQ2).

1.5. Research scope

This study has established a specific scope for each research question. To characterize the inclusion of social sustainability criteria in public-works procurement (RQ1), the scope was defined considering an international approach, and every stage of the infrastructure life cycle of building and civil engineering projects was covered. Later, the methodology proposed to integrate the social criteria in public-works procurement (RQ2) focused only on the construction stage of civil engineering projects. The reason was based on the fact that civil engineering projects, compared to building projects, are usually critical infrastructure projects that cause significant disturbances to the existing communities and environment; furthermore, the activities of the construction stage have a considerable influence on the social dimension of the project. The methodology was calibrated using European data. However, this methodology aims to be implemented at the international level.

1.6. Research method

This research has been structured in four phases. First, a literature review was performed to define the state-of-the-art referred to social sustainability in the construction industry and public-works procurement. Phase two was based on collecting 451 tendering documents from 10 English-speaking and Spanish-speaking countries. These documents were analyzed, characterizing the inclusion of social criteria in public-works procurement at the international level. Taking as a basis the results of this characterization, in the third phase, a methodology was defined to include social criteria in public procurement of civil engineering construction projects. Three groups of social criteria were identified (human rights, corporate social responsibility and social commitment in the project), and a specific methodology was established to assess them in public-works procurement. Finally, in phase four, a practical guide was developed to assist procurers in implementing social criteria in public procurement of civil engineering construction projects. Each of these phases is discussed in greater detail below:

1. Literature review

The first study carried out in the literature review focused on analyzing the state of the art concerning the relationship between sustainability and public procurement. Based on the results of this study, it was decided to focus this dissertation only on the social dimension of the sustainability and trying to concentrate efforts on analyzing how social criteria should be considered in public-works procurement. Thus, an exhaustive literature review was performed to establish the social criteria that should be included in the public procurement procedures of the construction industry. Additionally, the social sustainability assessment methods were characterized to define the state of the art in this field. Based on the results of these analyses, the point of departure of this research was established.

2. Analyzing tendering documents at the international level

To analyze the inclusion of social criteria in public-works procurement, the first step was based on collecting tendering documents at the international level to characterize the current performance in this regard. Through a content analysis, these documents were analyzed, and statistical techniques were performed to describe the level of inclusion of social criteria in public-works procurement and how and where these criteria are implemented in the procurement procedures. An additional analysis was performed to identify the variables that influence the inclusion of social criteria in public-works procurement the most.

3. Developing the methodology to include social criteria in public procurement of civil engineering construction projects

To encourage the effective inclusion of social criteria in public-works procurement, the development of a methodology was required to overcome the existing drawbacks identified in the previous phase. The aim of the methodology was analyzing the social performance of the construction companies involved in the procurement procedure. The scope of this work focused on the construction stage of civil engineering projects. Thus, the first step was based on determining the social criteria that should be considered in public procurement of civil engineering construction projects. These criteria were classified into three groups: human rights, corporate social responsibility, and social commitment in the project; and a methodology to assess them in public-works procurement was specified.

4. Practical guide

Once the methodology to include the three groups of social criteria was defined, a practical guide was developed to assist agencies in assessing the social performance of the construction companies in the procurement procedures of civil engineering construction project. This practical guide was based on defining the social indicators that should be included in the procurement procedures and establishing how these should be implemented and assessed in public-works procurement to guarantee their objective assessment.

1.7. Dissertation structure

This dissertation is structured in seven chapters. Chapter 1 provides a review of relevant literature to contextualize the problem statement, identify the knowledge gaps, define the research questions, and establish the research scope. Chapter 2 presents the literature review that identifies the knowledge gaps and motivates this research. Chapter 3 establishes the research method of this dissertation, discerning between the process to analyze the social criteria in the tendering documents, and the theoretical framework to define the methodology to include the social criteria in public procurement procedures. Chapter 4 examines the inclusion of social criteria in 451 tendering documents from ten countries. Chapter 5 presents three methodologies to include the three groups of social criteria in the procurement procedures of civil engineering construction projects at the international level. Chapter 6 gathers the practical guide to assist procurers in the inclusion of the social criteria in public procurement. Lastly, Chapter 7 presents the achievement of the objectives, summarizes the findings of this research, establishes the limitations, discusses the contributions, and proposes future research.

CHAPTER 2

LITERATURE REVIEW

This chapter tackles the literature review, analyzing the influence that two main aspects of the public-works contracting process (the procurement procedure and the project delivery) have on the sustainability of a construction project. Subsequently, social criteria that should be considered in the construction industry are defined. Furthermore, a review of the existing theoretical frameworks to assess the social performance at a project, process, or company level is presented. The literature review of the theoretical frameworks highlights the need to determine composite indicators to analyze and compare the social performance of projects, processes, and companies. Thus, the method that must be undertaken to define composite indicators is explicated. Finally, the conclusions of this chapter are gathered in the last section, where the point of departure of this research is established.

2.1. Public procurement and project delivery methods

Public procurement represents a large volume of public spending each year, constituting over 10% of the gross domestic product in developed countries (Zhu et al. 2013). Thus, numerous studies have highlighted the main role of public procurement to influence the market in terms of sustainability (Mont and Leire 2000). During the last decade, a high number of countries worldwide have implemented policies to encourage the development of social principles in public procurement (Iles and Ryall 2016). Signs of this endeavor are the National Actions Plans on Socially Responsible Public Procurement that seek to promote acceptable working conditions, social justice and human rights (Cravero 2017); in 2010, these were already implemented in countries such as Austria, the Czech Republic, Belgium, France, Germany, Italy, Slovakia, Spain, Sweden, Norway, the USA and Canada (Kahlenborn et al. 2011; Cravero 2017). However, in the construction industry, there is still much that needs to be done in terms of social practices. This is one of the industries most lagging and work needs to be done to address increased social challenges (Whyte and Sexton 2011; Loosemore 2015; Roman 2017).

Social requirements in construction procurement potentially affect processes and management systems and have important implications for both procuring organizations and suppliers (Sutherland et al. 2015). Thus, with the thrust of sustainability in public construction procurement, new challenges have emerged; and numerous authors highlight that, in addition to including social criteria in procurement procedures, moving from traditional procurement procedures and delivery methods becomes a key factor for the sustainability of the construction industry to ensure the achievement of sustainable outcomes (Ruparathna and Hewage 2015b; Xia et al. 2015; Naoum and Egbu 2016).

Within public-works procurement, the two basic procurement procedures are the low bid and the best value (Molenaar and Johnson 2003). On the one hand, in the low bid procurement procedure, construction contracts are awarded strictly on a low-bid basis; thus, open competition is promoted with the incentive to concentrate on cutting bid prices to the maximum extent possible (Ballesteros-Pérez et al. 2016; NCHRP 2006). On the other hand, in the best value procurement procedure, price and other key factors are considered in the evaluation and selection process to minimize impacts and boost the long-term performance and value of construction (NCHRP 2006).

In general, the low bid is used when aiming to maximize savings, whereas the best value is used more for complex projects (Ballesteros-Pérez et al. 2016). However, historically, contracting authorities of construction services have selected the low bid rather than the best value regardless of the complexity of the project (Korytárová et al. 2015). Currently, with the implementation of sustainability in public construction procurement, the formulation of environmental and social criteria in the tendering procedure is imperative to reflect clients' needs and project objectives (Palmujoki et al. 2010). Thus, the best-value procurement procedure gives latitude to public bodies to consider social policy objectives in their procurement activities (Brammer and Walker 2011).

Regarding project delivery methods, different approaches have been developed in recent years to satisfy specific requirements related to risk transfer, funding, and ownership, or to encourage integration and collaboration among diverse organizations involved in delivering construction projects (Broesterhuizen et al. 2014; Koolwijk et al. 2018). Several researchers have suggested that sustainable construction projects require a higher level of stakeholder engagement and collaboration to generate more intensive cooperative behavior. In this regard, to achieve the desired sustainable construction, Ball and Fortune (2000) claimed the need to encourage a cultural change toward the procurement process based on partnering; Berry, Shaun and Mccarthy (2011), in their guide to sustainable procurement in construction, highlighted the importance of engaging contractors and consultants early in the project to increase the overall sustainable performance of the project; Broesterhuizen et al. (2014) and Naoum and Egbu (2016) stated that the choice for a type of delivery system where contracting companies have freedom and can influence the design of the project is crucial to make a project as sustainable as possible; and Wu et al. (2017) analyzed the influence of cooperative relationship in sustainable construction project, concluding that the effort level and expected benefits of a sustainable construction project can be improved by enhancing the collaborative approach to the project.

On the other hand, numerous authors have pointed out team integration as a key factor for project success. The concept of team integration is based on the involvement of all the participants in the project at the correct time, and it is defined by aspects such as the timing of the involvement of project participants, early collaboration by the project participants, or the timing of communication (Drexler and Larson 2000; Mollaoglu-Korkmaz et al. 2013). Molenaar et al. (2009, p. 6) claimed that "the degree to which schedule, cost, and quality goals are met are heavily influenced by the level of team integration and the selected delivery method" and emphasized that to achieve high-level sustainable objectives, early team integration is necessary; Korkmaz et al. (2011) analyzed sustainable high-performance building project deliveries and concluded that timing of the contractors' involvement in projects significantly influences the performance outcomes and the project success; Naoum and Egbu (2016) highlighted the importance of team integration in alternative methods of procurement to overcome the existing problems that are facing the building process; and Manata et al. (2018) assessed the key communication behaviors in integrated project delivery teams and highlighted the importance of effective communication to facilitate integrative delivery processes and mitigate losses. Based on these aspects, different types of delivery methods can be identified: 1) design-bid-build (DBB); 2) construction manager at risk (CMR) and construction manager as general contractor (CM/GC); 3) design-build (DB); 4) integrated project delivery (IPD); and 5) public-private partnerships and concessions.

- <u>Design-Bid-Build (DBB):</u>

This delivery system involves the owner, the designer, and the contractor in two separate contracts (owner-designer and owner-contractor) (AIA/AGC 2011; Mollaoglu-Korkmaz et al. 2013). The owner remains responsible for the financing of all functions and activities throughout the process (AIA/AGC 2011). The contractor requires design completion before procuring construction (Molenaar and Gransberg 2001; Pellicer et al. 2016a).

- Construction Management at Risk (CMR) and Construction Manager as General Contractor (CM/GC):

Construction Management at Risk (CMR) and Construction Manager as General Contractor (CM/GC) are similar delivery systems that involve the owner, the designer, and the constructor in two separate contracts (AIA/AGC 2011). On the one hand, the owner contracts with a designer to provide the project design; on the other hand, the owner contracts with a constructor. The constructor typically has two contracts. The first is a preconstruction contract that may be retained about the same time as the designer to act as an advisor in the preconstruction phase; the second contract is for the construction of the project (NCHRP 2014; Francom et al. 2016). Many agencies use the terms CMR and CM/GC interchangeably; however, some authors differentiate between CMR and CM/GC depending on the flexibility to allocate the risk (ACRP 2009; NCHRP 2014). In line with this, CMR and CM/GC connotes that the construction manager stipulates a guaranteed maximum price above which the owner is not liable for payment, and the construction manager performs construction management services; however, in CMR, the construction manager takes on the risk of building the entire project in accordance with the plans and specifications for a fee (AIA/AGC 2011; NCHRP 2014; Pellicer et al. 2016a), and CM/GC does not restrict the primary contractor's performance of work tasks, allows to the construction manager to self-perform a certain percentage of the work, and gives more facility to relocate the risk among owner, construction, and designer (NCHRP 2014). In both delivery systems, the owner is responsible for all the financing aspects (Mollaoglu-Korkmaz et al. 2013).

- Design-Build (DB):

This project delivery method encompasses both project design and construction under one contract (AIA/AGC 2011); thus, one firm, or team, is contracted for an entire project (Molenaar and Gransberg 2001; Pellicer et al. 2016a). Design-build contracts do not involve the use of private financing (AIA/AGC 2011).

- Integrated Project Delivery (IPD):

IPD is based on "a collaborative arrangement of the major project stakeholders early in the process, implemented in an environment of 'best-for-project thinking' and shared risk and reward" (AIA/AGC 2011, p.7). In this delivery system, all key project stakeholders (including at a minimum the owner, the designer and the contractor) sign one multiparty contract before the design even starts (when 0% of the design is complete) (Asmar et al. 2013; Mollaoglu-Korkmaz et al. 2013; Pellicer et al. 2016a).

- Public-Private Partnerships and Concessions:

These delivery systems are characterized by the relationship between the private sector and public bodies (Cheung et al. 2010). This relationship is based on introducing private sector resources and/or expertise to provide public services or public assets (Liu et al. 2017). Thus, the private sector can participate in funding (Cheung et al. 2010), and it has a key role in the maintenance and operation of the infrastructure (Altamirano 2010). These delivery systems are characterized by the use of the competitive negotiation process, and the project proposal can come from both the private sector or the public bodies (Altamirano 2010).

Thus, taking into account these definitions and following to Naoum and Egbu (2016), who split the delivery systems into three groups (traditional method, fully integrated, and partially integrated), and Pellicer et al. (2016a), who differentiated in their research between integrated and non-integrated projects, in this research two groups of delivery systems are defined: 1) traditional, and 2) integrated.

- Traditional delivery system:

This group gathers the design-bid-build (DBB). It is featured by a scarce team integration because design and construction are undertaken by different entities with separate contracts (Pellicer et al. 2016a).

- Integrated delivery systems:

This group includes Design-Build (DB), Integrated Project Delivery (IPD), Construction Manager at Risk (CMR), Construction Manager-as-General Contrator (CM/GC), Public-Private Partnerships (PPP), and other concessionaire alternatives. In these delivery systems, the client generally provides initial planning and design criteria. The contractor team is entirely or partially responsible for the design, construction, operation, and maintenance of the facility (Mollaoglu-Korkmaz et al. 2013; Pellicer et al. 2016a).

2.2. Social sustainability criteria

Generally in the construction industry, the main benefits associated with the implementation of social sustainability are based on improving the quality of human life, increasing transparency, implementing skills training, seeking intergenerational equity, fair distribution of construction social cost and capacity enhancement of the disadvantaged (UNEP 2009; Pocock et al. 2016; Popovic et al. 2018). These social benefits can be intangible to developers; however, community experts highlight that social benefits are as significant as the economic and environmental ones (Valdes-Vasquez and Klotz 2013). Additionally, Sierra et al. (2018a) emphasized that the social contribution of an infrastructure project depends strongly on its interaction with the contextual conditions.

The term social sustainability has been in continuous evolution (Valdes-Vasquez and Klotz 2013). Andrecka (2017) claimed that the concepts of social sustainability and corporate social responsibility are connected in the context of public procurement due to being based on the same topics: labor issues, human rights protections and ethics issues. Popovic et al. (2018) stated that aspects related to health, safety, human rights, child labor, labor issues, community initiatives, and employment benefits are generally accepted within social sustainability. UNEP (2009) established a classification of social criteria based on stakeholders: (1) workers; (2) local community; (3) society; (4) consumers; (5) value chain actors. However, regarding the construction industry, social sustainability has various interpretations depending on the phase of the project life cycle and the stakeholder's perspective (Valdes-Vasquez and Klotz 2013). For each perspective, four classifications of social criteria can be found in the literature:

1) To estimate the impact associated with the development of construction projects in the planning and design phase (Yigitcanlar and Dur 2010; Valdes-Vasquez and Klotz 2013; Khalili-Damghani and Tavana 2014; Beiler and Treat 2015; Pardo-Bosch and Aguado 2016; Sierra et al. 2016; Sierra et al. 2017a).

2) To assess the companies' performance through corporate social responsibility practices and supplier evaluation procedures (GRI 2011; Sarkis et al. 2012; Rahdari and Rostamy 2015; Winter and Lasch 2016; Popovic et al. 2018).

3) To analyze the social life cycle of products and materials along the project life (UNEP 2009; Hosseinijou et al. 2014; Hossain et al. 2018).

4) To take part in the decision-making process of designing, constructing, and operating construction projects (Ugwu and Haupt 2007; Sourani 2008; CEEQUAL 2010; FHWA 2012; Harmer et al. 2012; Oltean-Dumbrava et al. 2014; Dong and Ng 2015a; ISI 2015; Sierra et al. 2017a).

Some examples of these classifications are Sowerby et al. (2014), who defined nine groups of social criteria to assess transport infrastructures (quality of life, working conditions, health, safety, education, community, culture, and justice) and Sierra et al. (2016), who established four macro-groups of social criteria to assess public infrastructure initiatives (internal human resources, external local population, social participation of stakeholders, and social activities at a regional or national level).

However, authors such as Landorf (2011) and Sierra et al. (2018b), claimed that the definition of the criteria that should be considered to assess social sustainability in construction projects had not been clearly established, and in many cases only a limited number of social aspects is taken into consideration (Ekener et al. 2018). To overcome this fact, a classification of social criteria to be considered in construction tendering documents was required. For further deepening into the social sustainability of the construction industry, the main groups of social criteria that should be considered in public procurement were established. A pool of social criteria were gathered from the scientific literature, guides and reports; and, using the affinity diagram technique (Carnevalli and Miguel 2008), a classification was established focused on the following categories: cultural heritage; employment; health and safety; local development; professional ethics; public participation; training; and users' impact.

- Cultural heritage:

Cultural heritage gathers those criteria focused on actions that favor the protection of architectural, archeological and paleontological resources as well as tribal cultural properties, historical, artistic and civil heritage in the area impacted by the projects (Arce and Gullón 2000; ISI 2015; UNESCO 2017). These criteria aim to enforce the feeling of respect towards the communities and protect the non-renewable cultural resources, which are essential elements for the current and future human development (CEEQUAL 2010; Abdel-Raheem and Ramsbottom 2016). CEEQUAL (2010) and Whang and Kim (2015) highlighted that the development of cultural heritage appraisal and management plan could be performed to relate the project with existing local cultural values and maintain the heritage value of the existing facility. Moreover, the collaboration with historic or cultural preservationists can be recommended to ensure that works do not damage the quality of the existing historical and/or cultural resources, as well as to guarantee the management and inspection of the mitigation works (CEEQUAL 2010; ISI 2015).

- Employment:

Employment forms a group of criteria since in the construction industry the traditional forms of employment, which characterize construction, such as subcontracting and increasing workforce casualization and self-employment, can contribute to social problems (Loosemore 2015). However, through social procurement, employment requirements may have important implications for both procuring organizations and suppliers (Petersen and Kadefors 2016). McCrudden (2004) stated that public procurement might be the tool to address unemployment through the creation and maintenance of employment as well as increasing the labor participation of the long-term unemployed and disadvantaged groups. Authors such as GRI (2011), Shiau and Chuen-Yu (2016) and Pellicer et al. (2016b) emphasized the enhancement of employment stability to improve sustainable development, to show how the organization structures its human resources to implement its overall strategy, and the level of satisfaction among employees. Additionally, the European Commission (2010) noted the important role of Small and Medium Enterprises (SMEs) in the economy; and UNEP (2009) and CEEQUAL (2010) mentioned the increase of relationship with SMEs through industry participation plans to have a positive impact on the community from an economic perspective.

- <u>Health and safety:</u>

The construction industry is characterized by competitive processes with high participation of subcontractors and extended supply chains that along with ever-changing work environment and harsh working conditions, make it dangerous (Oswald et al. 2018). Having a health and safety committee or expert workers in health and safety during the project can facilitate a positive health and safety culture (Popovic et al. 2018). Additionally, the development of protocols or workplace health and safety management plans is recommended to assess the risks associated with the construction works and the use of new materials, technologies, and/or methodologies (UNEP 2009; ISI 2015). Certificates to demonstrate the occupational health and safety performance of companies, offering healthcare services or voluntary health promotion services and programs for preventing harm to workers, and providing parental leave can improve employee satisfaction, maintain operational process and increase the company's image while promoting and protecting human health through a healthy and safe work environment (UNEP 2009; Rahdari and Rostamy 2015; Abdel-Raheem and Ramsbottom 2016; GRI 2018; Popovic et al. 2018).

- <u>Local development:</u>

Encouraging the participation and preference of local companies in the construction projects can have direct and indirect benefits for the community (CEEQUAL 2010). In addition to the creation of direct local jobs and the payment of wages and taxes, GRI (2011) and Abdel-Raheem and Ramsbottom (2016) emphasized that by enhancing local business, an additional investment can be attracted to the local economy. McCrudden (2004) remarked that the inclusion of local criteria in public procurement could protect local contractors and workers from foreign companies; and CEEQUAL (2010) and UNEP (2009) stated that the employment of local people or the use of local products and services could reduce the distances traveled to and from work and decrease the inconveniences over local communities. Finally, several authors referred to the crucial role of public procurement to boost social value, based on: encouraging the contractors and subcontractors to commit to act in a socially responsible way from; enhancing skills and knowledge amongst professional community; or training and raising community awareness in relation to the sustainable development (GRI 2011; Landorf 2011; ISI 2015; Abdel-Raheem and Ramsbottom 2016; Petersen and Kadefors 2016).

- Professional ethics:

The construction industry needs to change attitudes and practice towards workers and communities, through the creation and maintenance of ethical values and responsibilities over society (Abdel-Raheem and Ramsbottom 2016). Public procurement may be the tool to enforce respecting human rights in the construction industry (McCrudden 2004). GRI (2016a) defined discrimination on the grounds of race, color, sex, religion, political opinion, national extraction, and social origin; and also occurring based on factors such as age, disability, migrant status, HIV and AIDS, gender, sexual orientation, genetic predisposition, and lifestyles, among others. Thus, public procurement may: (1) boost non-discriminatory practices including racial and sexual harassment as well as discrimination against the disabled; (2) enhance diversity and equal opportunities with respect to gender, age, disabilities or cultural heritages; (3) work towards fair wages and fair income distributions; (4) ensure human rights implementations and integration, represented by curtailing practices such as child labor, forced labor, freedom of association and collective bargaining; and, (5) minimize corruption which has been noted by several researchers as one of the main problems in the construction industry (Kenny 2007; UNEP 2009; GRI 2011; Akenroye 2013; Popovic et al. 2018).

- Public participation:

According to GRI (2016b), local communities are the groups of persons living and/or working in any areas that are economically, socially or environmentally impacted (positively or negatively) by a specific project. The development of a construction project can have significant economic, social, cultural, and/or environmental impacts on local communities. Thus, boosting the public participation in the project through communication between decision-makers and local communities should be established to avoid project failures, to create values of public opinions, and to understand their expectations and needs (Abdel-Raheem and Ramsbottom 2016; GRI 2016b; Li et al. 2018). The project team should work closely with community stakeholders to identify and address issues and concerns (ISI 2015). Thus, collecting, evaluating, and incorporating community input into each phase of the project life is required based on the development of community relations programs which ensures the effective implementation of the project (CEEQUAL 2010; ISI 2015; Sierra et al. 2016).

- Training:

Training is essential to increase the skills, knowledge, and capacity of workers to enhance their growth and development (FHWA 2012; ISI 2015). Popovic et al. (2018) stated that aspects related to career development plans and job analysis could affect significantly employee productivity, performance, and professional satisfaction. However, according to Gervais (2003), training and awareness are interrelated; thus, not only improving the technical skills of workers is important, but raising awareness about social issues plays a vital role in building internal awareness (GRI 2011). Training and raising awareness in relation to the labor aspects and human rights may provide the necessary capacity to prevent incidents of corruption, improving labor aspects and sensitizing about each dimension of sustainable performance as well as addressing human rights in the course of their regular work (UNEP 2009; GRI 2011; Akenroye 2013; GRI 2016c; Popovic et al. 2018). Finally, CIRIA (2001) highlighted the importance of training to improve the sustainability of construction by creating more innovative technical solutions. This was emphasized by Popovic et al. (2018), the United Nations (2008a), and DVFA (2009), who claimed that encouraging companies to seek more innovative technical solutions is key to boost sustainability in business.

- Users' impact:

Adverse effects on users and neighbors can cause severe social costs and, thus, they can be one of the most important aspects to deal with a construction project (CEEQUAL 2010). Neighbors are those persons or groups of persons living and/or working in any areas that are impacted by the project. Thus, possible disturbances on human communities need to be addressed (Ugwu et al. 2006). Trucks, equipment and transport of goods, materials, and staff associated with a construction project, work hours, etc. can cause a nuisance to the neighborhood (ISI 2015; Abdel-Raheem and Ramsbottom 2016). Additionally, construction projects can affect existing services. Consequently, actions may be required to allow the communications with neighbors, as well as to ensure the correct coordination with the involved stakeholders (CEEQUAL 2010). Finally, construction projects can affect access and mobility in existing infrastructures. The development of traffic management plans are recommended to minimize disruptions (ISI 2015).

According to the definition of each group of social criteria and taking into account the social criteria gathered in the literature review, 24 social subcategories are established, covering all the different concepts that are encompassed by each group of social criteria. These subcategories represent the social criteria that should be considered to assess social sustainability in the construction industry (see Table 2-1). These subcategories are widely defined in chapter 5.

Table 2-1: Social categories and subcategories in the construction industry

Categories	Subcategories	References
Cultural Heritage	Cultural heritage appraisal and management plan	CEEQUAL (2010); Muench et al. (2011);ISI (2015); Whang and Kim (2015); Abdel-Raheem and Ramsbottom (2016)
	Collaboration with historical or cultural preservationists	CEEQUAL (2010); ISI (2015)
Employment	Employment creation	McCrudden (2004); GRI (2011)
	Job stability	GRI (2011); Pellicer et al. (2016b); Shiau and Chuen-Yu (2016)
	Industry participation plan	UNEP (2009); CEEQUAL (2010); European Commission (2010)
Health and Safety	Work health and safety management officer	UNEP (2009); Popovic et al. (2018)
	Occupational health and safety performance	UNEP (2009); Rahdari and Rostamy (2015); Abdel-Raheem and Ramsbottom (2016); Popovic et al. (2018)
	Workplace health and safety management plan	GRI (2011); ISI (2015)
	Social benefits and social security	UNEP (2009); Popovic et al. (2018); GRI (2018)
Local Development	Local preference	CEEQUAL (2010)
	Local employment through the use of local products and services	UNEP (2009); CEEQUAL (2010)
	Social value	Landorf (2011); GRI (2011); ISI (2015); Petersen and Kadefors (2016); Abdel-Raheem and Ramsbottom (2016)
Professional Ethics	Non-discrimination and equal opportunities	UNEP (2009); GRI (2016a);Popovic et al. (2018)
	Fair wages and fair income distributions	UNEP (2009); Popovic et al. (2018)
	Child labor	UNEP (2009); Popovic et al. (2018)
	Forced labor	UNEP (2009); Popovic et al. (2018)
	Freedom of association and collective bargaining	UNEP (2009); Popovic et al. (2018)
	Corruption	Kenny (2007); UNEP (2009); Akenroye (2013); Popovic et al. (2018)
	Respect of indigenous rights	UNEP (2009)
	Respect of intellectual property rights	UNEP (2009)
Public Participation	Community relations program	CEEQUAL (2010); ISI (2015); Abdel-Raheem and Ramsbottom (2016); GRI (2016b); Sierra et al. (2016); Li et al. (2018)
Training	Technical training	FHWA (2012); ISI (2015); Popovic et al. (2018)
	Sustainability training	CIRIA (2001); United Nations (2008a); DVFA (2009); GRI (2011); Akenroye (2013); GRI (2016c); Popovic et al. (2018)
Users' Impact	Effects on neighbors	CEEQUAL (2010); ISI (2015); Abdel-Raheem and Ramsbottom (2016)

SOURCE: Own elaboration

2.3. Social sustainability assessment methods

To assess social sustainability in the construction industry, three main theoretical frameworks can be used: social life cycle assessment, sustainability certifications systems, and corporate sustainability system (Rahdari and Rostamy 2015). These theoretical frameworks can be mainly characterized by their unit of analysis. The unit of analysis is the unit of reference that is used to define the product properties in the social assessment. This can be a process or a product, a project, or a company. In this regard, the theoretical frameworks based on social life cycle assessment tend to use, as the unit of analysis, products and the processes to produce the products. In this type of theoretical framework, only a scarce number of studies have used the project as the unit of analysis. However, in the theoretical frameworks based on sustainability certifications systems, the unit of analysis is the project; and in corporate sustainability system theoretical frameworks, the unit of analysis tipically is the company. These theoretical frameworks are described below.

- Social life cycle assessment:

According to the guide published by UNEP (2009, p.100), "social life cycle assessment is a social impact assessment technique that aims to assess the social aspects of products and their positive and negative impacts along their life cycle". UNEP (2009) establishes the basis to perform social life cycle assessments and defines the technique to assess the social and socio-economic aspects of products or processes and their impacts along their life cycle. The social assessment models that have been developed, referred to the construction industry, with this theoretical framework focus on analyzing products, as well as the processes to produce the products (Hosseinijou et al. 2014; Navarro et al. 2018) or, to a lesser extent, projects (Dong and Ng 2015b).

UNEP (2009) defines a four-phase structure to undertake social life cycle assessment. This four-phase structure is based on determining the goal and the scope of the evaluation, performing an inventory analysis, developing the impact assessment, and interpreting the results.

- **The goal and scope definition**, where issues such as the study goal, the intended audience, the system boundary, and the unit of analysis are defined.

- **The inventory analysis** lies in collecting data regarding the product's life cycle. Generic or case-specific data may be used, depending on the goal of the study (Parent et al. 2010). In this phase, the three different types of data that can be used are the activity variable, the data related to the social conditions, and the data necessary to compare the local situation to an international set of thresholds. The development of social indicators depends on the sector that is monitored and the national context (Hosseinijou et al. 2014).

- **The impact assessment.** The Guidelines propose two types of impact assessment methods depending on the impact categories. Impact categories are described by Benoit-Norris et al. (2013, p.7) as "logical groupings of social life cycle assessment results, related to social issues of interest to stakeholders and decision makers". Based on this, two types of impact categories can be differentiated: Type 1 and Type 2 impact categories. In the impact assessment method for Type 1, impact categories aggregate the results for the subcategories within a theme; whereas, in Type 2, impact categories aggregate the results for the subcategories that have a causal relationship. Parent et al. (2010) explained this difference: Type 1 impact categories are assessed using aggregation formulas, where semiquantitative and quantitative indicators can be accumulated using scoring and weighting systems; and Type 2 impact categories uses impact pathways as characterization models, passing through midpoint indicators and, potentially, endpoints.

- **The interpretation.** In this last phase, the aim is to interpret the results of the impact assessment and identify hotspots (Benoît et al. 2010).

In the construction industry, research so far analyzes life cycle social impacts of concrete and steel as building materials (Hosseinijou et al. 2014), building construction projects in Hong Kong (Dong and Ng 2015b), different timber composite structure for Malaysian low income housing (Balasbaneh et al. 2018), social performance associated with different construction materials applied to a reinforced concrete bridge deck (Navarro et al. 2018), social performance of construction materials using a case study on recycled and natural construction (Hossain et al. 2018), social impact of different pavement alternatives (Zheng et al. 2019), and social sustainability of buildings through a stakeholder interest-based approach (Liu and Qian 2019).

All these studies have been addressed towards the sustainable design of buildings and civil engineering infrastructures, trying to improve the decision-making in the feasibility and design stages of the infrastructures' life cycle. Additionally, although there has been a rapid development of social life cycle assessment studies in the last decade (Dong and Ng 2015b), many methodological deficiencies still exist that need to be resolved (Dong and Ng 2015b; Carmo et al. 2017; Tsalis et al. 2017). These deficiencies are mainly referred within the selection of the appropriate data and social indicators, the impact assessment methods and the lack of information associated with cultural and economic particularities of the countries where the products are sold

(Benoît et al. 2010; Carmo et al. 2017; Tsalis et al. 2017). For this reason, numerous authors have remarked that social life cycle assessment is still in an immature phase where plenty of chances for progress exists (Martínez-Blanco et al. 2014; Dong and Ng 2015b; Eizenberg and Jabareen 2017).

- Sustainability certifications systems:

Various certification systems and rating tools have emerged to measure the sustainability of infrastructure projects (Clevenger et al. 2016). These tools guide and assess individual infrastructure projects according to a range of sustainability criteria that usually cover the three dimensions of sustainability (environmental, social and economic) as well as project management and governance aspects (Griffiths et al. 2015). The main focus of these certification systems and rating tools is offering design teams and contractors a set of sustainable priorities and a method to analyze their performance (Clevenger et al. 2016; Griffiths et al. 2017).

The prominent certification systems and rating tools are gathered in Table 2-2. This table collects the sustainability categories that are included in each certification system, as well as the associated source. Most of these certification systems are developed specifically for use with highways (Clevenger et al. 2013). Only CEEQUAL and Envision have been designed for use on all civil infrastructure projects, including highways (Griffiths et al. 2015; Clevenger et al. 2016). Many of these systems were developed by or for specific agencies with a focus on specific, local environmental needs or context (Clevenger et al. 2016); and, some of these systems rely solely on self-assessment, whereas others such as CEEQUAL, Envision, and Greenroads have the option of third-party verification and certification, requiring a higher level of evidence and a more rigorous audit process (Griffiths et al. 2015).

The certification systems and rating tools assess performance against defined sustainability categories. Within each category, a set of associated criteria are defined and weights are allocated for each individual depending on relative sustainability impact and the level of performance (Griffiths et al. 2015). However, Muench et al. (2016) highlighted the lack of transparency connected to the explanation about the definition of the weights in most of these certification systems. Additionally, the main drawbacks claimed to the existing certifications systems in the literature are:

- **The lack of coverage of social issues**. Pocock et al. (2016) stated that none of the current rating systems fully develop the social aspect of sustainability, because assessment frameworks tend to give more emphasis to environmental indicators and considerations than to social and economic factors (Griffiths et al. 2015; Pocock et al. 2016; Griffiths et al. 2017).

- **The poor coverage on construction and operations phases of the infrastructure's life cycle.** Certification systems focus on the feasibility and design stages, with little research focusing on the construction stage (Ugwu and Haupt 2007; Lim 2009).

Table 2-2: Sustainability certifications systems for highways

Sustainability certification systems	Sustainability categories	Source
Greenroads	Project Requirements; Environment & Water; Access & Equity; Construction Activities; Materials & Resources; and Pavement Technologies.	Muench et al. (2011)
GreenLITES	Sustainable Sites; Water Quality; Materials and Resources; Energy and Atmosphere; and Innovation	NYSDOT (2009)
INVEST	System Planning Criteria; Project Development Criteria; and Operations and Maintenance Criteria	FHWA (2012)
I-LAST	Planning; Design; Environmental; Water Quality; Transportation; Lighting; Materials; Innovation; and Construction.	IDOT (2012)
STARS	Integrated Process; Access; Climate and Energy Ecological Function; Cost; and Innovation.	STC (2012)
Be^{2}st-in-highways	Energy Consumption; Global Warming Potential; Water consumption; In-situ Recycling Ratio; Recycled Material Content; Life Cycle Cost; Social Carbon Cost; Traffic Noise; and Resource Conservation and Recovery Act Hazardous Material.	RMRC/UW-M (2010)
CEEQUAL	Project Strategy; Project Management; People and Communities; Land Use and Landscape; The Historic Environment; Ecology and Biodiversity; Water Environment; Physical Resources Use and Management; and Transport.	CEEQUAL (2015)
Envision	Quality of Life; Leadership; Resource Allocation; Natural World; and Climate and Risk.	ISI (2015)

SOURCE: Own elaboration

- <u>Corporate sustainability systems:</u>

During the last decade, corporate social responsibility has gathered strength, and significant efforts have focused on analyzing the extent to which companies incorporate economic, environmental and social factors into their activities and how their actions impact their environment (Singh et al. 2012; Rahdari and Rostamy 2015; Dočekalová and Kocmanová 2016). Accordingly, to integrate sustainability management into business organizations, normative frameworks and management systems, reporting guidelines, and rating systems have emerged (Lee and Saen 2012; Rahdari and Rostamy 2015). These are described below.

- **Normative frameworks and management systems.** Examples of normative frameworks such as the Tripartite Declaration of Principles Concerning Multinational Enterprises and Social Policy (MNE Declaration) of the International Labor Organization (ILO) or the OECD Guidelines for Multinational Enterprises have defined non-bindings frameworks that help companies to improve their sustainability performance. These documents gather a voluntary set of principles designed to promote a more sustainable business environment (Rahdari and Rostamy 2015). On the other hand, management systems focus on proposing self-assessment tools to help firms assess their sustainability performance. Some examples of social management systems are Occupational Health and Safety Assessment Series 18001 (OHSAS 18001), AccountAbility Framework Standard 1000 (AA1000), Social Accountability 8000 (SA8000), International Organization for Standardization 26000 (ISO 26000), etc. (Veleva and Ellenbecker 2001; Krajnc and Glavič 2005a; Rahdari and Rostamy 2015)

- **Reporting guidelines.** Sustainability reporting guidelines gather an extensive set of indicators that can be used to measure the sustainability performance of a company. These indicators allow measuring, quantitatively and/or qualitatively, the sustainability issues providing information to help companies address critical sustainability concerns and to assess how the company contributes to sustainable development (Azapagic 2004; Krajnc and Glavič 2005a; Tokos et al. 2012; Afzal et al. 2017)**.** Different organizations such as Global Reporting Initiative (GRI), the International Integrated Reporting Council (IIRC) and Sustainability Accounting Standard Board (SASB) have developed reporting frameworks and have defined numerous sustainability indicators (Veleva and Ellenbecker 2001). GRI has become the most prominent framework for non-binding reporting of non-financial performance, and is one of the most credible sources for the extraction of corporate social responsibility indicators (Krajnc and Glavič 2005a; Rahdari and Rostamy 2015). However, a large number of existing indicators and the fact that these indicators are measured in very different units make the performance assessment and the decision-making difficult (Rahdari and Rostamy 2015). On the other hand, social issues have received the least attention in existing indicator frameworks. Most indicator social frameworks are still under development, and none is applicable as a whole to evaluate social production (Krajnc and Glavič 2004; Afzal et al. 2017).

- **Rating systems.** There are numerous regional rating agencies in countries across the world that rank companies on their corporate sustainability responsibility (Rahdari and Rostamy 2015). Lu and Zhang (2016) listed a group of these rating systems and emphasized the Dow Jones Sustainability Index as the most accepted global index. This index assesses the opportunities and risks derived from economic, environmental, and social dimensions; it tracks the financial performance of the leading sustainability-driven companies worldwide, and it ranks the leading companies by corporate sustainability assessment. However, Rahdari and Rostamy (2015) claimed these rating systems are not consistent as they were developed by different agents and with various perspectives and objectives.

Although all these theoretical frameworks are helping to persuade the industry to move proactively towards sustainable development, significant drawbacks exist associated with the lack of definition of social indicators for specific sectors depending on each national context, the different units of analysis of the social indicators, the absence of common benchmarks, or the qualitative nature of most of the social indicators (Lee and Saen 2012; Tokos et al. 2012; Bonwick 2014; Hosseinijou et al. 2014; Rahdari and Rostamy 2015). All these facts make difficult the assessment of the social performance of processes or products, projects, and companies, and claim the need of defining aggregation formulas or composite indicators that help to undertake a holistic assessment of their social performance, and to carry out an easy and effective social comparison among them (Krajnc and Glavič 2005b; Glass 2012; Martínez-Blanco et al. 2014; Dong and Ng 2015b; Eizenberg and Jabareen 2017; Tsalis et al. 2017).

2.4. Composite indicators

An indicator is a quantitative or a qualitative measure derived from a serie of observed facts (Joint Research Centre-European Commission 2008). Indicators allow assessing and monitoring performance, benchmarking, identifying trends, and setting policy priorities (Tokos et al. 2012). Indicators can be used alone, in thematic sets or composite indicators (Krajnc and Glavič 2004). According to Freudenberg (2003), individual indicator sets represent a menu of separate indicators; thematic indicators are individual indicators grouped around a specific theme, but they are generally presented individually rather than synthesized in a composite; and, finally, composite indicators are formed when thematic indicators are compiled into a synthetic index and presented as a single composite measure.

A composite indicator is the mathematical combination of individual indicators that represent different dimensions of a concept whose description is the objective of the analysis (Nardo et al. 2005; Tokos et al. 2012). The Equation 2-1 shows the simplest form of a composite indicator, where this is formulated as a weighted average of the individual indicators. In general, weights are bounded from 0 to 1, and the sum of the weights is equal to 1.

$$CI_j = \sum_{i=1}^{n} W_i \cdot I_{ij} \qquad (2\text{-}1)$$

With:

- CI_j : Composite indicator for the construction company j.
- W_i : Weight assigned to the indicator i in the model.
- I_{ij} : Value for the construction company j on the indicator i in the model.

The quality of a composite indicator depends mainly on the methodology used in its construction (Freudenberg 2003). The creation of a composite indicator is based on four essential steps: (1) defining the theoretical framework, (2) establishing the indicators, (3) determining the weighting and aggregation methodology, and (4) performing a sensitivity analysis (Joint Research Centre-European Commission 2008).

- Defining the theoretical framework:

The aim of a theoretical framework is providing the basis for the selection and combination of single indicators into a meaningful composite indicator. Consequently, taking into account the complexity of characterizing the concept of social sustainability, the aim of this first step is understanding and defining what it is going to be measured (Freudenberg 2003). The theoretical framework must guide the definition of categories and subcategories, as well as the choice of the type of indicators deemed necessary to assess the subcategories (Joint Research Centre-European Commission 2008). Different stages in the construction of a composite indicator can be quite subjective; for that reason, the Joint Research Centre-European Commission (2008) emphasizes that transparency is essential in constructing credible composite indicators, and UNEP (2009) recommends getting stakeholders or group of experts involved, and engaged in the making-decision stages of this procedure.

- Establishing the indicators:

A composite indicator can be defined using both quantitative and/or qualitative indicators (Freudenberg 2003). Once the categories and subcategories have been established in the theoretical framework, the strengths and weaknesses of composite indicators are largely derived from the quality of its individual indicators (Joint Research Centre-European Commission 2008). In order to determine the individual indicators to be used to build the composite indicator, the following steps are defined: data selection, statistical analysis, normalization, weighting, and aggregation.

- **Data selection.** Two methods exist for selecting indicators, the top-down and the bottom-up. A bottom-up approach involves, first, gathering inventory information, which is provided at the organization and process level; and, second, compiling the final set of indicators after asking the appropriate stakeholders what would be relevant summary indicators and aggregation methods according to their perspective (Puig et al. 2014; Cook et al. 2017). Contrarily, the top-down approach consists of identifying broad social and socio-economic issues of interest and, according to these issues, identifying indicators from the literature review (e.g. publications, reports, and standards) and narrowing down to a final set of agreed-upon indicators (UNEP 2009; Puig et al. 2014; Cook et al. 2017). The top-down and the bottom-up approaches are complementary (UNEP 2009).

Additionally, indicators should be selected based on their analytical soundness, measurability, relevance to the phenomenon being measured and related to each other (Joint Research Centre-European Commission 2008). Several studies and reports have provided information on criteria used to select individual indicators. Some examples of these criteria are policy relevance, utility, soundness, interpretability, data availability, quality, informative, measurable, representative, practical, etc. (Yli-Viikari et al. 2007; Joint Research Centre-European Commission 2008; Puig et al. 2014; Cook et al. 2017). On the other hand, occasionally, the use of proxy indicators is advisable, mainly when data are scarce (Cook et al. 2017). The Joint Research Centre-European Commission (2008) highlights the importance of involving experts and/or stakeholders in the selection of proxy variables.

- **Statistical analysis.** Techniques based on multivariate analysis, such as factorial analysis, are widely used in the construction of composite indicators to investigate the overall structure of the indicators, assess the suitability of the data set and explain the methodological choices (Joint Research Centre-European Commission 2008). However, these techniques are advised when the sample to be analyzed is at least ten times greater than the number of variables (indicators) (Hair et al. 2014). Besides, aspects such as correlation and compensability issues among indicators need to be considered, being corrected for or treated depending on the features of the phenomenon that want to be analyzed (Joint Research Centre-European Commission 2008).

- **Normalization.** A composite indicators aims to enable comparison between the units of analysis (companies, projects, countries, etc.) regarding the aspect to be analyzed. However, indicators can be defined quantitatively or qualitatively, and they are usually expressed in different units of measure (Zhou et al. 2012). To be aggregated in a composite indicator, often, the indicators need to be normalized. There are different normalization techniques**:** ranking, standardization (or z-scores), min-max, distance to a reference measure, categorical scales, indicators above or below the mean, cyclical indicators, the balance of opinions, and percentage of annual differences over consecutive years (Joint Research Centre-European Commission 2008). The normalization method should take into account the data properties, as well as the objectives of the composite indicator (Freudenberg 2003). Zhou et al. (2012) stated that minimum–maximum and the distance to a reference are the most commonly used methods in the construction of composite indicators.

- Weighting and aggregation:

Selecting appropriate weighting and aggregation procedures that respect both the theoretical framework and the data properties is an essential step in the definition of a composite indicator (Freudenberg 2003). The weights are the elements of a composite indicator that represent the level of importance of each individual indicator. The aggregation method represents the way the indicators and weights are combined into a composite indicator.

- **Weighting method.** In many composite indicators, all indicators receive the same weights, mainly for reasons of simplicity; however, this method is not recommended by their nature, since this technique may be incapable of reflecting the complexity of the phenomenon to be analyzed (Freudenberg 2003). Consequently, two main groups of weighting methods can be defined depending on whether the weights are obtained through statistical models or participatory methods (Joint Research Centre-European Commission 2008).
  The main weighting methods based on statistical models are factor analysis, data envelopment analysis, and unobserved component models.
    - Factor analysis. This technique groups the individual indicators which are collinear to form a composite indicator that captures as much as possible of the common information. The idea of this statistical method is using the smallest possible number of factors, where each factor reveals the set of indicators with which it has the strongest association. This technique defines the same weights for each case in the sample, and individual indicators must have the same unit of measurement.
    - Data envelopment analysis (DEA). This technique defines the weights for each case in the sample, taking into account the performance of each case with respect to each considered indicator. DEA employs linear programming tools to estimate an efficiency frontier that would be used as a benchmark to measure the relative performance of each case in the

sample. The application of DEA to the field of composite indicators is known as the "benefit of the doubt" approach.

- Unobserved component models. In this technique, individual indicators are assumed to depend on an unobserved variable plus an error term. The aim is estimating the unknown component and setting the weights to minimize the error in the composite. This is a complex method characterized by high computational cost. Authors such as Singh et al. (2007) claimed that this is not a robust method, because the weights are a decreasing function of the variance indicators.

The main weighting methods based on participatory methods are: budget allocation processes, analytic hierarchy processes, and conjoint analyses.

- Budget allocation processes. This technique uses the opinion of experts on a given theme to assess the importance of a set of indicators. Experts are asked to allocate a "budget" of one hundred points to the indicator set, based on their experience and subjective judgment of the relative importance of the respective indicators. Weights are calculated as average budgets. The main advantages of this method are its transparent and relatively straightforward nature and short duration.
- Analytic hierarchy processes. This is a technique for multi-attribute decision-making, which facilitates the decomposition of a problem into a hierarchical structure. Weights represent the trade-off across indicators since this technique evaluates the level of importance for one criterion versus another using Saaty's fundamental scale on a ranking of 1–9 (Pellicer et al. 2016b).
- Conjoint analyses. It is a decompositional multivariate data analysis technique where experts are asked for an evaluation, based on preference, of a set of alternative scenarios. A scenario might be a given set of values for each individual indicator (Freudenberg 2003). This methodology uses statistical analysis to treat the data; however, it relies on the opinion of people to choose the set of individual indicators they prefer.

▪ **Aggregation method.** According to Joint Research Centre-European Commission (2008), the main aggregation techniques are linear and geometric methods.

- Linear aggregation methods are calculated as a summation of weighted and normalized individual indicators. This method is widely used, because of its simplicity, transparency, and easy understanding (Zhou et al. 2012).
- Geometric aggregation methods are calculated as a product of normalized individual indicators as the power of their weights. This method is recommended when non-comparable and strictly positive sub-indicators are expressed in different ratio scales (Zhou et al. 2012).

- Sensitivity analysis:

A sensitivity analysis aims to determine what sources of uncertainty are more influential in the results. Sensitivity measures represent how much the uncertainty in the composite indicator for a unit of analysis would be reduced if that particular input source of uncertainty were removed. Several judgments have to be made when constructing composite indicators with respect to the selection of indicators, data normalization, weights and aggregation methods, etc. (Freudenberg 2003).

2.5. Point of departure

Most of the literature published on construction procurement has focused on the evaluation and analysis of its relationship with different types of procurement procedures or project delivery methods (Wardani et al. 2006; Sourani and Sohail 2011; Xia et al. 2013; Ruparathna and Hewage 2015b). In terms of sustainability in public construction procurement, considering the three dimensions (economic, environmental, and social), the majority of research has been conducted on economic and environmental issues, overshadowing the social dimension (Illankoon et al. 2017). Loosemore (2016) stated that, although during the last 50 years there has been considerable research in construction procurement, the study of social procurement has barely been addressed; and social and economic objectives associated with sustainable procurement have only received attention more recently (Walker and Phillips 2009). These pieces of evidence strengthen the fact that there is a need for the study of the social dimension of sustainability and its inclusion in public construction procurement, analyzing the aspects that demonstrate a significant influence on its implementation at the international level.

On the other hand, regarding the social criteria that should be considered to assess social sustainability in the construction industry, these still have not been clearly established (Sierra et al. 2018b). A literature review was performed to determine the social criteria that should be taken into account by the construction industry to assess the social dimension of sustainability. In this regard, eight categories (cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact) and 24 subcategories were defined. However, not only the identification of the social criteria that should be considered in the construction industry was important. The literature review demonstrated that, concerning the existing theoretical frameworks to assess social sustainability in the construction industry, there is a lack of theoretical and empirical studies in terms of social sustainability (Eizenberg and Jabareen 2017). Xiahou et al. (2018) stated that a systematic framework for evaluating the social performance of construction projects is absent in the industry. Additionally, due to the relatively limited literature on social sustainability in the construction industry, there is generally a lack of agreement as to which indicators should be used, causing social sustainability to be the most challenging sustainability pillar to assess (Popovic et al. 2018).

It should be added that public tendering are procedures where the selection of the project team must be based on a regulated system where fair and objective competition is required (Schöttle and Arroyo 2017). Thus, in public-works procurement, avoiding the subjectivity of best value criteria is essential to ensure the transparency, objectivity, and equitability of bid-selection processes (Park et al. 2015). For that reason, Popovic et al. (2018) claimed that measuring social sustainability in a quantitative form is currently an important research topic. Consequently, the need to go one step further concerning the existing literature is claimed, as well as the development of a methodology to include social criteria in public-works procurement, focusing efforts to define methods that overcome the existing drawbacks and to assist procurers in the proper integration of social sustainability in procurement procedures.

Therefore, characterizing the current scenario with respect to the inclusion of social sustainability criteria within public-works procurement at the international level is required. The aim of this characterization is identifying the current weaknesses that are hindering the effective implementation of this type of criteria in the public procurement of the construction industry. Based on this purpose, the goal is to develop a methodology that contributes to the correct inclusion of the social sustainability criteria in public-works procurement and to help procurers to promote the movement of the construction industry towards its socially sustainable development.

CHAPTER 3

RESEARCH METHOD

This chapter describes the research method established to answer the two research questions. To characterize the inclusion of social sustainability criteria in public-works procurement, tendering documents are collected at the international level. Content analysis and statistical techniques such as descriptive statistics, logistic regressions, Mann-Whitney U-test, correspondence analysis, and Chi-square contingency table analysis are the methods developed in this research to analyze these documents and the data extracted from them. Subsequently, the theoretical framework to define the methodology to include social criteria in procurement procedures of civil engineering construction projects is established. First, goal and scope are defined. A group of experts was set to be involved in some of the different decision-making stages of the development of the methodology. The group of experts, through a focus group, selected the social criteria that should be considered in procurement procedures of civil engineering construction projects. These social criteria were classified into three groups, and a methodological approach was defined for each one of these groups.

3.1. Research questions and objectives

As indicated previously in the introduction, in order to fullfil the knowledge gap (even partially), two Research Questions (RQ) have been defined:

- RQ1: What is the current scenario of inclusion of social sustainability within public-works procurement at the international level?

- RQ2: How can the integration of social sustainability criteria in public-works procurement be improved to overcome the current scenario?

To achieve these research questions, this research proposes the following specific Objectives (O):

- O1: Analyzing how public-works procurement procedures and project delivery methods are considered at the international level.

- O2: Identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined depending on the stage of the tendering procedure where these are considered.
- O3: Assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures.
- O4: Defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures.
- O5: Determining a methodology to include the social sustainability criteria in public-works procurement procedures.
- O6: Identifying the stage of the public-works procurement procedures to include the social sustainability criteria.

The specific objectives O1, O2, and O3 seek to respond to Research Question 1 (RQ1); whereas O4, O5, and O6 seek to accomplish Research Question 2 (RQ2).

3.2. Overall approach

The research is divided into four phases. The first phase presents the literature review. Three research fields were addressed to identify the gap in knowledge that serves as the motivation of this research. First, the relationship between sustainability and procurement procedures and project delivery method was studied. The lack of research about the social dimension in the construction industry motivated focusing this work only on this dimension of sustainability. Thus, an exhaustive review was performed, and a selection of the social criteria that should be considered in construction tendering documents was established. Finally, the social sustainability assessment methods were characterized, concluding the need to develop aggregation formulas to assess the social performance. Consequently, this phase ends up describing the methodology defining composite indicators and establishing the point of departure of this research.

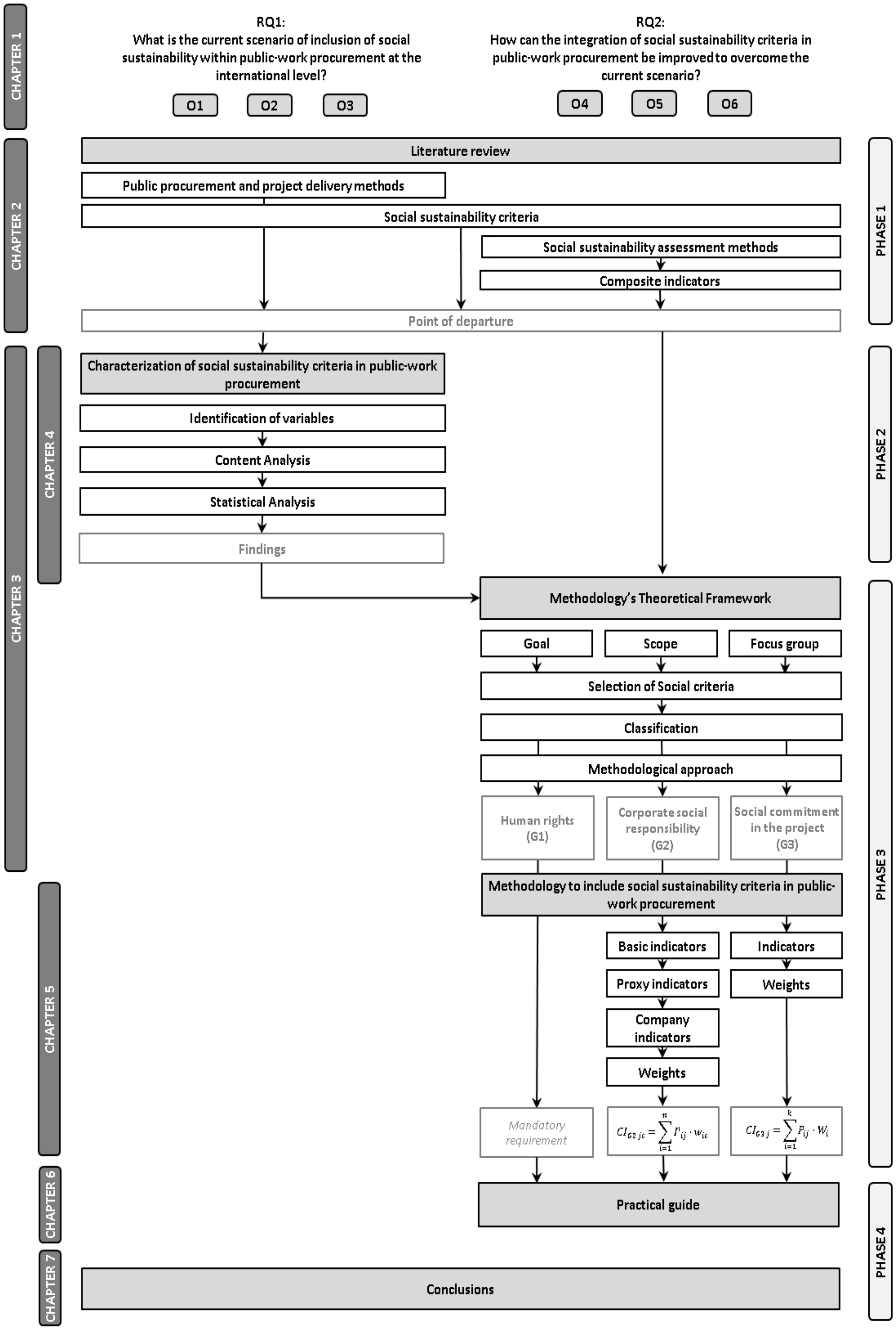
In the second phase, the research method taken to undertake the analysis of tendering documents was established. The aim of this phase was characterizing the inclusion of social criteria in public-works procurement at the international level to achieve the research objectives: analyzing how public-works procurement procedures and project delivery methods are considered at the international level (O1), identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined depending on the stage of the tendering procedure where these are considered (O2), and assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures (O3). A total of 451 tendering documents were collected from 10 English-speaking and Spanish-speaking countries. Thus, after establishing the variables to be analyzed in the documents, the content analysis was carried out. To examine how public-works procurement procedures and project delivery methods are considered at the international level, descriptive statistics and logistic regressions were performed. Descriptive statistics were developed to identify the main social sustainability criteria that, currently, are included in public-works procurement. To characterize how social criteria are defined depending on the stage of the tendering procedure, the analysis focused on descriptive statistics and the Mann-Whitney U-test. Finally, the most important project characteristics on the inclusion of social criteria in public-works procurement procedures were defined through performing descriptive statistics, logistic regressions, correspondence analysis, and chi-square contingency table analysis. The description of the research process is gathered in chapter 3; the detailed results can be found in chapter 4.

The third phase focuses on the development of the methodology to include social criteria in public procurement procedures of civil engineering construction project. The first step was based on establishing the theoretical framework to develop the methodology. The goal and scope of this phase were defined. A group of experts was formed to collaborate in the decision-making stages to determine the methodology. This group of experts, by the focus group technique, ascertained the social criteria that should be considered in every procurement procedure of civil engineering construction project. To develop a comprehensive framework of social criteria that focuses on assessing the social performance of the construction companies in the public procurement of civil engineering construction project, the social criteria were classified in three groups: human rights (G1), corporate social responsibility (G2), and social commitment in the project (G3). The methodological approach was established for each of these groups of social criteria. This process is gathered in chapter 3. In chapter 5, the indicators that should be used to assess the social criteria in public-works procurement procedures were defined (O4). Based on these indicators, the methodologies to evaluate each group of social criteria in procurement procedures were established (O5). First, the inclusion of human rights group (G1) is based on a mandatory requirement to guarantee that every procurement procedure considers requirements related to the human right subcategories, and ensure that every construction company who is involved in the process knows and complies with this group of criteria. The corporate social responsibility group (G2) and the social commitment in the project group (G3) are based on the definition of two composite indicators to assess the social performance of the construction companies involved in the procurement procedure. Thus, the indicators and the weights to be considered in each composite indicator were established.

The fourth phase gathers the definition of a practical guide to include social sustainability criteria in public-works procurement. This guide was developed to assist agencies in the inclusion of the social criteria in public procurement, helping them to collect the data and to perform the assessments according to the methodologies established. Additionally, this guide proposes the most suitable stage of the procurement procedures to include each group of social criteria (O6), taking into account the goals established for each of them. This work is presented in chapter 6.

The process ends up showing the main conclusions of this research, describing the achievements of the six goals, the findings of this research, as well as establishing the limitations, contributions, and, finally proposing future research. This is colleted in chapter 7.

Figure 3-1 displays the overall process defined to undertake this research, highlighting the tasks associated with each chapter in their chronological sequence. The four phases are represented on the right side of this figure. These phases are discussed in greater detail below.



SOURCE: Own elaboration

Figure 3-1: Research process

3.3. Characterization of social sustainability criteria in public-works procurement

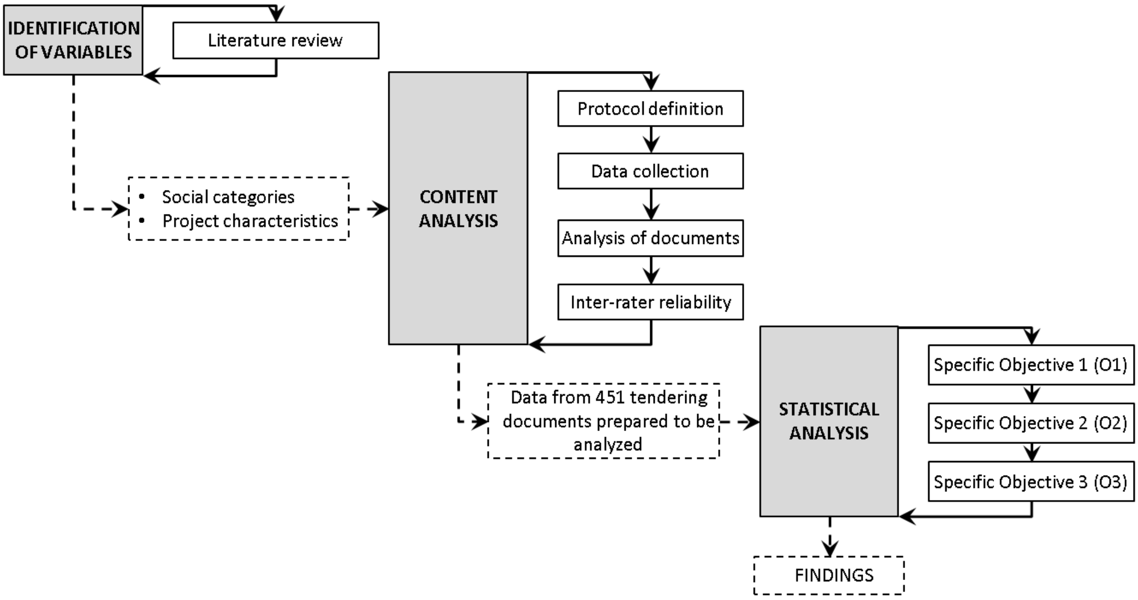
In the scientific literature, methods which have been used to measure the state and progress of social sustainability in public-works procurement are mainly based on the use of questionnaires (Sourani 2008; Brammer and Walker 2011; Akenroye 2013), interviews (Ruparathna and Hewage 2015a; Loosemore 2016) and tender analyses (Akenroye 2013; Ruparathna and Hewage 2015a; Hueskes et al. 2017). Each method shows several advantages, but also some important limitations. A low response rate and self-selection bias associated with the use of questionnaires or interviews can influence the representativeness of the sample (Testa et al. 2016b). Interviews can offer good response rates, but the information gathered depends strongly on the judgment of the surveyor (Kippo-Edlund et al. 2005; Nissinen et al. 2009). Finally, tenders analysis may be strongly influenced by the interpretation of researchers if methods of analysis are not rigorous enough (Stanford et al. 2016). Several researchers have highlighted the adequacy of analyzing the content of public tenders to investigate the inclusion of sustainability criteria (Nissinen et al. 2009; Adham and Siwar 2012). Therefore, in this research, the method selected to characterize the inclusion of social sustainability in public-works procurement was based on the analysis of tendering documents in the construction industry at the international level.

To perform the analysis of tender documents, content analysis was the method developed in this research. Content analysis is a research method that is widely used for systematically and objectively identifying characteristics of large volumes of written material (Neuendorf 2017). Content analysis is a method that may be used in an inductive or deductive way; it may be based on quantitative or qualitative descriptions (Bryman 2012). An inductive way is used when there is not enough knowledge about the phenomenon of study; hence, this approach is characterized to be an open procedure where categories of aggrupation can be defined or modified during the process of analysis (Essl and Mauerhofer 2018). Deductive content analysis is performed when the analysis is structured to operate based on previous knowledge, and the purpose of the study is theory testing (Bryman 2012).

On the other hand, quantitative content analysis aims to produce quantitative accounts of the analyzed material in terms of the established categories (Neuendorf 2017), quantifying content in terms of pre-determined categories in a systematic and replicable way (Sutterlüty et al. 2018). A qualitative content analysis is focused on the analysis of themes within the text through searching for specific ideas in it (Bryman 2012), the analysis of characteristics of language with attention to the content or contextual meaning of the text (Hsieh and Shannon 2005) and the development of a non-quantitative analysis (Neuendorf 2017). The content analysis of this research involves quantitative content analysis, which combines both inductive and deductive approaches. Thus, for its implementation, a characterization outline composed of two levels was established.

The first level was based on a group of pre-established categories centered on variables defined through an in-depth analysis of scientific literature, guides and reports focused on social sustainability in the construction industry. Following a deductive approach, these variables were used to undertake a first classification of the information contained in the tendering documents. On the other hand, although in the literature review the social subcategories that should be taken into consideration in the construction industry were also established, it was preferred to perform an inductive approach to define the second level of classification according to the information gathered from the tendering documents. The reason was that, although the social subcategories defined in chapter 2 were used as a reference, not all the aspects of each subcategory were found in the tendering documents. Therefore, a new classification of subcategories, named "sub_2", was defined as a result of an inductive process in each category using the affinity diagram technique (Carnevalli and Miguel 2008). This allowed giving more detail to the analysis of the extracted information from the tendering documents, without the need to add a third level of classification.

Consequently, the content analysis method allows describing and quantifying the information content in terms of predetermined categories, following a systematic approach that allows achieving valid inferences (Sierra et al. 2018b). Additionally, although content analysis is characterized by following a systematic approach, it is a subjective method which requires a structured and replicable approach to maximize the objectivity of this research process (Rodrigues and Mendes 2018). To achieve the objectives stated previously, the research process defined in Figure 3-2 was followed. It involved three main steps, which were defined based on the recommendations of Stanford et al. (2016): identifying the variables through a literature review, performing the content analysis (defining the protocol, collecting the data, analyzing the documents, and assessing inter-rater reliability), and using statistical analysis (descriptive statistics, logistic regressions, Mann-Whitney U test, correspondence analysis and chi-squared contingence tables). These steps are explained in-depth in the following subsections.



SOURCE: Own elaboration

Figure 3-2: Tendering analysis research process

3.3.1. Identification of variables

Two types of variables need to be defined to perform the content analysis: variables for characterizing the project, and social categories to classify the information of the tendering documents. On the one hand, to characterize the project, Gransberg and Barton (2007) only took into account the type of infrastructure and project delivery method. However, Xia et al. (2013) defined project size, type of infrastructure, procurement procedure, and project delivery method; Stanford et al. (2016) established a type of work (vertical, horizontal, electrical, etc.), contract value, duration of the contract, and delivery method; and Molenaar et al. (2010) defined project location and time, budget size, project type, project size, procurement procedure, and project delivery method. Based on this, six variables were defined to characterize the tendering documents in terms of: (1) country; (2) infrastructure type, discriminating between buildings and civil engineering projects; (3) contract size, represented by the initial budget of the project in €; (4) procurement procedure, discerning between low bid and best value; and, (5) project delivery method, gathering traditional and integrated delivery methods. On the other hand, taking into account the groups of social criteria that should be considered in construction tendering documents, established in the literature review, the eight social categories (or groups of criteria) were used to perform the first level of classification of social indicators from the tendering documents. These eight categories were cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact (see Table 3-1).

Table 3-1: Study variables

Groups	**Variables**
Project characteristics	Country
	Infrastructure type: Buildings and civil engineering projects
	Contract size (Initial budget (€))
	Procurement procedure: Low bid and best value
	Project delivery method: Traditional (DBB) and Integrated (DB, CMR, CM/GC, Concessions, PPP, etc.)
Social criteria	Cultural heritage
	Employment
	Health and safety
	Local development
	Professional ethics
	Public participation
	Training
	Users' impact

SOURCE: Own elaboration

3.3.2. Content analysis

As indicated in Figure 3-2, the procedure to perform the content analysis was based on: (1) defining a protocol; (2) collecting the data; (3) analyzing the documents; and (4) performing inter-rater reliability.

- Protocol definition:

According to Bryman (2012), Neuendorf (2017) and Stanford et al. (2016), to perform the content analysis, a well-defined protocol is required. The aim of the protocol is establishing the procedure to gather information, to enable later replication of the research process. The protocol contained the two main elements in a content analysis coding layout: conceptualization and coding manual.

- **Conceptualization** is performed to define the variables that have to be identified in the documents. Thus, in this section, the concepts of the social categories were presented. Additionally, the definitions of each social category and some examples of the literature review were included to give understanding to coders.

- **The coding manual** is a statement with the instructions to coders. This manual also includes all the possible categories for each dimension being coded. Therefore, the coding manual provided a list of all the variables and categories to be employed in the coding process. It established the dimensions subsumed under each variable or category, the codes that correspond to each dimension and guidance on what each dimension is concerned with, and any factor that should be taken into account in deciding how to allocate any particular code to each dimension.

Therefore, the protocol determined the coding procedure, variables of interest, recommended search terms, and examples of expected typical results, according to the recommendations of Neuendorf (2017) and Stanford et al. (2016). The complete protocol can be found in Appendix A.

- Data collection:

After defining the protocol, the tendering documents at the international level were collected. To perform this task, public procurement internet websites were searched; and tendering documents related to construction projects and services were gathered. The tendering documents were collected from those countries whose documents were available free online and were published in English or Spanish. The search was carried out from January 2016 to January 2017 to capture the most recent trends.

Each country uses a classification system for public procurement that aims to standardize the references used to contract authorities and entities and to describe the subject of procurement contracts. Two of the main examples of these classification systems are the common procurement vocabulary (CPV) established by the European Union (European Commission 2008) or the United Nations Standard Products and Services Code (UNSPSC) defined by the United Nations. Thus, to select the appropriate documents, the classification system that each country uses for public procurement was identified.

A total of 534 tender documents, from 13 countries, were obtained as initial candidates from the database. However, to carry out a comprehensive and homogeneous study of each project, only those tender documents that included tender characteristics, technical specifications of the project, and contract performance clauses were selected. For this reason, countries such as New Zealand, South Africa, and Mexico were excluded. Finally, 451 tendering documents were selected from the following 10 countries: Argentina, Australia, Canada, Chile, Colombia, Panama, Peru, Spain, the United Kingdom, and the United States.

- Analysis of the documents:

The tendering documents were analyzed by two independent coders; and, the information which appeared in each tendering document associated with the established variables was gathered and coded following the protocol. According to the recommendations of Stanford et al. (2016), firstly, the two coders examined one tendering document randomly selected from each country. This allowed the researcher to refine the coding process and to ensure consistency since the terms used to refer to any of the variables can significantly vary depending on the country.

- Inter-rater reliability:

Inter-rater reliability quantifies the level of agreement between judges (Watson 2013). In this research, the continuous variables were assessed by the percentage of agreement between raters PA_o. This is a measure that is widely used and easily understood for determining inter-rater agreement (Stanford et al. 2016; Neuendorf 2017). The observed proportion agreement (PA_o) is calculated as the number of agreements between coders divided by the total number of units coded by both coders.

On the other hand, Cohen's kappa was the method used to analyze the discrete variables. Cohen's kappa is an indicator of agreement which has been widely used internationally due to having the additional benefit of accounting for chance agreements among raters selected between pre-defined categories (Watson 2013; Neuendorf 2017). Cohen's kappa is calculated according to Equation 3-1 (Cohen 1960):

$$\kappa = \frac{(\mathrm{PAo} - \mathrm{PAg})}{(1 - \mathrm{PAg})} \tag{3-1}$$

where PA_o is the proportion of units in which the judges agreed, and it has been previously defined as the number of agreements between coders divided by the total number of units coded by both coders; PA_g is the proportion of units for which agreement is expected by chance, which is determined by finding the joint probabilities of the marginal (Cohen 1960). Both measures, PA_o (for continuous) and κ (for discrete), range from 0.0 to 1.0, with 1.0 indicating perfect agreement. Values equal to or greater than 0.8 are often considered satisfactory (Stanford et al. 2016; Neuendorf 2017).

To perform inter-rater reliability, 50 tendering documents, more than 10% of the total of documents gathered (Cohen 1960), were randomly selected for independent coding to measure inter-rater reliability. The aim of this analysis was to ensure the objectivity of the process and to verify that the judges of the coders operated independently (Cohen 1960).

3.3.3. Statistical analysis

The statistical analysis aimed to characterize the inclusion of social sustainability criteria within public-works procurement at the international level (RQ1). Thus, the research goals were achieved through the use of different statistical techniques. All calculations were performed using IBM SPSS Statistics 23.0.

- Analyzing how public-works procurement procedures and project delivery methods are considered at the international level (O1):

Firstly, a simple descriptive analysis was undertaken to characterize the sample. This analysis helped to visualize the use of the different type of procurement procedures and the project delivery methods in the collected sample. Later, to assess the use of project delivery methods and procurement procedures within the gathered sample, two logistic regression analyses were performed. Logistic regression is one of the best techniques to measure the relationships among factors consisting of both categorical and continuous variables having a binary outcome (Lowe and Parvar 2004; Field 2013). Logistic regression analysis is a technique that is generally used to predict the probability of failure (or success) of a given process, system, product, or phenomenon (Aznar et al. 2017). It allows identifying those variables (predictors) that demonstrate a strong relationship with the dependent variable subject of study (Aznar et al. 2017), because the technique allows the examination of many independent variables and their strength of influence on a binary dependent variable (Lowe and Parvar 2004). Thus, logistic regression analysis was used to develop two predictive models to analyze, on the one hand, the independent variables which influence on the selection of the procurement procedure and, on the other hand, the independent variables which weigh on the selection of the project delivery method.

The variables procurement procedure and project delivery method were the dependent variables of the two logistic regressions. The independent variables in each logistic regression model were: country, infrastructure, and contract size. The analysis of the logistic regression results was based on Lowe and Parvar (2004), Field (2013), and Aznar et al. (2017). Coefficients of the independent variables (b), the Wald statistic, the p-value, and the odds ratio were used to interpret the results.

- **Coefficients of the independent variables (B)** which allow predicting the probability of occurrence of a dichotomous dependent variable.

- **The Wald statistic** which assesses the significance of the best coefficient values (B) found for the logistic regression model. This corresponds to the ratio between the square of B and square of the standard error, and it is asymptotically distributed as a chi-square distribution. The Wald statistic determined the individual contribution of each variable in the logistic regression model, allowing the identification of those variables with the most influence.

- **The p-value,** which informs about the level of significance of each independent variable. It allows identifying the variables which are statistically significant.

- **The odds ratio (Exp(B))**, which is an indicator of the change in odds resulting from a unit change in the predictor. It allows the characterization of the relationship between the levels of each variable.

- <u>Identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined depending on the stage of the tendering procedure where these are considered (O2):</u>

To identify and classify the social indicators gathered from the tendering documents, in the content analysis, a characterization outline composed of two levels was established. The first level focused on a deductive approach, where the social indicators were classified according to the eight groups of social criteria. The second level was based on an inductive approach, and a new classification of subcategories, named "sub_2", was determined using the affinity diagram technique (Carnevalli and Miguel 2008). This new classification of subcategories was defined to give more detail to the analysis of the extracted information from the tendering documents. The reason was that not all the aspects of each subcategory established in chapter 2 were found in the tendering documents. Thus, with this new classification, the most important indicators were highlighted without the need to add a third level of classification.

Once the indicators were classified in the "sub_2" subcategories, this information was used to identify the main social criteria and social subcategories that are currently included in public-works procurement at the international level. This analysis focused on descriptive statistics, and it was developed under the assumption that each category and each "sub_2" subcategory was identified at least once in each tendering document. The objective was to avoid the possible variability associated with the *modus operandi* of each public agency, trying to show a normalized comparison based on frequencies of appearance.

To analyze how social criteria are defined, the following two terms were differentiated: "indicator" and "metric" (Winter and Lasch 2016). Sustainability indicators are generally used to evaluate and motivate progress toward sustainability objectives (e.g., to promote employment of non-qualified personnel from the influenced region during the development of this project). However, the metrics of sustainability are those indicators that submit quantitative associated measurement (e.g., to employ at least *x*% of non-qualified personnel from the influenced region during the development of the project). Once the data were prepared following these premises, descriptive statistics were used to characterize each category and "sub_2" subcategory. This analysis was extended focusing on the influence of the country, the contract size, and the stages of the tendering procedures on the results.

To assess the use of social criteria in each stage of the tendering procedure, descriptive statistics were performed considering the following three phases within a tendering procedure (European Commission 2018). These three phases are: 1) selection criteria; 2) award criteria; and 3) technical specifications and contract performance clauses.

- **"Selection criteria" (SC) phase** includes information about exclusion provisions and selection criteria based on economic, financial, and technical or professional solvency conditions. Exclusion grounds or exclusion criteria are meant to prevent certain categories of firms from participating in award procedures (European Commission 2018). Selection criteria address the assessment of tendering firms based on their capacity to execute the contract (Kiiver and Kodym 2014).
- **"Award criteria" (AC) phase** gathers the criteria that are considered to select the best bid in the procurement procedure. Depending on the procurement procedure (low bid or best value), the award criteria can be focused only on price criteria or can consider more criteria to seek the achievement of most value for money (Kiiver and Kodym 2014).
- **"Technical specifications and contract performance clauses" (TS&CPC) phase** describes the content of the performance that firms must offer, and must execute in case they are awarded the contract (Kiiver and Kodym 2014). According to the European Commission (2018), TS&CPC should cover at least: technical works description, technical report, design package, assumptions and regulations including working conditions, bill of quantities (if applicable), works price list and a time schedule.

To analyze the significant differences between procurement procedures with respect to the mean of social criteria in each tendering document, the Mann-Whitney U-test was performed. This is a non-parametric statistical procedure for comparing two samples that are independent (Xia et al. 2014a; Loosemore and Denny-Smith

2016). The results of this non-parametric technique allows identifying if two variables are not significantly different depending on their p-value, being significantly different when p-value is lower than 0.05 (Xia et al. 2014a).

- <u>Assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures (O3):</u>

To identify which variables are the most influential in introducing social criteria in public construction procurement, logistic regression for each social category was performed. In each logistic regression, the social category was the dependent variable. The independent variables were: country, infrastructure, contract size, project delivery method, and procurement procedure.

The analysis of the logistic regression results was based on the p-value, the Wald statistic, and the odds ratio (Field 2013). In this case, the p-value allowed identifying the variables that showed significant differences between their levels with respect to the inclusion of the social criteria. The odds ratio characterized the relationship between the levels of each variable to the use of social criteria. The Wald statistic determined the individual contribution of each variable in the logistic regression model, allowing the researcher to identify those variables which influence on the inclusion of each social category the most (Field 2013).

Subsequently, an in-depth analysis of the influence that the variables contract size and country have in the inclusion of social criteria in tendering documents was performed. Descriptive statistics were used to analyze the variable contract size. On the other hand, considering that the data sample is categorical, a correspondence analysis was developed to analyze similar trends between countries. According to Hair et al. (2014), this technique is the most appropriatewhat used as an exploratory method to identify unrecognized dimensions that affect behavior; and, as an alternative to obtain comparative results when the specific bases of comparison are not known or are not defined.

Correspondence analysis is a multivariable statistical technique. It provides a detailed analysis of the relationships between categorical data and a graphical illustration of the data in two-dimensional space (Hair et al. 2014; Yildirim et al. 2017). This technique has been used by researchers to demonstrate similarities and differences in judgement models, to analyze the interaction of multi-criteria decision-making methods with the life-cycle phases of infrastructures or construction industry aspects, and to study the relationship between knowledge and public perception in an analyzed sample (Jato-Espino et al. 2014; Penadés-Plà et al. 2016; Gisi et al. 2017; Jelodar et al. 2017).

Correspondence analysis was developed to perform a comparative study between countries with respect to the inclusion of social criteria in tendering documents. This analysis enables researchers to visualize the correlations between variables and the possible existence of groups into the graph based on the distances between variables (Jelodar et al. 2017). This technique is based on chi-square statistics to standardize the frequency value and to constitute the basis of associations (Hair et al. 2014). It is mainly used to analyze inertia and association relations between two variables (Penadés-Plà et al. 2016). Inertia is directly related to chi-square statistics and demonstrates the relationship between the variable categories depending on the chi-square values of each section or row (Sourial et al. 2010; Jelodar et al. 2017). Departing from the inertia value, the correspondence analysis creates orthogonal dimensions to represent the variables taking into account the strengthening of their associations (Hair et al. 2014; Yildirim et al. 2017). Each dimension has an eigenvalue. Eigenvalues demonstrate the relative importance of the dimensions and the extent to which each dimension contributes to the total inertia (Sourial et al. 2010; Hair et al. 2014). The results of this analysis were verified through a chi-square (χ^2) contingency table analysis. The analysis was performed by comparing the countries in the sample. Two groups of countries were defined: 1) the group formed by English-speaking countries (ESCs), which gather Australia, Canada, the United Kingdom, and the United States of America; and, 2) the group formed by Spanish-speaking countries (SSCs), which encompasses Argentina, Chile, Colombia, Panama, Peru, and Spain. Thus, firstly, ESCs and SSCs were compared; and, secondly, the ESCs and SSCs were assessed independently, comparing the countries within each group.

To compare the ESCs with the SSCs, Chi-square (χ^2) contingency table analysis was performed. This type of analysis is one of the most commonly used statistical analyses for categorical data analysis (Xia et al. 2012a), and it determines the extent to which a statistical relationship exists between two variables (McClave et al., 2010; Field, 2013). The null hypothesis in this analysis is that a dependent relationship between the variables does not exist, being satisfied when $p > 0.05$. In the case in which the null hypothesis is rejected and the results show that the relationship between the variables is dependent, different statistics can be selected to calculate the association between variables. The Phi coefficient was selected to calculate the association between variables, and the odds ratio was calculated to measure the effect size of the categorical data (Field 2013). These statistics can be used when the categorical variable has only two dimensions (ESCs, SSCs). However, regarding the analysis of the ESCs and

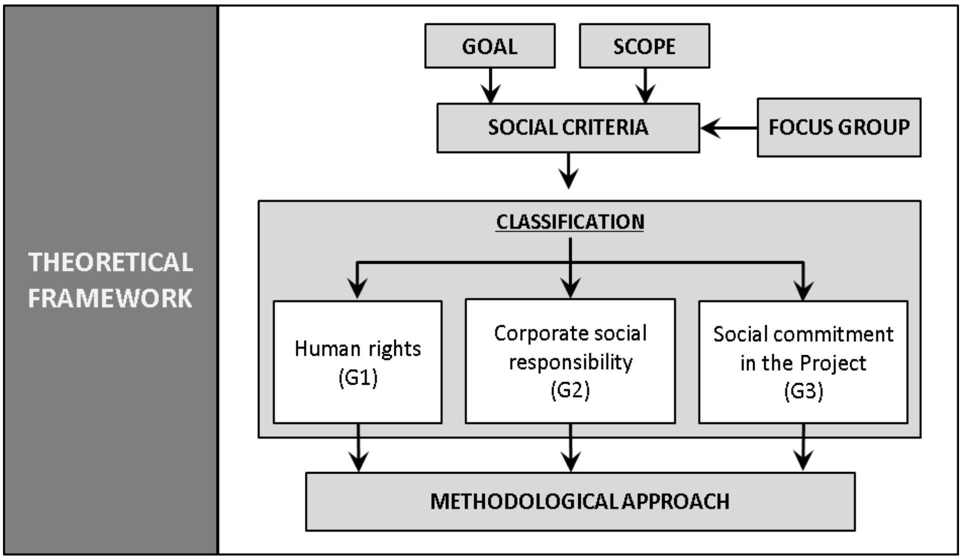
SSCs independently, the categorical variables had more than two dimensions (six dimensions for SSCs and four dimensions for ESCs); therefore, in case the variable was dependent, contingency coefficients (CC) were calculated for each pair of variables. This coefficient allows determining how strongly the categorical variables are associated through its comparison with the maximum contingency coefficients (CC_{max}). Based on the ratio between CC and CC_{max}, the different levels of dependence can be strong dependence when $CC/CC_{max} \geq 0.7$, moderate dependence when $0.5 \leq CC/CC_{max} < 0.7$, and low dependence when $CC/CC_{max} < 0.5$ (Field 2013).

All these developments seek to characterize the current inclusion of social sustainability criteria in public-works procurement to offer an international perspective of the existing weaknesses. These existing weaknesses are the root of the problem; the reason why the transformation of the construction industry towards socially sustainable development has not yet been achieved. Consequently, the findings of these analyses will serve as the foundations to define a new methodology aiming is to improve and strengthen the correct implementation of the social criteria in the public-works procurement at the international level.

3.4. Definition of the methodology's theoretical framework

According to UNEP (2009), the first step to define a methodology to assess social sustainability lies in defining a theoretical framework. Currently, there is a lack of theoretical and empirical studies regarding social sustainability (Eizenberg and Jabareen 2017). This fact is highly significant in the construction industry because the relatively limited literature on social sustainability in this industry entails a lack of agreement as to which indicators should be used to assess the social sustainability (Popovic et al. 2018). Hence, there is a lack of a systematic framework which allows evaluation of the social sustainability performance of projects and companies in the construction industry (Xiahou et al. 2018).

Social sustainability is a multi-dimensional concept that contains complex implications (Yu et al. 2017). Thus, the aim of the theoretical framework establishes the basis for simplication of the concept, to address the decision-making (Eizenberg and Jabareen 2017; Yu et al. 2017), and to define the methodology under a fitness-for-purpose principle (Joint Research Centre-European Commission 2008; UNEP 2009). To define the theoretical framework, six interrelated steps were defined: goal definition, scope definition, focus group definition, selection of social criteria, social criteria classification, and methodological approach. Figure 3-3 shows the process to undertake the interrelated steps.



SOURCE: Own elaboration

Figure 3-3: Process to establish the methodology's theoretical framework

3.4.1. Goal definition

To drive the integration of social sustainability initiatives into construction practices, governments need to encourage the inclusion of social criteria in public procurement (Adetunji et al. 2003; Brown et al. 2012; Walker et al. 2012; Sierra et al. 2018a). The criteria included in the procurement procedure mainly focus on characterizing the companies involved in the procedure with respect to their economic and financial standing, as well as their technical and professional ability to perform the work or services covered by the contract (European Commission 2018). However, to promote the movement of the construction industry towards its socially sustainable development, the inclusion of social criteria within the group of criteria which are considered in the procurement procedures is required.

In social assessment establishing the unit of analysis plays an important role in the definition of the theoretical framework. Since the aim is defining a methodology to include social criteria in the procurement procedure, the unit of analysis must be the companies involved in the procedure. This approach is in line with authors such as Krajnc and Glavič (2005b) who stated that assessing the social attitude of the company towards its own employees, suppliers, contractors, and customers can be determinant to transform the industry towards social sustainability. Similar conclusions were established by Andrecka (2017), claiming that in the context of public procurement the concepts of social sustainability and corporate social responsibility are strongly connected.

On the other hand, in public procurement, the selection of the project team must be based on a regulated system where fair and objective competition is required (Schöttle and Arroyo 2017). Thus, in public-works procurement, avoiding the subjectivity of best value criteria using quantitative or semi-qualitative indicators is essential to ensure the transparency, objectivity, and equitability of bid-selection processes (Park et al. 2015). For that reason, it is essential to highlight that the method requires the ability to measure social sustainability in a quantitative form (Popovic et al. 2018).

Thus, based on all these facts, the goal of the new methodology is to assess the social performance of the construction companies involved in public contracting, through the inclusion of social criteria in public procurement procedures. This methodology needs to be developed, ensuring the transparency, objectivity, and equitability in the bid-selection processes.

3.4.2. Scope definition

A theoretical framework is valid only within established boundary conditions, where the model must reflect the multidimensional nature of the phenomenon to be measured, as well as specifying the single aspects and their interrelation (Nardo et al. 2005).

The construction industry is one of the first sectors to require specific attention in addressing social sustainability (Hall and Purchase 2006; Bratt et al. 2013; Myers 2013; Pellicer et al. 2016). Construction firms operate with complex social systems influenced by the economic environment and the social-political environment (Glass 2012). This is the reason why the government policies have a significant influence on firms' competitive strategy, and the role of public procurement should be encouraged to influence the industry in favor of socially responsible products and services (Adetunji et al. 2003; Chang et al. 2017; Sierra et al. 2018a).

On the other hand, civil engineering projects, compared to building projects, cause important disturbances to the existing communities and environment (Ugwu and Haupt 2007; Abdel-Raheem and Ramsbottom 2016). Civil engineering projects are usually critical infrastructure projects due to their complexity, high budgets, frequent occurrences, and the inevitable disturbance they cause (Abdel-Raheem and Ramsbottom 2016). For that reason, Chang et al. (2017) claimed that the application of sustainability principles in this type of projects requires a broad interpretation of the construction process, where sustainable construction must be practiced across the project life cycle (Shen et al. 2010). In line with this, and taking into account that the stages of the infrastructures' life-cycle are feasibility, design, construction, operation and demolition (Ugwu and Haupt 2007; Pellicer et al. 2012), most of the studies have focused on the feasibility stage (Shen et al. 2010; Sierra et al. 2017a; Sierra et al. 2017b; Sierra et al. 2018a) and the design stage (Ugwu and Haupt 2007; Lu and Zhang 2016; Navarro et al. 2018; Hossain et al. 2018). Although the activities of the construction stage have a significant influence on the social dimension of the project (Ugwu and Haupt 2007; Sierra et al. 2016), little research has addressed the social dimension of civil engineering projects in the construction stage (Abdel-Raheem and Ramsbottom 2016), positioning itself as a need to be resolved.

Thus, the scope of the methodology has been defined to assess the social sustainability of construction companies in the procurement procedures of civil engineering construction project at the international level.

3.4.3. Focus group definition

According to UNEP (2009) and Nikolaou et al. (2019), among others, the main weaknesses of theoretical frameworks are the lack of transparency in the decision-making procedures. Thus, following the recommendations defined by UNEP (2009), a group of experts was set to be involved and engaged in some of the different decision-making stages of the new methodology defined in this research. Two techniques are mainly highlighted in the literature to involve experts in decision-making procedures: the Focus Group and the Delphi Method.

- <u>Focus Group</u>

This technique is a qualitative research method. Its aim is integrating the different opinions of various stakeholders. This technique is based on encouraging the interactive discussions and knowledge sharing between a group of experts to generate new ideas and knowledge, defining a consistent and holistic viewpoint (Xenarios and Tziritis 2007; Yu et al. 2017). This technique can help to acquire a large amount of information within a relatively short period of time (Yu et al. 2017).

- <u>Delphi Method</u>

The Delphi Method is a research technique focused on obtaining the judgment of a panel of independent experts on a specific topic (Hallowell and Gambatese 2010). The methodology is based on performing two or more rounds of structured surveys. In the first round, facilitator carries out individual surveys with each expert. In the second round, the facilitator provides an anonymous summary of the experts' inputs obtained in the first surveys and participants are encouraged to review the anonymous opinion of the other panelists and consider revising their previous response (Hallowell and Gambatese 2010). The objective of this process is to decrease the variability of the responses until the consensus is reached (Sierra et al. 2017a).

Brüggen and Willems (2009) analyzed and compared the effectiveness of these two research techniques, showing that focus group results have the highest depth and breadth, and are the most efficient, leading to high-quality outcomes. Additionally, taking into account that the concept of social sustainability encompasses complex terms (Landorf 2011; Nikolaou et al. 2019) and the need to be analyzed from different perspectives (UNEP 2009), the focus group was the selected technique.

According to Brüggen and Willems (2009), heterogeneity between the members of the focus group enables guaranteeing a wide spectrum about experiences, perceptions, and opinions; it avoids a strictly homogeneous group which could generate a redundant discussion. Therefore, following to Yu et al. (2017) and Valdes-Vasquez and Klotz (2013), three profiles of experts were identified depending on the following areas of knowledge:

- Profile 1: Public procurement procedures and project delivery methods.
- Profile 2: Construction of civil engineering projects.
- Profile 3: Social sustainability in the construction industry.

The focus group was formed by 12 members with extensive experience in the established profiles. Regarding profile 1, all the experts have more than 20 years of expertise in public procurement procedures and project delivery methods. Concerning profile 2, the minimum number of years of experience in the construction of civil engineering projects was 16, and the maximum was 28. Finally, in profile 3, only one of them has 10 years of expertise in the study of social sustainability in the different stages of the infrastructure life cycle; however, the rest of experts have more than 20 years of expertise in this field. Table 3-2 gathers the years of experience of each expert in each profile.

Table 3-2: Years of experience of each expert in each profile

	Years of experience of each expert		
Expert	**Profile 1**	**Profile 2**	**Profile 3**
1	25		
2	27		
3	25		
4	28		
5		26	
6		16	
7		25	
8		28	
9			10
10			28
11			43
12			45

Note: Profile 1: Public procurement procedures and project delivery methods; Profile 2: Construction of civil engineering projects; Profile 3: Social sustainability in the construction industry.

SOURCE: Own elaboration

Additionally, the following criteria were used to characterize the experts. It was considered appropriate that the experts had to fulfill at least the requirements A and B to participate in the focus group. These requirements were adjusted taking into account the criteria defined by Hallowell and Gambatese (2010):

A. Having at least 10 years of professional experience in the construction industry regarding any of the three profiles.
B. Holding an advanced degree in the field of civil engineering, or other areas related to the three defined profiles.
C. Primary or secondary author of at least three peer-reviewed journal articles.
D. Worker in a private company.
E. Faculty member at an accredited institution of higher learning.
F. Doctoral degree.

Table 3-3 gathers the percentage of experts in each profile that satisfies each criterion. As can be seen, every member has broad expertise in any of the established profiles and held at least a civil engineering degree. Regarding profile 1, two experts were professionals from public agencies, and the other two came from private companies with extensive experience in public procurement procedures and project delivery methods at the national and the international level. All of them have more than 10 years of expertise. Additionally, 50% of these experts have developed a professional career in the research field of this profile, and they also collaborate as faculty members. Concerning profile 2, the four experts have been working on civil engineering projects for more than 15 years. All of them work in a private company, and two of them are Ph.D. professionals, having researched in the field of this profile.

Finally, the experts in profile 3 have vast experience in the study of sustainability in the construction industry, demonstrated by their peer-reviewed journal articles. Most of them are also faculty members.

Table 3-3: Characterization of the focus group

	Percentage of experts that satisfies the criteria per profile		
Criteria	**Profile 1**	**Profile 2**	**Profile 3**
A	100%	100%	100%
B	100%	100%	100%
C	25%	75%	75%
D	50%	100%	0%
E	50%	50%	75%
F	50%	50%	75%

Note: A: Having at least 10 years of professional experience in the construction industry regarding any of the three profiles; B: Holding an advance degree in the field of civil engineering, or other fields related to the three defined profiles; C: Primary or secondary author of at least three peer-reviewed journal articles; D: Worker in a private company; E:Faculty member at an accredited institution of higher learning; F: Doctoral degree; Profile 1: Public procurement procedures and project delivery methods; Profile 2: Construction of civil engineering projects; Profile 3: Social sustainability in the construction industry.

SOURCE: Own elaboration

3.4.4. Selection of social criteria

Eights categories and 24 subcategories of social criteria have been defined to be considered in the construction industry. These represent the main social criteria that should be included in public-works procurement. However, the 24 subcategories were defined taking into account each and every stage of the infrastructure life cycle and considering building and civil engineering projects. As the scope of the theoretical framework focuses on the construction stage of civil engineering projects, the subcategories need to be adjusted to this new scope, selecting only those which are important in the construction stage of this type of projects.

The concept of social sustainability is still evolving (Valdes-Vasquez and Klotz 2013), and social sustainability is a multi-dimensional concept that contains complex implications (Yu et al. 2017). Thus, deciding what social criteria should be considered in the construction phase of civil engineering projects based solely on the previous literature will be limited by the individual bias of the researchers (Valdes-Vasquez and Klotz 2013). To overcome this limitation, a focus group meeting was conducted to investigate the opinions of experts with respect to the decision about how the subcategories should be considered.

The protocol of the focus group meeting was consistent with the suggestions of Morgan (1997) and Yu et al. (2017). Firstly, the table of social categories and subcategories (Table 2-1) was shown to each participant in the focus group. Each member of the focus group was interviewed by the facilitator to know his/her personal experience associated with each social subcategory. Finally, during the meeting, the subcategories were analyzed, and the participants were encouraged to conduct an open discussion about the convenience of taking into account each subcategory to assess the social sustainability during the procurement procedure of civil engineering construction projects. Modifications were made until these interviewees reached an agreement on the subcategory list. The facilitator led this process.

The main results of the focus group focused on the category of “local development”. Experts decided that the subcategories “local preference” and “local employment through the use of local products and services” should not be considered in the new methodology focused on the procurement procedure of civil engineering construction projects. The reasons argued by the focus group members were the following:

- “Local preference” represents giving better scores to national companies in comparison with foreign companies, or limiting the participation in the procurement procedure to national companies. Therefore, the focus group decided that the decision about the inclusion of this subcategory, its level of importance, and the way to be included in the procurement procedure should only depend on governments according to the national, regional and local policies established (Nijaki and Worrel 2012; Burke and King 2015). Another reason to exclude this subcategory was that the decision concerning the consideration of this subcategory should depend on the industry factors, ensuring that the preference of the local industry does not detract from the final quality of the project (NCHRP 2015a).
- “Local employment through the use of local products and services” was discerned between “local products” and “local services”. With respect to the decision about the inclusion of local products in the project, this should be determined in the design stage. The selection of materials must depend on economic, environmental, and social aspects that should be taken into account in the design stage (Navarro et al. 2018). Thus, experts decided to exclude it from consideration in the construction stage. On the other hand, regarding “local services”, the group of experts stated that this part is already considered within the employment category in the subcategory “industry participation plan”. Consequently, this was also excluded to avoid overlaps between subcategories.

The categories and subcategories selected by the focus group to be considered in the procurement procedures for civil engineering construction projects are gathered in Table 3-4.

Table 3-4: Social categories and subcategories to be considered in the procurement procedures of civil engineering construction projects

Categories	Subcategories
Cultural Heritage	Cultural heritage appraisal and management plan
	Collaboration with historical or cultural preservationists
Employment	Employment creation
	Job stability
	Industry participation plan
Health and Safety	Work health and safety management officer
	Occupational health and safety performance
	Workplace health and safety management plan
	Social benefits and social security
Local Development	Social value
Professional Ethics	Non-discrimination and equal opportunities
	Fair wages and fair income distributions
	Child labor
	Forced labor
	Freedom of association and collective bargaining
	Corruption
	Respect of indigenous rights
	Respect of intellectual property rights
Public Participation	Community relations program
Training	Technical training
	Sustainability training
Users' Impact	Effects on neighbors

SOURCE: Own elaboration

3.4.5. Social criteria classification

The methodology to include social sustainability criteria has to be defined to be performed in any procurement procedure for civil engineering construction projects at the international level. Thus, before the development of the methodology, the existing constraints with respect to the inclusion of social criteria in public-works procurement need to be identified. In this regard, the most important restrictions are established by the European Commission. Consequently, these will be taken into consideration to guarantee that the methodology can be tailored to the particular needs of each national context.

Over time, social considerations have become relevant in public procurement (Sanchez-Graells 2018). Initially, countries, such as the USA and Canada, defined specific programs based on social goals to both promote supplier diversity, involving less-competitive bidders, and to create employment opportunities for workers who are generally excluded from the labor market. This approach was for years criticized by the European Union (EU) because this type of actions discriminate among economic operators and are therefore contrary to full and open competition (Cravero 2017). However, the 2014 Directives introduced a unique change, promoting a different approach in both the employment context and in supplier diversity (IHRB 2015). New and powerful terms were presented in the 2014 Directives to go beyond regarding the contractor's compliance with general legal requirements, such as occupational health and safety, and providing broader social benefits. This provided an exception to the competition principle based on a socially-oriented justification, and the new strategy opened a new chance for companies with aligning social values to win public contracts (IHRB 2015; Cravero 2017). Consequently, the EU's 2014 rules provided an increased scope for contracting authorities to include social considerations in the design and execution of public tenders (Sanchez-Graells 2018).

Although the 2014 Directives give the member states some freedom to define national mechanisms to include social considerations in public procurement (IHRB 2015), these require that criteria within the technical specifications, award criteria, and contract performance clauses must be "linked to the subject matter"; in other words, being directly related to the performance of the company with respect to the individual item, work or service being purchased. The criteria, therefore, cannot refer to the bidder at a company-wide level, unless these are included within the exclusion grounds and/or selection criteria of the procurement procedures (IHRB 2015; Cravero 2017). Another requirement established in the 2014 Directives is about the obligation of the member states to take appropriate measures to ensure compliance with human rights and social and labor law obligations by bidders (IHRB 2015).

Based on these facts, and to facilitate the inclusion of the social criteria in public-works procurement at the international level, the social subcategories should be classified into the following two groups:

- Group A, which includes those subcategories related to human rights.
- Group B, which represents those subcategories that can be "linked to the subject matter of the contract".

However, to cope up with the complexity of integrating social sustainability in the construction industry, an approach for integrated assessment of companies is required to provide good guidance for decision-making, offering the opportunity to define new policy guiding instruments and better integration of decision-making (Krajnc and Glavič 2005a). This approach is in line with numerous authors, whose studies have focused on analyzing the framework and methodology regarding the definition of indicators for sustainable production (Veleva and Ellenbecker 2001; Krajnc and Glavič 2004, Krajnc and Glavič 2005a; Dočekalová and Kocmanová 2016). Social indicators reflect the attitude of the company towards its employees, suppliers, contractors, and customers (Krajnc and Glavič 2005b). For that reason, these authors highlight the importance of assessing the entire company and involving all employees to help raise the overall awareness and skills and, thus, build the intellectual capital of an organization (Krajnc and Glavič 2004; Dočekalová and Kocmanová 2016). Then, if subcategories are defined at a company level, companies will be able to use indicators to set targets and help the decision-maker visualize what actions will need to be emphasized in future (Krajnc and Glavič 2004).

These facts are especially important in public procurement taking into account that inconsistencies exist in the way each different EU member state addresses the companies' commitment to respecting social and human rights in their activities and operations (IHRB 2015). Analyzing only the company linked to the project could imply an important bias, because the social performance of the company in the project will not necessarily be the social performance in the whole company. Decision-makers need to measure the social progress of construction companies to know whether they are meeting the goal of social responsibility in the construction industry or to determine the direction of change on social sustainability of the national industry (Krajnc and Glavič 2005a). Therefore, based on the need to develop a comprehensive framework of social criteria that focuses on assessing the social performance of the construction companies in the public procurement of civil engineering construction projects, Group B of subcategories should split into two subgroups:

- Criteria that could be defined at the company level and, thus, linked to its daily social performance considering the entire company.
- Criteria whose definition could be based on the project characteristics and, therefore, linked to the project.

Based on these classifications, three groups of criteria are identified: (1) human rights (G1), (2) corporate social responsibility (G2); and, (3) social commitment with in the project (G3). The categories and subcategories associated with each group of criteria are gathered in Table 3-5.

- **Human rights (G1)** is related to human rights, and includes the subcategories child labor, forced labor, freedom of association and collective bargaining, corruption, respect of indigenous rights, respect of intellectual property rights.
- **Corporate social responsibility (G2)** is associated with the daily corporate social responsibility of the entire construction company. This group clusters the subcategories employment creation, job stability, occupational health and safety performance, social benefits and social security, social value, non-

discrimination and equal opportunity, fair wages and fair income distributions, technical training, and sustainability training.

- **Social commitment in the project (G3)** refers to the commitment of the construction companies in the project, and it includes the subcategories cultural heritage appraisal and management plan, collaboration with historical or cultural preservationists, industry participation plan, work health and safety management officer, workplace health and safety management plan, community relations program, and effects on neighbors.

Table 3-5: Social subcategories gathered in each group

Groups	Category	Subcategories
Human Rights (G1)	Professional Ethics	Child labor
		Forced labor
		Freedom of association and collective bargaining
		Corruption
		Respect of indigenous rights
		Respect of intellectual property rights
Corporate Social Responsibility (G2)	Employment	Employment creation
		Job stability
	Occupational Health and Safety	Occupational health and safety performance
		Social benefits and social security
	Local Development	Social value
	Professional Ethics	Non-discrimination and equal opportunities
		Fair wages and fair income distributions
	Training	Technical training
		Sustainability training
Social Commitment in the Project (G3)	Cultural Heritage	Cultural heritage appraisal and management plan
		Collaboration with historical or cultural preservationists
	Employment	Industry participation plan
	Occupational Health and Safety	Work health and safety management officer
		Workplace health and safety management plan
	Public Participation	Community relations program
	Users' Impact	Effects on neighbors

SOURCE: Own elaboration

3.4.6. Methodological approach

The objective of this section is establishing the foundations to determine in detail a straightforward methodology that can be applied to any procurement procedure for civil engineering construction projects. The methodology has to lead to the formation of a comprehensive assessment of the social performance of the construction companies involved in the procurement procedure. Thus, the basis to give answer to the specific objectives “Defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures” (O4) and “Determining a methodology to include the social sustainability criteria in public-works procurement procedures” (O5) are addressed in the following subsections for each one of the established groups of subcategories.

3.4.6.1. Human Rights (G1)

Directives and policies at the international level have been defined to integrate human rights considerations into national rules and practices on public procurement (IHRB 2015). In fact, in 2014, a new set of rules of the European Commission were published regarding the procurement procedures of the EU member states:

- Directive 2014/23/EU on concession contracts (OJ 2014 L94/1).
- Directive 2014/24/EU on public sector procurement (OJ 2014 L94/65).
- Directive 2014/25/EU on utility procurement (OJ 2014 L94/243).

According to Sanchez-Graells (2018), the new set of rules depicts the emerging consensus towards including human rights considerations in the design and execution of public tenders. The IHRB (2015, p.5) claimed that these new EU Public Procurement Directives: "explicitly welcome the use of social and human rights related criteria within procurement processes in a way most would not have thought possible only a few years ago"; they encourage the inclusion of a much broader range of social and human rights-related measures in all phases of the procurement process, covering not only the main contractor but also their subcontractors.

However, significant limitations have been identified regarding the way to be implementation, because many of the human rights-related provisions are entirely discretionary on EU member states with respect to the choice of implementing them and how to do it. For this reason, IHRB (2015) emphasized the risk of a low inclusion of social terms in public procurement procedures; Sanchez-Graells (2018) and IHRB (2015) stated that the protection of human rights through public contracts is just starting and needs to gain traction as a key area of procurement policy and practical application by the EU member states.

Therefore, the goal of the methodology associated with this group of human rights is guaranteeing that every procurement procedure considers requirements related to the human right subcategories, and ensuring that every construction company who is involved in the process knows and complies with each of these human rights subcategories. Thus, the methodological approach is based on defining each subcategory that takes into account both the literature review and the tendering documents; and, analyzing how these subcategories could be included in tendering documents at the international level. A comprehensive definition includes each of these subcategories and allows adaptation to each procurement procedure, taking into account the normative framework of each country.

3.4.6.2. Corporate Social Responsibility (G2)

The corporate social responsibility group (G2) was formed by those subcategories that can be defined to assess the corporate social responsibility of the construction companies involved in the procurement procedure. The methodological approach is based on the definition of a composite indicator. Thus, the definition of the goal of the composite indicator, as well as the process to establish the individual indicators and the weights of each indicator are explained as follows.

- <u>Goal:</u>

The goal of this composite indicator is assessing the corporate social features of each company that participates in the tendering procedure. The methodology to implement this group in public-works procurement was based on the following two principles:

- **Company indicators** need to be quantitative, reliable and verifiable to guarantee the robustness of the methodology.
- **Weighting system** has to be addressed to minimize the social weaknesses in each country over time.

The reason why these principles have been defined is justified in the following bullet points.

- <u>Company Indicators:</u>

The final objective of the methodology in corporate social responsibility group is prioritizing those companies that, among other criteria, offer the best corporate social performance. Consequently, the definition of indicators to quantitatively assess the companies will guarantee the transparency and reliability of the method.

Regarding the definition of social indicators to assess the social performance of construction companies, Székely and Knirsch (2005) claimed that social indicators need to be: simple, understandable, easy to reproduce, comparable, involve cost-effective data collection, and be useful as a management tool. Additionally, the United Nations (2008a) established the following quality criteria to define indicators in corporate responsibility reporting:

- Comparability: Metrics need to be compared over time and between enterprises to enable identifying and analyzing the effect as a result of changes in policy and management.

- Relevance: Represents the importance of a specific metric to explain a problem under analysis, depending on if its omission or misstatement could influence users' decisions.
- Understandability: The information on corporate responsibility must be understandable to the reader. The manner of the presentation should be concise, explaining the unknown terms.
- Reliability and verifiability: Information has to be free from material error and bias, and it has to give a true, complete, and balanced view of the actual situation. Additionally, it should allow for internal or external verification.

Thus, these premises must be taken into account to determine the company indicators. Additionally, the most important feature of a procurement procedure is guaranteeing a fair, transparent, and objective competition (Schöttle and Arroyo 2017). Therefore, an essential requirement to define the company indicators is ensuring their reliability and verifiability in the procurement procedure. This is a key aspect in case the procurer considers the need for auditing and verifying the truthfulness of the data provided by the construction companies involved in the procedure. Consequently, the collaboration with experts will be essential to define the company indicators.

- Weights:

Currently, establishing the weights in the social assessment of product, projects, or companies is a critical issue due to the subjectivity of these tasks (UNEP 2009). The most widely accepted methods are based on assigning equal weights or using expert judgments to establish the weights of each subcategory (Hosseinijou et al. 2014; Fan et al. 2016; Opher et al. 2017; Garrido et al. 2018). However, according to UNEP (2009), these techniques are not generally accepted by practitioners. For that reason, recent studies in the field of social assessment highlight the need to establish new approaches to assign weights (Liu and Qian 2019). In line with this, Garrido et al. (2018) stated that new approaches had been identified to assign weights, being one of the most highlighted, the one based on the prioritization of the worst performance indicator within a subcategory. This approach focuses on assigning a weighting factor of 1.0 to the worst scored indicator and 0.0 to the rest of the indicators in a subcategory. Nevertheless, this approach would not be valid for use in public-works procurement, because it could result in companies focusing on a small group of social indicators instead of seeking the global social performance of the company. However, this research finds in this new approach the opportunity to define a methodology to assign the weights to the social indicators.

The aim of this methodology focuses on the fact that the weights of social indicators should depend on the social weaknesses that exist in a specific area, region, or country. Assigning the maximum weights to the most important weaknesses in a country may encourage construction companies to focus on these social aspects without abandoning the rest of social issues. This approach leads to the improvement of the social performance in the industry working over the current weaknesses, and it was supported by studies such as Cherchye et al. (2008) or Cook et al. (2017). These authors claimed that what is needed is a weighting scheme based on allowing weights to vary across objectives, over countries and through time. Thus, the weighting system has to be capable of adapting to the social needs of each country over time.

Regarding the weighting techniques that exist in the literature review, only data envelopment analysis (DEA) satisfies this approach. DEA is a well established non-parametric technique. Through a mathematical programming model, DEA defines an efficiency frontier and uses this frontier as a benchmark to measure the performance of a given set of entities (such as countries, companies, projects, etc.) (Nardo et al. 2005; Joint Research Centre-European Commission 2008). Then, a set of weights is assigned to each entity comparing it with the benchmark and looking for its maximum/or minimum efficiency (depending on the optimistic or pessimistic approach of the model). Thus, the weights assigned to each entity will be different from the other entities if their performances are different (Cherchye et al. 2008).

Concerning the construction of composite indicators through data envelopment analysis (DEA), the most widely accepted method is the Data Envelopment Analysis - Benefit of the Doubt (DEA-BOD) approach. This method emerged to increase discriminating powers of the DEA method, improving the comparisons among different entities (Zhou 2008). According to Rogge (2018), there has been a rapid increase in the use of this method in various policy contexts. Two versions have been developed for the DEA-BOD approach: the optimistic version and the pessimistic version (Rogge 2018). The goal of the pessimistic version is to minimize the efficiency, assigning the maximum weights to the worst performance indicators in a country (Zhou et al. 2007). This pessimistic version represents the methodological approach of the corporate social responsibility group, and is the basis of its development.

3.4.6.3. Social Commitment in the Project (G3)

Social commitment in the project group (G3) has been defined with those social subcategories whose definition must be linked to the project and, thus, depict the commitment of the construction companies in the project. The subcategories gathered in this group are associated with the cultural heritage protection, the enhancement of the industrial participation in the project, the assurance of the occupational health and safety in the project, the promotion of the public participation, and the reduction of the users' impacts. The inclusion of these social subcategories in the procurement procedure allows laying down the needs and priorities identified by the procurer so that the companies interested in participating in the procurement procedure can appropriately account for cost, risks or staffing requirements (NCHRP 2015a). However, generally, when these types of requirements are needed for a project, their selection and definition are made by the project team without guidance or a standardized and transparent decision process. Consequently, the aim of this section is defining the methodology to assess these subcategories objectively in the procurement procedures of construction projects.

The methodological approach needs to be based on the definition of a composite indicator that helps to undertake a holistic assessment of the construction companies' social performance. The definition of the composite indicator's goal, as well as the process to establish the individual indicators and the weights of each indicator are explained below.

- Goal:

The goal of this composite indicator has to focus on assessing, objectively, the social commitment that the construction companies, involved in the procurement procedure, intend to achieve during the development of the project. A composite indicator can be defined using quantitative, semi-quantitative and/or qualitative form indicators (Freudenberg 2003). However, social effects are not always quantifiable (UNEP 2009), and although indicators should be quantitative whenever possible, for some aspects of social sustainability qualitative descriptions may be more suitable (Azapagic 2004). This is the case of the subcategories gathered in the social commitment in the project group (G3), where their definitions must be based on qualitative or semi-quantitative indicators. Additionally, the indicators to assess each subcategory must be directly linked to the subject matter of the project; consequently, both the definition of each indicator and their level of importance must adapt to the project characteristics.

- Indicators:

As noted in the literature review, many studies have developed social sustainability indicators based on the opinion of stakeholders. However, stakeholder perception can be limited in this regard because of the complexity to define and understand most of the different aspects that represent this dimension of sustainability (Yu et al. 2017). Thus, in this research, to determine the indicators, a comprehensive definition of each subcategory was performed. Through this information, the definition of each indicator to be used in the new methodology was established.

To define each subcategory, the characterization started analyzing sustainability certification systems. Various certification systems and rating tools have emerged to measure the sustainability of infrastructure projects (Clevenger et al. 2016). These tools guide the assessment of individual infrastructure projects according to a range of sustainability criteria, to analyze the sustainable performance of the project (Griffiths et al. 2015; Clevenger et al. 2016; Griffiths et al. 2017). However, authors such as Pocock et al. (2016) and Griffiths et al. (2017) highlighted the lack of coverage of social issues in these certification systems. Therefore, to solve this handicap and give a more comprehensive approach to the definition of each subcategory, 451 tendering documents from 10 countries were analyzed, and the best descriptions found in these documents were used to improve the definition of each subcategory.

Once the subcategories were characterized, the indicators to assess each subcategory and their definitions were established. In each definition, the description of the indicators and the evaluation method to assess each of them in the procurement procedure were included. This is a key step in the definition of this new methodology; because the selection of the project team in public procurement must be based on a regulated system where fair and objective competition is required (Schöttle and Arroyo 2017). Thus, it is essential to avoid the subjectivity ensuring the transparency, objectivity, and equitability of bid-selection processes.

- Weights:

The relative level of importance of each indicator needs to be defined depending on project characteristics. Kraft and Molenaar (2015) and Yu et al. (2017) stated that the definition of an assessment system that uses various project factors to determine the level of importance of different qualitative indicators could be very useful for practitioners. Project factors represent the project characteristics that are going to influence the level of importance of each indicator in social commitment in the project group (G3). These project factors were defined considering the literature review and the findings established through the analysis of the tendering documents.

According to UNEP (2009), the aggregation of qualitative indicators requires expert judgment. For that reason, the determination of the level of importance of each indicator depending on the project characteristics was carried out through the focus group. Finally, a methodology to calculate the composite indicator was determined; and, a sensitivity analysis was performed to analyze the possible variation that the indicators may experience depending on the project characteristics. This is a key step to assess if the method satisfies the requirements of the theoretical framework in terms of the model's ability to adapt to the project characteristics.

3.5. Chapter summary

This chapter gathers the research method to characterize the inclusion of social criteria in public-works procurement at the international level. This is based on analyzing the contents of 451 tendering documents from 10 countries. The analysis of these documents focuses on giving an answer to the first three raised research goals by using statistical techniques. Additionally, this chapter also proposes the theoretical framework to develop the methodology to include the social sustainability criteria in procurement procedures of civil engineering construction projects. Three groups of social criteria are established: human rights, corporate social responsibility, and social commitment in the project. The methodological approach for each group of social criteria is established with the aim of guaranteeing their effective and efficient implementation in public-works procurement.

CHAPTER 4

CHARACTERIZATION OF SOCIAL SUSTAINABILITY CRITERIA IN PUBLIC-WORKS PROCUREMENT

This chapter focuses on characterizing the inclusion of social sustainability criteria in public-works procurement. The sample of tendering documents is analyzed according to the variables associated with the project characteristics: country, infrastructure type, and contract size. Then, the sample is assessed with respect to the consideration of procurement procedures and project delivery methods at the international level. The aim of this second task is analyzing the robustness of the sample for drawing conclusions. Subsequently, descriptive statistics are developed to identify the main social sustainability criteria that, currently, are included in public-works procurement; furthermore, descriptive statistics and the Mann-Whitney U-test are performed to characterize how social criteria are defined depending on the stage of the tendering procedure. Finally, descriptive statistics, logistic regressions, correspondence analysis, and chi-square contingency table analysis are undertaken to identify the relationship between the social criteria and the variables associated with the project characteristics. The most influential project characteristics on the inclusion of social criteria in public-works procurement procedures are identified too.

4.1. Introduction

To characterize the inclusion of social sustainability in public construction procurement, this research proposes the analysis of tendering documents. The research objectives fulfilled in this chapter are: analyzing how public-works procurement procedures and project delivery methods are considered at the international level (O1); identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these are defined depending on the stage of the tendering procedure (O2); and assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures (O3). Thus, in this chapter, after characterizing the sample, different statistical techniques are combined to achieve the maximum understanding of these three specific objectives. Finally, based on the main results of these analyses, the most important findings are summarized to establish the foundations for the proposed methodology.

4.2. Sample characterization

The dataset includes 451 tendering documents representing a wide variety of government agencies from 10 countries. The information gathered from these tendering documents proved satisfactory for inter-rater reliability by achieving values over or equal to 0.8 for every variable.

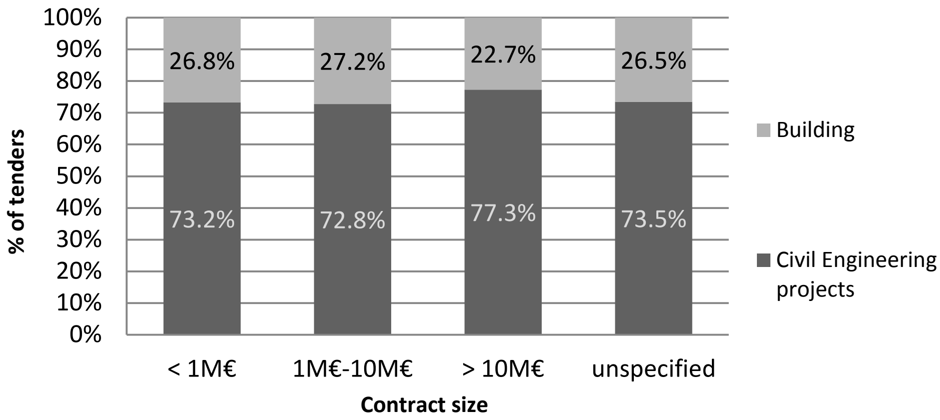
To characterize the sample, the variables country, infrastructure type, and contract size have been used. Table 4-1 shows the distribution of the 451 gathered tendering documents according to these variables. As can be seen, 40.1% of the tendering documents are from English-speaking countries (ESCs), and 59.9% from Spanish-speaking countries (SSCs). A total of 67.3% (15.7% + 35.0% + 16.6%) of the tendering documents represent a total contracting capacity above 6,000,000 euros, while the other 32.6% correspond to projects in which the budget is not previously specified in the award phase. This scenario is notably common in countries such as Australia (100%), Canada (71.0%), and, to a lesser extent, the United Kingdom (57.6%). In addition, 26.2% of the analyzed tenders are building projects, and 73.8% are civil engineering projects.

Table 4-1: Characterization of the data sample

Country	Tenders	Infrastructure Type		Contract Size			
		Building	Civil Engineering Projects	<1,000,000€	1,000,000€-10,000,000€	> 10,000,000€	Unspecified
Australia	66	28.8%	71.2%	0.0%	0.0%	0.0%	100.0%
Canada	31	29.0%	71.0%	6.5%	12.9%	9.7%	71.0%
UK	33	45.5%	54.5%	18.2%	18.2%	6.1%	57.6%
USA	51	23.5%	76.5%	13.7%	43.1%	29.4%	13.7%
ESCs	181 (40.1%)	31%	69%	8%	18%	11%	63%
Argentina	29	13.8%	86.2%	27.6%	44.8%	10.3%	17.2%
Chile	71	19.7%	80.3%	33.8%	19.7%	9.9%	36.6%
Colombia	25	16.0%	84.0%	24.0%	36.0%	40.0%	0.0%
Panama	22	31.8%	68.2%	68.2%	13.6%	9.1%	9.1%
Peru	29	31.0%	69.0%	10.3%	48.3%	41.4%	0.0%
Spain	94	25.5%	74.5%	0.0%	77.7%	22.3%	0.0%
SSCs	270 (59.9%)	23%	77%	21%	47%	20%	12%
Total	451 (100%)	26.2%	73.8%	15.7%	35.0%	16.6%	32.6%

SOURCE: Own elaboration

On the other hand, Figure 4-1 illustrates the percentages of building and civil engineering projects in each category of contract size, showing that the proportions are similar. The percentage of tenders associated with civil engineering projects is by far superior to building projects.



SOURCE: Own elaboration

Figure 4-1: Distribution of percentage of tenders per contract size and type of infrastructure

4.3. Analyzing how public-works procurement procedures and project delivery methods are considered at the international level

The low bid and best value are the two main procurement procedures in public-works procurement (Molenaar and Johnson 2003). Concerning delivery methods, two groups have been established: traditional (DBB) and integrated (comprising DB, IPD, CMR, CM/GC, PPP, concessions, etc.) delivery methods. The success of a project is significantly influenced by the criteria that are established to evaluate the bids. In fact, numerous investigations highlight the serious problem associated with the use of the lowest price as the sole evaluation criterion to reach sustainability goals, since this procurement procedure is based on reducing bid prices as much as possible, even when a higher cost product may be in the owner's best interest (NCHRP 2006). Thus, including suitable criteria is a key element to ensure the technical, economic, and professional capability of the contractor, and to illustrate the project goals. For that reason, during the last decades, construction procurement has experienced a transformation from low bid to best-value procurement (Okunlola 2012). Table 4-2 shows the distribution of the 451 tendering documents per project delivery method and procurement procedure, showing the percentage of each category of these variables per group of countries. As can be seen, the best-value procurement is considered in 61.7% of the analyzed sample; being the use of low bid considered in 38.3% of the tendering documents. However, these values vary notably depending on the group of countries that is analyzed. On the other hand, regarding project delivery methods, the traditional method is considered in 80.3% of the tendering documents; the use of this delivery method in both ESCs and SSCs, 76% and 83%, respectively.

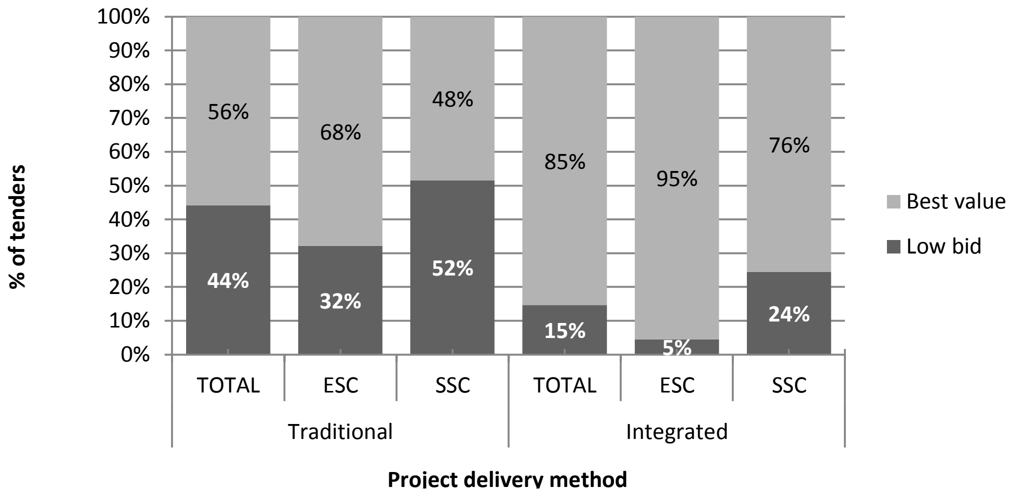
Table 4-2: Summary of the data sample

Country	Total (#)	Procurement Procedure		Project Delivery Method	
		Low bid	Best Value	Traditional	Integrated
ESCs	181	46 (25%)	135 (75%)	137 (76%)	44 (24%)
SSCs	270	127 (47%)	143 (53%)	225 (83%)	45 (17%)
Total	451	173 (38.3%)	278 (61.7%)	362 (80.3%)	89 (19.7%)

Note: ESCs: English-speaking countries; SSCs: Spanish-speaking countries

SOURCE: Own elaboration

Figure 4-2 shows the distribution of the tendering documents depending on the procurement procedure and discriminating between the project delivery method and group of countries. As can be seen, 56% of traditional delivery methods and 85% of integrated delivery methods include best-value procurement procedures. However, these percentages are highly influenced by the results associated with the ESCs; since these countries show a clear predisposition towards the use of best-value in both traditional and integrated delivery methods, and the use of best-value procurement procedures in the integrated delivery methods of the ESCs being 95%.



SOURCE: Own elaboration

Figure 4-2: Distribution of percentage of tenders per procurement procedure and delivery method

Although the transformation towards best-value procurement is a fundamental feature to include social sustainability criteria in the awarding of a project, Broesterhuizen et al. (2014) remarked that, in the procurement phase of a construction project, not only setting sustainable criteria is important, but the choice of an integrated delivery method can be decisive to facilitate project sustainability. Numerous researchers have highlighted that, during recent years, projects have been evolving towards integrated approaches (Oyegoke et al. 2009; Shrestha, O ’Connor, and Gibson 2012; Bo Xia et al. 2014). However, the results show that only 20% of the sample comprises integrated delivery contracts. This fact concurs with the findings of authors such as Naoum and Egbu (2016), who emphasized that the traditional form is still the dominating procurement method.

To assess the use of project delivery methods and procurement procedures within the gathered sample, two logistic regressions were developed. The aim of these two analyses was identifying, on the one hand, the independent variables that influence the selection of the project delivery and, on the other hand, the independent variables that weigh on the selection of the procurement procedure. The independent variables in each logistic regression model were country, infrastructure, and contract size. The groups of contract size were analyzed to reduce the number of categories for these statistical analyses. Based on the results, the groups of tendering documents with contract size 1 M€-10 M€ and those with an unspecified budget were grouped after verifying that both did not show significant differences. The levels for each dependent and independent variable are defined in Table 4-3.

Table 4-3: Categories defined for each variable in the logistic regressions

Variables	Categories
Project delivery method	0: Traditional
	1: Integrated
Procurement procedure	0: Low bid
	1: Best value
Country	0: Spanish-speaking countries (SSCs)
	1: English-speaking countries (ESCs)
Infrastructure	0: Building
	1: Civil engineering
Contract size	0: Budget less than 1,000,000€
	1: Budget between 1,000,000€ and 10,000,000€, and unspecified budget
	2: Budget greater than 10,000,000€

SOURCE: Own elaboration

The analysis of the logistic regression was based on those independent variables found to be statistically significant. If an independent variable is statistically significant, its p-value is lower than 0.05, and it represents that this variable influences significantly the value of the dependent variable (Field 2013). Secondly, the coefficients of the independent variables (B), the Wald statistic, and the odds ratio (Exp(B)) were used to assess the level of influence of these variables on the dependent variable.

- <u>Project delivery method:</u>

In this regression logistic, the dependent variable is the project delivery method, and the independent variables are country, infrastructure, and contract size. Table 4-4 shows the results associated with the statistical significance of the independent variables ($p\text{-value} < 0.05$). According to the Wald statistic of each independent variable, the project contract size is the most influential variable with respect to the decision of using integrated project delivery methods, followed by the type of infrastructure. Based on the odds ratio (Exp(B)), building projects tend to be procured through integrated project delivery methods; however, civil engineering projects are more oriented towards traditional methods. Furthermore, ESCs show more significant use of integrated methods in comparison with SSCs. The use of integrated delivery methods increases considerably in projects whose contract size is over 10 M€.

Table 4-4: Results of logistic regression. Dependent variable: project delivery method

Independent Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Country	0.666	0.271	6.036	1	0.014	1.946
Infrastructure	-1.121	0.273	16.840	1	0.000	0.326
Contract size	-	-	41.785	2	0.000	-
Contract size: 1-0	0.182	0.425	0.183	1	0.669	1.199
Contract size: 2-0	2.097	0.461	20.708	1	0.000	8.144
Constant	-1.532	0.422	13.151	1	0.000	0.216

Note: B: Regression coefficients (in log-odds units); S.E.: square errors; Wald: Wald statistic; df: degrees of freedom; Sig.: 2-tailed *p*-value (significant if < 0.05); Exp(B): log-odds of success. Infrastructure (0: building; 1: civil engineering). Country (0: SSCs; 1: ESCs). Contract size (0: < 1 M€; 1: 1 M€-10 M€ + unspecified budget; 2: > 10 M€).

SOURCE: Own elaboration

Oyegoke et al. (2009) stated that the use of integrated delivery methods, such as DB, has increased for projects with important contract value due to the needs of achieving significant change in project organization, structure, and communication channels. However, the countries that have primarily boosted these types of delivery methods are the USA (Hale et al. 2009) and the UK (Barraket and Weissman 2009), especially in building projects. In fact, Xia et al. (2014) pointed out that 75% of the current new building construction projects seeking sustainability certification in the USA were delivered with integrated project delivery methods.

- Procurement procedures:

In the logistic regression to analyze the use of the procurement procedures, project delivery method was included as an independent variable. Thus, the independent variables were country, infrastructure, contract size, and project delivery method. The dependent variable was the procurement procedure. Table 4-5 shows the results associated with the statistical significance of the independent variables (p-value < 0.05). As can be seen, the use of best value is notably higher in ESCs compared to SSCs, where the odds ratio is 2.3 times higher; the greater the contract size, the higher the odds of using the best value; and, the best value prevails in integrated delivery methods, where the odds ratio is 3.5 times higher with respect to traditional methods. Additionally, the Wald statistics highlight that contract size is the most influential variable, followed on a similar level by the project delivery method and country.

Table 4-5: Results of logistic regression. Dependent variable: Procurement procedures

Independent Variables	B	S.E.	Wald	df	Sig.	Exp(B)
Country	0.818	0.229	12.727	1	0.000	2.267
Infrastructure	-0.659	0.267	6.116	1	0.013	0.517
Contract size	-	-	32.048	2	0.000	-
Contract size: 1-0	1.568	0.310	25.557	1	0.000	4.799
Contract size: 2-0	2.104	0.412	26.037	1	0.000	8.195
Project delivery method	1.253	0.35	12.821	1	0.000	3.500
Constant	-0.912	0.344	7.038	1	0.008	0.402

Note: B: Regression coefficients (in log-odds units); S.E.: square errors; Wald: Wald statistic; df: degrees of freedom; Sig.: 2-tailed p-value (significant if < 0.05); Exp(B): log-odds of success. Infrastructure (0: Building; 1: Civil engineering). Project delivery method (0: traditional; 1: integrated); Country (0: SSCs; 1: ESCs). Contract size (0: <1 M€; 1: 1 M€-10 M€ + unspecified budget; 2: >10 M€).

SOURCE: Own elaboration

These findings are consistent with the literature because authors such as Molenaar et al. (2010) and Xia et al. (2015) have highlighted that integrated delivery methods tend to utilize best-value procurement to provide opportunities for the contractor to pursue sustainability objectives as well as those concerning time, cost, and quality. Moreover, Doloi (2013) remarked that the traditional method generally selects the low bid to reduce the costs associated with the project. However, civil engineering projects are oriented towards the use of the low bid due to the many uncertainties in the pre-construction stage (Varnäs 2008) and the difficulty of defining objective criteria (Ruparathna and Hewage 2015b).

Thus, according to the results obtained in both logistic regressions and its discussion based on the literature review, the results obtained in both logistic regressions confirm the robustness of the analyzed sample for drawing conclusions.

4.4. Identifying the main social sustainability criteria and how these criteria are defined depending on the stage of the tendering procedure

The characterization of the social sustainability criteria in current public-works procurement was based on the identification of the main social criteria in the tendering documents, as well as the analysis about how these social criteria were defined in these documents.

4.4.1. Main social criteria

To characterize the inclusion of social criteria in public procurement, a quantitative content analysis combining both inductive and deductive approaches was performed. Thus, for its implementation, a characterization outline composed of two levels was established. First, following a deductive approach, the social indicators gathered in tendering documents were associated with each social category using the affinity diagram technique (Carnevalli and Miguel 2008). Second, these social indicators related to each social category were clustered following an inductive process in "sub_2" subcategories. This analysis was based on the assumption that each "sub_2" subcategory was identified at least once in each tendering document. The objective was to avoid the possible variability associated with the *modus operandi* of each public agency, trying to show a normalized comparison based on frequencies of appearance. Table 4-6 shows the 22 "sub_2" subcategories established through the inductive process; the number of times that each subcategory appeared in the 451 tendering documents; and the number of tendering documents that at least once included indicators related to each subcategory.

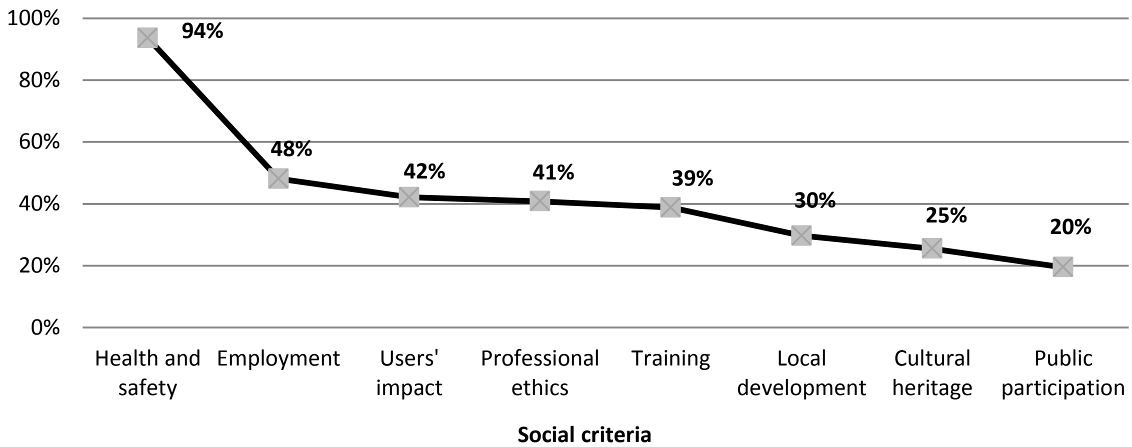
Table 4-6: Results of logistic regression. Dependent variable: Procurement procedures

Categories (groups of criteria)	Sub_2 Subcategories (groups of social indicators)	Number of indicators that were gathered for each subcategory	Tendering documents that at least once included the subcategory
Cultural heritage	Preservation of historic and cultural resources	117	109
	Professional expertise in cultural heritage	11	10
	Total	128	111
Employment	Employment created or retained	107	91
	Employment of vulnerable groups	272	176
	Job stability	65	60
	Industry participation plan	54	51
	Total	498	217
Health and safety	Workplace health and safety management plan	569	414
	Public safety	164	147
	Occupation health and safety certifications	36	34
	Professional expertise in health and safety	83	76
	Total	852	422
Local development	Local preference	47	44
	Local participation	138	101
	Social value	60	44
	Total	245	134
Professional ethics	Non-discriminatory hiring practices	38	38
	Commitment to anti-corruption	52	52
	Gender equality	131	128
	Fair wages	65	64
	Total	286	184
Public participation	Public participation	177	97
	Total	177	97
Training	Technical and sustainability training of workers	212	175
	Total	212	175
Users' impact	Avoiding or minimizing the harm done to the neighborhood	89	80
	Avoiding or minimizing the harm done to the existing services	14	14
	Avoiding or minimizing mobility disruption	223	159
	Total	326	190
	Total	2724	451

SOURCE: Own elaboration

The results show that within the 451 analyzed tendering documents, 2,724 social indicators were included. The most considered "sub_2" subcategories are workplace health and safety management plan, employment of vulnerable groups, avoiding or minimizing mobility disruption and technical and sustainability training of workers. Contrarily, “sub_2” subcategories related to professional expertise in cultural heritage and occupation health and safety certifications were the least included despite their easy quantification.

Figure 4-3 shows the percentage of consideration of each category in the analyzed sample. The number of times that the category health and safety shows up is notably higher in comparison with the rest of the categories. This is followed by employment, users’ impact, professional ethics, and training. In contrast, the percentage of tenders that consider local development, cultural heritage, and public participation criteria is less than 30%. Additionally, it is essential to highlight the low percentage of instances associated with public participation criteria, having been considered in only 20% of the tendering documents. This result may be because the legislation of most of the countries mandates citizen participation in different phases of the tendering procedure, making it unnecessary to include this type of criteria in the documents of the tendering criteria since it is an action that is inherent to the procedure. This fact makes the analysis of this category unrepresentative; consequently, it has not been considered in the next stages of the analysis.



SOURCE: Own elaboration

Figure 4-3: Percentage of consideration of each group of social criteria in the sample

According to the results, the categories of social criteria can be clustered depending on their level of inclusion in the tendering documents. Thus, three groups are established based on the frequency of consideration of these social criteria in the analyzed tendering documents.

Health and Safety criteria form the first and most important level. As Reyes et al. (2014) remarked, the incorporation of health and safety criteria in constructions project improves working conditions, minimizes accident rates, and reduces projects cost. This knowledge seems to have been accepted by procurers at the international level because instances associated with this group of criteria appear in almost the whole analyzed sample; this represents its strong acceptance at the international level. Within this group, indicators related to the development of workplace health and safety management plans and ensuring public safety are the most frequently considered.

The second level gathers employment, users' impact, professional ethics, and training criteria. McCrudden (2004) remarked that public procurement could be used to enforce anti-discrimination law in the employment context and to boost the recruitment of disadvantaged groups. The results show that the employment of vulnerable groups has been one of the most frequently cited instances within the group of employment criteria. However, sub_2 subcategories such as job stability and industry participation plan were included in very low percentages; although, the enhancement of employment stability is the key to improve sustainable development (Pellicer et al. 2016b), and Burke and King (2015) remarked on the importance of Small and Medium Enterprises (SMEs) in developing the social value of the construction industry. On the other hand, strong efforts are needed regarding the use of professional ethics criteria. None of the sub_2 subcategories in this group overcomes one third in the frequency of occurrence. The consideration of non-discriminatory hiring practices and fair wages have been scarce; and, although gender equality has been the most considered within this group, it has been included in less than one-third of the analyzed sample. These results are important since the construction industry is still a notably male-dominant industry where only 12% of professional construction roles (such as architect, quantity surveyor and engineer) are women and where concerns such as unemployment, low pay or the gender pay gap are important issues that need to be addressed (Wright 2015). Criteria related to training of workers and minimizing mobility disruption have become increasingly important. As Akenroye (2013) remarked, public procurement can create skills development, and requiring training programs in procurement procedures can boost suppliers' understanding of social issues. Additionally, the affection over the community due to the work development is an important aspect that needs to be addressed during the design and planning stages (ISI 2015).

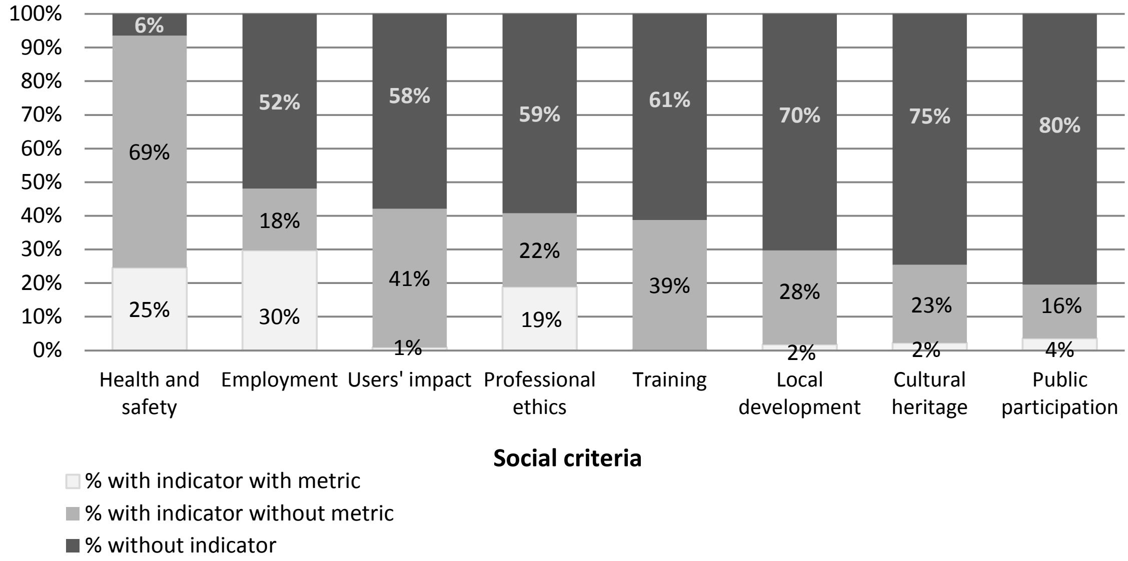
The third level comprises local development and cultural heritage criteria. Results showed a lack of cultural heritage criteria in most of the tendering documents. This fact shows the lack of awareness about the relevance of these criteria in tendering procedures. Cultural heritage is essential to uphold fundamental human rights and respecting the customs and values of communities (Akiwumi 2014), and this is a strategic factor in the promotion of local economic development (Guccio et al. 2014). Finally, local development criteria present wide variability in the obtained results. It seems that some countries are aware of the importance of including local criteria in the procurement procedures to mediate equity concerns and economic and social development (Nijaki et al. 2012); however, a low percentage of tendering documents consider this type of criteria.

4.4.2. Definition of social criteria

The aim of this section is characterizing how the social criteria are defined in the tendering documents. Thus, after gathering the 2724 indicators from the documents, two terms are established to characterize the indicators: indicator with metric and indicator without metric. The term "metric" represents the quantitative measurement included in the definition of the indicator. For example, if the indicator is "to employ at least *x*% of non-qualified personnel from the influenced region during the development of the project", the metric would be "at least *x*% of non-qualified personnel", and the indicator would be defined as an indicator with metric. Once the indicators were characterized, the analysis about how social criteria are defined depending on the variables country and contract size was performed; and the differences with respect to the inclusion of the social criteria in each stage of the tendering procedure was characterized.

- <u>How social criteria are defined in the tendering documents</u>

Within the 451 analyzed tendering documents, 2,724 social indicators were included, and only 19% of them had associated metrics. Figure 4-4 represents the percentage of consideration of each category in the analyzed sample considering indicators with metrics and indicators without metrics. It can be highlighted that the health and safety group of criteria is generally linked to an indicator (94%), and often to an indicator with metric (25%). The rest of the categories have associated indicators in less than half of the documents, varying from 48% (employment) to 20% (public participation). However, employment has more metrics associated than health and safety (30% vs. 25%), and even professional ethics gets 19% of the sample related to a metric. These facts indicate the lack of objective methods to assess social sustainability in public-works procurement.



SOURCE: Own elaboration

Figure 4-4: Percentage of consideration of each group of social criteria considering indicators and metrics

Table 4-7 shows the inclusion of the indicators with metric in the tendering documents per each sub_2 subcategories. The main categories of indicators considered with metrics have been associated with the inclusion of professionals in terms of health and safety, the requirement of occupational health and safety certifications, job stability, employment of vulnerable groups and, finally, gender equality. Nevertheless, categories of indicators such as workplace health and safety management plans, technical and sustainability training of workers, minimizing the harm done to the neighborhood or the existing services, industry participation plan, and employment created or retained were characterized by a lack of metrics to be assessed. This implies uncertainty and complexity on the assessment of social criteria and the measurement of performance, being one of the main barriers that is affecting the effective implementation of social sustainability in the construction industry, and it hinders the compliance of clients' needs and the achievement of social sustainable objectives (Sutherland et al. 2015; Bruno et al. 2018). It is generally accepted that indicators should be specifically designed to promote the implementation of better practice and to demonstrate the progress being made (CIRIA 2001). However, there seems to be a lack of understanding of how to include metrics to make indicators quantifiable for bid evaluation in construction public procurement (Molenaar et al. 2010). As is shown in this table, this malpractice encompasses the inclusion of social criteria in tendering procedures of the construction industry (Ruparathna and Hewage 2015a).

Table 4-7: Indicators with metric in tendering documents per sub_2 subcategory

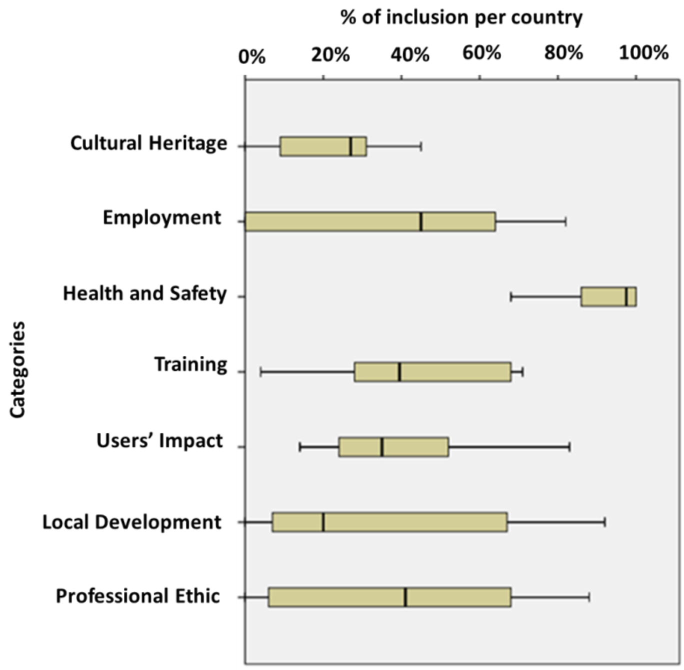
Categories (groups of criteria)	Sub_2 Subcategories (groups of social indicators)	Percentage of indicators with metric in each subcategory	Tendering documents with at least one indicator with metric in each subcategory
Cultural heritage	Preservation of historic and cultural resources	-	-
	Professional expertise in cultural heritage	100%	10
	Total	9%	10
Employment	Employment created or retained	4%	4
	Employment of vulnerable groups	74%	127
	Job stability	97%	58
	Industry participation plan	-	-
	Total	54%	135
Health and safety	Workplace health and safety management plan	1%	-
	Public safety	3%	4
	Occupation health and safety certifications	91%	31
	Professional expertise in health and safety	99%	75
	Total	14%	110
Local development	Local preference	-	-
	Local participation	7%	8
	Social value	-	-
	Total	4%	8
Professional ethics	Non-discriminatory hiring practices	3%	1
	Commitment to anti-corruption	-	-
	Gender equality	66%	84
	Fair wages	-	-
	Total	31%	85
Public participation	Public participation	9%	17
	Total	9%	17
Training	Technical and sustainability training of workers	-	2
	Total	-	2
Users' impact	Avoiding or minimizing the harm done to the neighborhood	-	-
	Avoiding or minimizing the harm done to the existing services	-	-
	Avoiding or minimizing mobility disruption	2%	5
	Total	1%	5

SOURCE: Own elaboration

- <u>Analysis of how social criteria are included in the tendering documents depending on the country:</u>

To analyze the inclusion of the seven social criteria in the tendering documents depending on the countries, first, the variability concerning the inclusion of each social criteria in the ten countries is shown. Second, the percentage of inclusion of each social category in each country is defined. Finally, detailed information is shown regarding the average of indicators and categories that are considered in each tendering document per country.

To show the variability of the consideration of social criteria at the international level, Figure 4-5 shows the distribution of the percentage of inclusion of each category in each country. A wide variability (from 0% to 80%) generally exists with respect to their inclusion, except the health and safety category, which was considered in over 70% of the documents in every country. Alternatively, cultural heritage is the least considered category with no country including this category in more than 50% of its tender documents.



SOURCE: Own elaboration

Figure 4-5: Distribution of the percentage of inclusion of each category in each country

The percentage of inclusion of each social category in each country is shown in Table 4-8. Except for health and safety category, strongly differences between ESCs and SSCs can be observed mainly with respect to professional ethics, local development, and users' impact categories. Employment was not considered in any of the tendering documents from Argentina, Panama, and Peru. Spain and Chile do not consider the local development category in their tendering documents, and Panama and Peru do not consider the professional ethics category.

Table 4-8: Percentage of consideration of each group of social criteria in each country

ESCs	Cultural heritage	Employment	Health and safety	Training	Users' impacts	Local development	Professional ethics
Australia	30%	42%	98%	70%	83%	67%	6%
Canada	45%	19%	77%	71%	79%	26%	19%
U.K.	24%	64%	100%	55%	52%	52%	80%
U.S.A.	31%	82%	98%	48%	47%	67%	88%
Average	33%	52%	93%	61%	65%	53%	48%
SSCs	**Cultural heritage**	**Employment**	**Health and safety**	**Training**	**Users' impacts**	**Local development**	**Professional ethics**
Argentina	31%	0%	100%	31%	10%	10%	10%
Chile	30%	48%	97%	30%	24%	0%	44%
Colombia	0%	48%	68%	28%	32%	92%	68%
Panama	9%	0%	86%	68%	32%	14%	0%
Peru	3%	0%	100%	14%	14%	7%	0%
Spain	21%	72%	93%	4%	23%	0%	26%
Average	16%	28%	91%	29%	23%	20%	24%

Note: ESCs: English-speaking countries; SSCs: Spanish-speaking countries

SOURCE: Own elaboration

The inclusion of social indicators and social indicators with metrics in the tendering documents of each country was performed. Table 4-9 shows: 1) the indicators with and without metrics considered per tender; 2) the indicators with metrics included per tender; 3) the average and the standard deviation with respect to the categories which are considered per tender.

Table 4-9: Inclusion of indicators per country

Country	Indicators per tender	Indicators with metric per tender	Average of categories per tender	Standard Deviation
Argentina	3.97	0.14	2.48	1.35
Australia	10.42	0.89	4.18	1.29
Canada	4.87	0.26	2.87	1.69
Chile	5.86	0.62	2.72	1.88
Colombia	7.24	1.32	3.36	1.29
Panama	3.00	0.05	2.09	1.23
Peru	2.07	0.55	1.38	0.86
Spain	4.72	2.65	2.62	1.34
UK	7.21	0.64	4.24	1.58
USA	7.16	1.57	4.84	1.55
Total	**6.04**	**1.14**	**3.18**	**1.75**

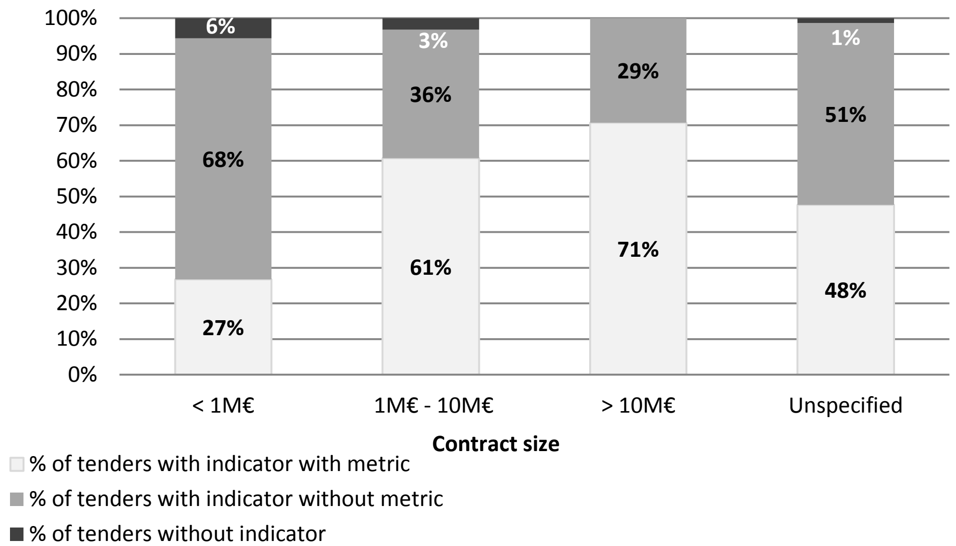
SOURCE: Own elaboration

In general, the average of categories per tender is 3.18. The USA (4.84), the UK (4.24), and Australia (4.18) are the countries that exceeded this value, covering an average of 4 categories per tender. These countries are followed by Colombia (3.36). According to the number of indicators that are included in tendering documents per country, Australia (10.42), Colombia (7.24), the USA (7.16), and the UK (7.21) are the countries that included the most social indicators. However, Spain (2.65), the USA

(1.57), and Colombia (1.32) are the countries with the greatest inclusion of indicators with metrics per tender.

- Analysis of how social criteria are included in the tendering documents depending on the contrac size:

Regarding the use of social indicators depending on the contract size, the distribution is the following: 42% for projects with an unspecified budget, 18% for projects greater than 10 M€, 30% for projects between 1 M€ and 10 M€, and 10% for projects smaller than 1 M€. Additionally, the distribution of indicators with metric was 46% for projects between 1 M€ and 10 M€. Moreover, concerning the inclusion of indicators with metric, only 6% of indicators with metric were for projects with a budget less than 1 M€, whereas the remaining percentage was distributed similarly in the other two groups of projects (see Figure 4-6).



SOURCE: Own elaboration

Figure 4-6: Percentage of tenders that contains social indicators and distribution of the social indicators per contract size

Regarding the average number of social indicators included in the tendering documents, there were 3.87 for projects with a budget smaller than 1 M€, 5.18 for projects between 1 M€ and 10 M€, 6.31 for projects greater than 10 M€, and 7.84 for projects with an unspecified budget. Thus, the inclusion of social indicators sharply increases as the contract size rises. Additionally, the inclusion of indicators with metric was analyzed. The average number of social metrics included in the tendering documents was 0.48 for projects with a budget smaller than 1 M€, 1.51 for projects between 1 M€ and 10 M€, 1.76 for projects greater than 10 M€, and 0.75 for projects with an unspecified budget. Consequently, a slight increase in the inclusion of metrics is accompanied by the growth of contract sizes (see Table 4-10).

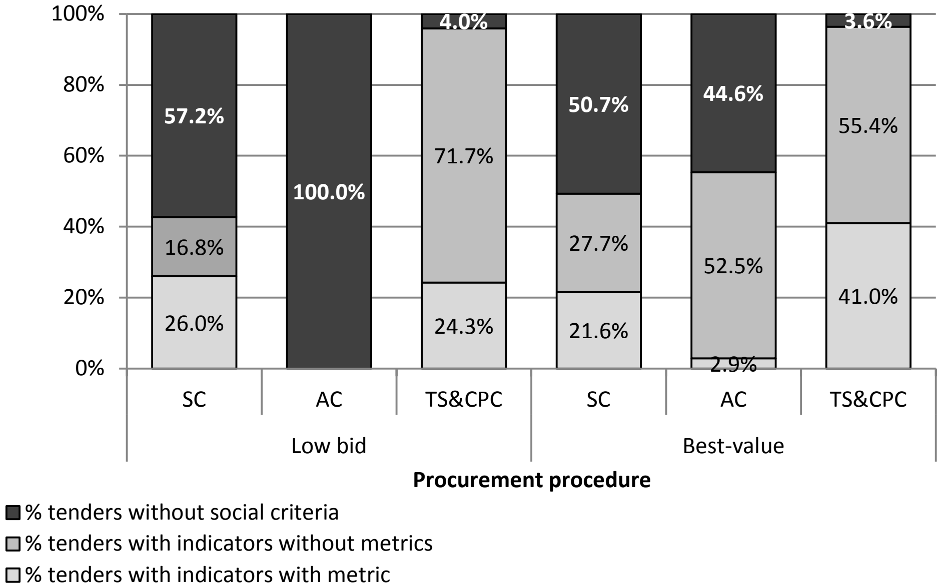
Table 4-10: Inclusion of indicators per contract size

Country	Indicators per tender	Indicators with metric per tender
< 1M€	3.87	0.48
1M€ - 10M€	5.18	1.51
> 10M€	6.31	1.76
Unspecified	7.84	0.75
Total	**6.04**	**1.14**

SOURCE: Own elaboration

- Analysis of how social criteria are included in the tendering documents depending on the stage of the tendering procedure:

The following task was assessing how social categories are included in tendering documents, depending on the procurement procedure (low bid and best value). To assess the use of social criteria in each stage of the tendering procedure, descriptive statistics were performed, considering the following three phases within a tendering procedure: 1) selection criteria (SC); 2) award criteria (AC); and 3) technical specifications and contract performance clauses (TS&CPC). The main differences between both procurement procedures lie in the award criteria (AC) phase. Predictably, the percentage of social criteria in the AC phase of low bid procurement procedures is 0.0; however, best value considers social criteria as award criteria in 55.0% of their tenders. This percentage is low if it is compared with findings by Testa et al. (2016), who stated that, regarding tenders based on best value, environmental criteria were included as award criteria in 87.0% of their sample. Regarding the inclusion of social criteria in the selection criteria (SC) and technical specifications and contract performance clauses (TS&CPC) phases, results reveals that there are no substantial differences between procurement procedures with respect to the percentage of tenders that considers any social criteria (SC phase: 42.8% for low bid and 49.3% for best-value; TS&CPC: 96.0% for low bid and 96.4% for best-value) (see Figure 4-7).



SOURCE: Own elaboration

Figure 4-7: Percentage of tenders with social criteria in each phase of the procurement procedure

On the other hand, the mean number of social criteria included in this phase of best-value procurement tenders is 1.5 (see Table 4-11). This value is slightly lower than the one found by Ruparathna and Hewage (2015b), who disclosed that the mean number of social criteria included in their analyzed tendering documents was 2.0. Additionally, it is worth pointing out that only 3.0% of the tenders based on best-value procurement use metrics to assess social criteria in the AC phase. This result is in line with the findings by Park et al. (2015), who remarked on the lack of appropriate evaluation procedures that avoid the subjectivity of best-value criteria and ensure transparency, objectivity, and equitability of bid selection processes. Consequently, these results highlight the low consideration of social criteria as AC and the lack of objective methods for bid evaluation, depicting two of the main challenges for sustainable procurement.

Additionally, to analyze whether there are significant differences between procurement procedures with respect to the mean of social criteria included in the SC and TS&CPC phases, the Mann-Whitney U-test is conducted. The results showed that only the SC phase has statistically different means (p-value <0.05), revealing that low bid procurement procedures tend to include a more significant number of social criteria in the SC phase in comparison with best-value procedures. However, the mean of social criteria for both procurement procedures is similar in the TS&CPC phase (p-value >0.05). Additionally, the global analysis of tenders shows that, regarding the mean of social criteria per tender, there is no significant difference between the low bid and best-value procurements procedures, as the mean of social criteria per tender is approximately three for both procurement procedures (see Table 4-11).

Table 4-11: Statistical description of the number of social criteria included in tenders that consider any social criteria

Procurement Procedure	Statistical Description	SC Phase	AC Phase	TS&CPC Phase	Total
Low bid	Mean	1.96	0.00	2.90	3.22
	S.D.	1.03	0.00	1.79	1.88
Best Value	Mean	1.54	1.53	2.81	3.28
	S.D.	0.68	0.79	1.61	1.58
Mann-Whitney U test	Sig.	0.008	-	0.835	0.348

Note: SC: Selection criteria; AC: Award criteria; TS&CPC: Technical specifications and contract performance clauses; S.D.: Standard deviation; Sig.:2-tailed p-value (significant if<0.05)

SOURCE: Own elaboration

Thus, it can be emphasized that, even using the low bid procurement, contractors are forced to reduce the initial bid price (Lo and Yan 2009), and the inclusion of performance indicators is key to ensure compliance of clients' needs and social sustainable objectives (Bruno et al. 2018). Tenders based on the low bidprocurement only compensate for the lack of inclusion of social criteria in the award criteria (AC) phase with an increase of these criteria in the selection criteria (SC) phase.

Regarding the use of the different groups of social criteria in each phase of the tendering procedure, there are some interesting findings. First, health and safety, and employment are the most considered social criteria in the SC phase for both low bid (30% and 25%, respectively) and best-value (29% and 22%, respectively) procurement procedures, followed by local development criteria (9% in low bid and 12% in best-value). In the AC phase, the most frequently used criteria in tenders based on the best-value procurement are health and safety (31%), local development (21%), employment (15%), and training (10%). Moreover, in the technical specifications and contract performance clauses (TS&CPC) phase, every group of social criteria is similarly included in both procurement procedures. However, professional ethics criteria are considered more in the low bidprojects (46%) than in the best-value projects (24%), and local development is included in 24% of the best-value tenders and 13% of the low bidtenders. Finally, the global analysis on tendering documents shows that health and safety, professional ethics and employment are the social criteria most frequently used in the low bid procurement procedure, while health and safety, employment and users' impact are the social criteria most commonly included in the best-value procurement procedure

Summarizing, regarding the inclusion of metrics, results show strong differences depending on the analyzed variables. A lack of awareness about the need for using metrics to measure social sustainability has been found regardless of the contract size. Although it seems that procurers are more conscious about the necessity of including social indicators in public construction procurement, there is a need associated with the inexperience of procurers to include quantitative indicators in procurement procedures (Sourani and Sohail 2011).

4.5. Influence of project characteristics on the inclusion of social criteria in public construction delivery and procurement

To identify the most influential variables in the inclusion of social criteria into public construction procurement, logistic regression was developed for each category of social criteria. For each logistic regression, the dependent variable was the social criteria, coded as 0 (not inclusion) and 1 (inclusion), and the independent variables were: project delivery method, procurement procedure, country, infrastructure, and contract size (see Table 4-12).

Table 4-12: Categories defined for each independent variable in the logistic regressions

Variables	Categories
Project delivery method	0: Traditional
	1: Integrated
Procurement procedure	0: Low bid
	1: Best value
Country	0: Spanish-speaking countries (SSCs)
	1: English-speaking countries (ESCs)
Infrastructure	0: Building
	1: Civil engineering
Contract size	0: Budget less than 1,000,000€
	1: Budget between 1,000,000€ and 10,000,000€, and unspecified budget
	2: Budget greater than 10,000,000€

SOURCE: Own elaboration

Table 4-13 gathers only the results associated with those independent variables that were significant (p-value < 0.05). The group of health and safety criteria was not included because this is used in practically all the tendering documents, and the differences with respect to each independent variable were not going to be significant.

Cultural heritage and employment are strongly influenced by contract size and country. Their odds ratio shows that the use of both increases significantly with the contract size, and these are more common in English-speaking countries (ESCs). However, employment is also influenced by the project delivery method, which is more frequent in the traditional method. Regarding professional ethics, in addition to the contract size, this criterion is also influenced by the procurement procedure, since it is more commonly used in the low bid projects and ESCs. Furthermore, training, users' impact, and local criteria are primarily considered in ESCs; however, users' impact is strongly influenced by the type of infrastructure because it tends to be considered more in civil engineering projects.

Table 4-13: Results of logistic regressions. Dependent variables: social criteria

Dependent Variable	Independent Variables	Wald	df	Sig.	Exp(B)
Cultural heritage	Project delivery method	5.595	1	0.018	0.423
	Procurement procedure	8.826	1	0.003	0.469
	Country	13.249	1	0.000	2.468
	Infrastructure	5.293	1	0.021	2.018
	Contract size	16.433	2	0.000	-
	Contract size: 1-0	11.394	1	0.001	4.880
	Contract size: 2-0	16.374	1	0.000	9.008
Employment	Project delivery method	12.896	1	0.000	0.358
	Country	10.725	1	0.001	2.018
	Contract size	24.633	2	0.000	-
	Contract size: 1-0	16.348	1	0.000	3.804
	Contract size: 2-0	23.994	1	0.000	7.684
Training	Country	69.631	1	0.000	7.185
Users' impact	Country	69.007	1	0.000	7.405
	Infrastructure	22.648	1	0.000	3.765
Local development	Country	82.264	1	0.000	10.742
Professional ethics	Procurement procedure	8.820	1	0.003	0.506
	Country	5.207	1	0.022	1.641
	Contract size	24.994	2	0.000	-
	Contract size: 2-0	21.361	1	0.000	6294

Note: Wald: Wald statistic; df: degrees of freedom; Sig.: 2-tailed p-value (significant if < 0.05); Exp(B): log-odds of success. Project delivery method (0: traditional; 1: integrated); Procurement procedure (0: low bid, 1: best value); Country (0: SSCs; 1: ESCs). Infrastructure (0: Building; 1: Civil engineering). Contract size (0: <1 M€; 1: 1 M€-10 M€+unspecified budget; 2: >10 M€)

SOURCE: Own elaboration

Regarding the inclusion of social criteria in tendering documents, the results show that there are generally no significant differences between project delivery methods and procurement procedures. Only employment and cultural heritage are more frequently included in traditional delivery methods. Additionally, criteria associated with professional ethics and cultural heritage are important in low bid procurement procedures to ensure that the cost-cutting tactics that characterize this type of project do not end up leading to malpractice or affecting social heritage (Lines and Miao 2016).

Therefore, based on the results of the Wald statistics, the most influential variables concerning the inclusion of social criteria in public construction procurement are country and contract size. The insertion of cultural heritage, employment, and professional ethics in tendering documents is notably influenced by the contract size. Alternatively, training, users' impact, and local development depend mainly on the country. As Kahlenborn et al. (2010) asserted, national policies are the main drivers to integrate social sustainability in public procurement, and the inclusion of social performance indicators in tendering procedures increases with the contract size and with the complexity of the project. A more detailed analysis of the most influential variables (contract size and country) is presented next.

- Analysis of the influence of contract size:

Depending on the contract size of the project, the inclusion of social criteria in tendering documents can notably vary. Table 4-14 shows the median of the percentage of consideration for each social criterion in all countries, considering the different groups of contract size. The groups referred to projects over 10 M€, and unspecified budgets are not clustered to show more in-depth information. Although the median of health and safety criteria remains fixed at approximately 100%, for different groups of contracts, generally, the rest of the criteria show important increases as the contract size is raised. Accordingly, the median of employment increased 47% from projects smaller than 1 M€ to projects over 1 M€. Cultural heritage changed 27%. Users' impact changed 25%, while professional ethics increased 32% and training 34%. However, the median of local development criteria tended to decrease as the contract size increased; that value varied from 0% for projects over the 10 M€ to a range of between 20% and 30% for the remaining cases.

Table 4-14: Median of percentage of each group of social criteria in each country per contract size

Contract Size	Cultural Heritage	Employment	Health and Safety	Training	Users' Impact	Local Development	Professional Ethics
< 1M€	0%	9%	100%	16%	20%	33%	25%
1M€-10M€	20%	50%	100%	29%	29%	21%	50%
> 10M€	27%	56%	100%	50%	45%	0%	57%
Unspecified	27%	37%	100%	55%	50%	32%	14%

SOURCE: Own elaboration

Sutherland et al. (2015) noted that social requirements in construction procurement potentially affect processes and management systems and have important implications for both procuring organizations and suppliers. In line with this, results highlight a wide variability in the inclusion of social criteria at the international level. However, results show that there is an important increase in the inclusion of social indicators as the contract size of projects increases. This trend is common for each one of the analyzed social criteria, except for local criteria, which suffer an opposite tendency and tend to be included as the budget size of projects decreases. According to the European Commission (2010), an effective way to promote local Small and Medium Enterprises (SMEs) is giving them greater access to public procurement, ensuring them contracts whose size is not an obstacle in itself to their participation.

- Analysis of the influence of country:

To carry out a comparative analysis between countries, the first step was analyzing the data sample globally. A correspondence analysis (CA) was developed. The chi-square (χ^2) test of independence was undertaken to determine whether there was a relationship between the social criteria and countries. The null hypothesis (H_0) was that an independent relationship between the variables exists, being satisfied when *p* > 0.05. The results showed that χ^2 was 452.039, and *p* = 0.000. Therefore, H_0 was rejected, and it was determined that there is a relationship between the social criteria and the studied countries. Additionally, the CA creates orthogonal dimensions to represent the variables taking into account the strengthening of their associations (represented as the total inertia). Considering the entire data, the CA showed that four dimensions were needed to explain 88.5% of the total inertia (0.375) (see Table 4-15).

Table 4-15: Main results of the Correspondence Analysis considering the entire data sample

	χ^2	**Sig.**	**Total inertia**	**Dimensions to explain 88.5%**
value	452.039	0.000	0.375	4

Note: χ^2: Chi-square; Sig.: 2-tailed p-value (significant if > 0.05); Total inertia: Strengthening of the associations

SOURCE: Own elaboration

Consequently, with the aim of reducing the number of dimension to obtain more detailed information, four correspondence analyses were developed to assess the grouping individually, based on the contract size. The distribution of the data in two-dimensional space and the visualization of the correlations between variables for each group were carried out. The chi-square test of independence was conducted within each group of contract size to determine whether there was a relationship between countries and social criteria. The results showed that, in each group of contract size, there was a dependent relationship between the countries and social criteria. However, projects smaller than 1 M€ presented different behavior patterns compared to the remaining sample, since the distribution of the data was different, and more than two dimensions were needed to represent the data of this group of projects. Hence, to analyze the relationship between countries and social categories, the group formed by projects with a budget over 1 M€ and projects with an unspecified budget (87% of the sample) was selected.

Regarding the group formed by projects with a budget over 1 M€ and projects with an unspecified budget, a correspondence analysis (CA) was developed. The results showed a dependent relation between social criteria and countries (χ^2: 196.674 and *p*: 0.000). Two dimensions were needed to explain 80% of the total inertia (0.187) (see Table 4-16).

Table 4-16: Main results of the Correspondence Analysis considering projects with a budget over 1 M€ and projects with an unspecified budget

	χ^2	Approx. Sig. (p)	Total inertia	Dimensions to explain 80%
value	196.674	0.000	0.187	2

Note: χ^2: Chi-square; Sig.: 2-tailed p-value (significant if > 0.05); Total inertia: Strengthening of the associations

SOURCE: Own elaboration

Tables 4-17 and 4-18 display each dimension. The first dimension explained 61% of the total inertia, and the second dimension explained 19% of the total inertia. Every country and every group of social criteria was well explained by these dimensions, having achieved values over 75%. Only cultural heritage and local development criteria presented a minimum value of representation (22% and 35%, respectively); thus, they were eliminated from this analysis.

Table 4-17: Overview of row points. Correspondence analysis

Categories of social criteria	Mass	Score in dimension		Inertia	Contribution				
		1	2		Of point to inertia of dimension		Of dimension to inertia of point		
					1	2	1	2	Total
Employment	0.192	-0.560	0.234	0.034	0.191	0.049	0.562	0.197	0.759
Health and safety	0.343	0.134	-0.631	0.031	0.020	0.637	0.063	0.937	1.000
Training	0.150	0.780	0.451	0.044	0.290	0.143	0.661	0.150	0.810
Users' impact	0.161	0.494	0.417	0.028	0.124	0.131	0.564	0.216	0.780
Professional ethics	0.154	-0.877	0.236	0.050	0.375	0.040	0.744	0.036	0.780
Active total	1.000			0.187	1.000	1.000			

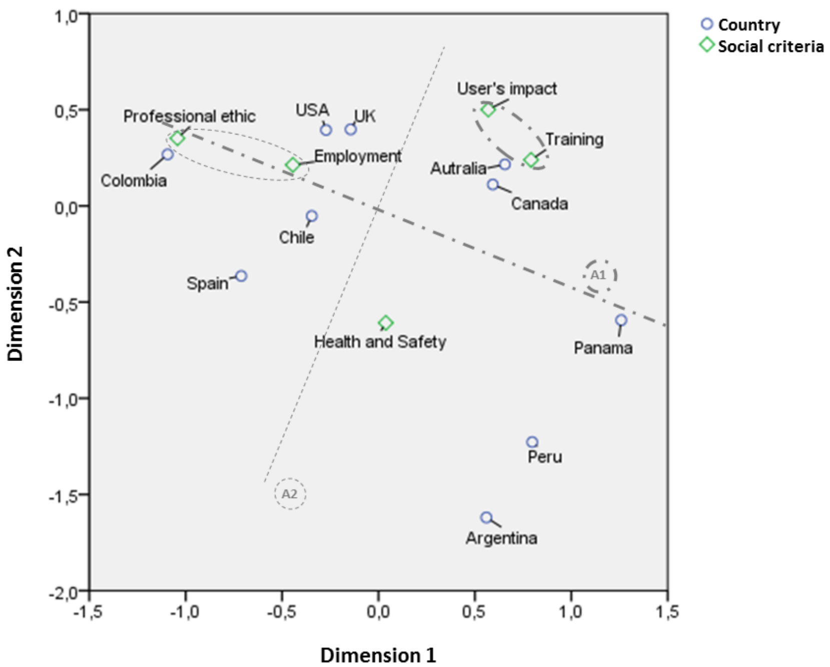
Table 4-18: Overview of column points. Correspondence analysis

Countries	Mass	Score in dimension		Inertia	Contribution				
		1	2		Of point to inertia of dimension		Of dimension to inertia of point		
					1	2	1	2	Total
Spain	0.215	-0.731	-0.360	0.047	0.363	0.130	0.768	0.126	0.894
Australia	0.202	0.669	0.296	0.043	0.285	0.083	0.664	0.088	0.753
Panama	0.013	1.383	-0.431	0.013	0.081	0.012	0.615	0.165	0.780
Colombia	0.047	-0.504	0.351	0.006	0.038	0.027	0.666	0.220	0.886
Chile	0.132	-0.175	-0.014	0.003	0.013	0.000	0.580	0.178	0.758
USA	0.168	-0.218	0.392	0.015	0.025	0.121	0.395	0.490	0.885
Canada	0.062	0.616	0.015	0.009	0.074	0.000	0.854	0.000	0.855
UK	0.092	-0.019	0.310	0.009	0.000	0.041	0.301	0.450	0.751
Argentina	0.036	0.693	-0.809	0.015	0.055	0.110	0.383	0.369	0.752
Peru	0.032	0.800	-1.776	0.029	0.066	0.476	0.228	0.764	0.992
Active total	1.000			0.187	1.000	1.000			

SOURCE: Own elaboration

Figure 4-8 shows the correlations between the social categories (employment, health and safety, training, users' impact, and professional ethics) and the ten countries. According to the axis “A1” defined, two groups of countries can be clearly differentiated: the group formed by English-speaking countries (ESCs), comprising Australia, Canada, the UK, and the USA, and the group formed by Spanish-speaking countries (SSCs), including Argentina, Chile, Colombia, Panama, Peru, and Spain. These groups have similarities, such as the notable use of health and safety criteria. However, two main features imply the need for differentiating them. Firstly, the inclusion of local development, training, and users' impact criteria is considerably higher for ESCs with respect to SSCs. Secondly, SSCs show a lower percentage of inclusion for each one of the analyzed social criteria in comparison to ESCs. McCrudden (2004) highlighted that the use of public procurement, to put social policies into effect, has a long history in countries such as the USA or the UK.

Additionally, the experience of these countries has, through the years, a strong influence on countries such as Canada and Australia. However, studies, such as the United Nations (2008), Serpell et al. (2013) and Revington et al. (2015), analyzed the inclusion of social aspects in public procurement in Latin American countries, and these noted that social sustainability had not been a priority for these countries until now. It is only currently that countries such as Chile, Colombia, and Brazil are boosting measures for using public procurement to support local industries and to increase participation of small businesses.



SOURCE: Own elaboration

Figure 4-8: Correlation diagram between countries and social categories

Regarding the axis “A2”, ESCs were displaced in the plot compared to SSCs along this axis. SSCs consider each group of social criteria at a lower percentage than ESCs. Thus, SSCs are further from the social criteria in the plot. Additionally, considering axis “A2”, important differences can be highlighted within each group of countries. The consideration for professional ethics and employment criteria from every country causes the distribution of these along axis “A1”. Accordingly, within the SSCs, Colombia, Spain, and Chile are the countries that most consider these criteria. Similar patterns are presented by the USA and the UK with respect to the rest of the ESCs. These results were verified through a chi-square (χ^2) contingency table analysis. This is one of the most commonly used statistical analyses for categorical data analysis (Xia et al. 2012a). Table 4-19 shows the results of the comparison between both groups of countries (ESCs and SSCs), whereas Table 4-20 shows the main differences within each group of countries. The null hypothesis was that a dependent relationship between the variables does not exist, being satisfied when $p > 0.05$. In the case in which the null hypothesis is rejected, and the results show that the relationship between the variables is dependent, the Phi coefficient was selected to calculate the association between variables. Furthermore, the odds ratio was calculated to measure the effective size of the categorical data (Field 2013).

Through the comparison between SSCs and ESCs, the null hypothesis was satisfied by health and safety and professional ethics ($p > 0.05$). However, significant differences were found for training, users’ impact, and local development whose odd ratios reveal the importance of these groups of criteria in ESCs with respect to SSCs (training: 6.098; users’ impact: 5.875; and local: 10.181) (see Table 4-19). Therefore, these results confirm the distinction between ESCs and SSCs presented in Figure 4-8.

Table 4-19: Odds ratio for groups of countries

Comparison SSCs - ESCs	Cultural Heritage	Employment	Health and Safety	Local Development	Professional Ethics	Training	Users’ Impact
χ^2	9.001	10.572	1.068	107.062	1.015	77.886	75.792
Degrees of freedom	1	1	1	1	1	1	1
Approx. Sig. (p)	0.003	0.001	0.301	0.000	0.314	0.000	0.000
Phi	0.141	0.153	-	0.487	-	0.416	0.410
Odds Ratio	1.931	1.877	-	10.181	-	6.098	5.875

Note: SSCs: Spanish-speaking countries; ESCs: English-speaking countries

SOURCE: Own elaboration

To analyze the significant differences that could be found within each group of countries, the ESCs and SSCs were assessed independently (see Table 4-20). For this analysis, the chi-square (χ^2) contingency table analysis was applied. In case the variable was dependent, contingency coefficients (CC) were calculated for each pair of variables because the categorical variables have more than two dimensions (six dimensions for SSCs and four dimensions for ESCs). This coefficient allows determining how strongly the categorical variables are associated through its comparison with the maximum contingency coefficients (CC_{max}). Based on the ratio between CC and CC_{max}, the different levels of dependence can be strong dependence when $CC/CC_{max} \geq 0.7$, moderate dependence when $0.5 \leq CC/CC_{max} < 0.7$, and low dependence when $CC/CC_{max} < 0.5$ (Field 2013).

Table 4-20: Contingency coefficient for each group of countries

		Cultural Heritage	Employment	Health and Safety	Local Development	Professional Ethics	Training	Users' Impact
ESCs	χ^2	3.242	31.846	18.955	16.904	99.0933	11.98	20.083
	Degrees of freedom	3	3	3	3	3	3	3
	Approx. Sig. (p)	0.356	0.000	0.000	0.001	0.000	0.007	0.000
	Contingency coefficient (CC)	-	0.401	0.320	0.304	0.613	0.259	0.329
	CC/CC_{max}	-	0.57	0.45	0.43	0.86	0.37	0.47
SSCs	χ^2	13.615	43.683	17.685	112.486	35.988	41.619	6.479
	Degrees of freedom	5	5	5	5	5	5	5
	Approx. Sig. (p)	0.018	0.000	0.003	0.000	0.000	0.000	0.262
	Contingency coefficient (CC)	0.281	0.464	0.316	0.644	0.430	0.455	-
	CC/CC_{max}	0.40	0.66	0.45	0.91	0.61	0.64	-

Note: SSCs: Spanish-speaking countries; ESCs: English-speaking countries

SOURCE: Own elaboration

Results showed that in ESCs, the dependence on training, local development, health and safety, and users' impact was low. Only the consideration of cultural heritage did not differ significantly ($p > 0.05$), demonstrating similar patterns for these social criteria. In ESCs, cultural heritage is normally used in 35% of their tenders. However, strong dependence has been observed concerning professional ethics (CC/CCmax = 0.85) since the USA, and the UK tend to consider this group of criteria in more than 80% of the tenders, in contrast to the rest of the countries, which considered it in less than 20% of the tenders. Regarding employment, this has revealed moderate dependence within the ESCs.

Regarding Australia, the results showed that this country strongly promotes the use of local and employment criteria. However, Australia, along with Canada, presents a low use of professional ethics criteria. This result can be compared with findings of Ruparathna and Hewage (2015b), who highlighted that fair wages to the workers in the construction industry were considered in 4% of their documents, whereas, in this study, it was 6%. Thus, the behavior is similar, which may show low growth with respect to 2013. If Canada is compared with the rest of the ESCs, this is behind these countries in terms of employment and professional ethics. However, regarding cultural heritage, users' impact, and training, Canada is on a similar level in comparison with ESCs.

The SSCs present similar behavior concerning users' impact ($p = 0.262$). This indicates that this criterion tends to be considered in only approximately 20% of their tenders. Cultural heritage and health and safety showed low significant differences. Employment, professional ethics, and training revealed a moderate level of dependence. Results showed that Spain is encouraging the inclusion of employment and professional ethics. This trend has been followed by Chile since it considers these criteria at a similar percentage**.** Argentina does not consider employment, and the percentage of inclusion of users' impact and professional ethics are lower than 10%. Panama only considers health and safety in their tenders, considering the training and users' impact criteria at a lower level. This behavior is similar to Peru, which has only considered health and safety in their tenders.

The strong significant difference that has been found concerning local development criteria exists because, in general, the SSCs do not consider local development criteria in more than 10% of their tenders, except for Colombia, which considered local development criteria in 100% of their tenders in the category of projects between 1 M€ - 10 M€ and projects greater than 10 M€. The AECID (2016) analyzed a group of tendering documents from different Latin American countries in the construction industry, concluding that there is a high degree of consideration of social criteria in the tendering procedures of Colombia, especially with those criteria related to increasing local employment. This is because the Colombian government, in 2011, required that national procurers included measures to promote local participation in their tendering procedures.

Therefore, in the study of the relationship between the countries within the ESCs group, similar patterns are found for cultural heritage criteria, presenting low consideration in their tendering documents. However, minor differences are highlighted regarding training, health and safety, users' impact, local development and employment criteria. The differences associated with professional ethics are strong, mainly due to the high consideration of this type of criteria in countries such as the USA and the UK; these are the countries that include professional ethics criteria in social procurement the most (McCrudden 2004). The USA is mainly focused on indicators associated with gender equality and fair wages for construction workers. However, the UK is more involved with indicators related to non-discriminatory hiring practices and avoiding corruption. Moreover, the USA is the ESCs most focused on employment criteria, by including industry participation plans and the employment of the vulnerable population in 60% of their tenders. This was noted by Loosemore (2015), who emphasized the effort that this country is making to employ minorities in business**.** Australia, however, is more focused on the creation and maintenance of employment. Additionally, Australia is strongly promoting the use of local development and employment criteria; it is encouraging indigenous opportunity policies and improving opportunities for local people with limited employment and training opportunities (Barraket and Weissman 2009; Petersen and Kadefors 2016). Furthermore, SPAG (2012) stated that Australia had implemented policies to enhance opportunities for Australian small and medium enterprises to win government contracts; governments and departments have inserted social procurement guidelines or policies into their procurement processes, requiring that procurement officers consider social benefits when awarding contracts (Burkett 2010; SPAG 2012). On the other hand, Canada is the most aware country regarding the importance of cultural heritage, and it includes this social category in 50% of their analyzed tenders. With respect to users' impact, and training, Canada is on a similar level in comparison with ESCs; however, this country is behind the rest of ESCs in terms of employment and professional ethics. Revington et al. (2015) affirmed that Canada has been slow in comparison to the rest of the ESCs in adopting social procurement. Thus, it developed the "2013-16 Federal Sustainability Strategy" to promote social goals in public procurement and to increase employment and local development.

The comparison between the countries gathered in SSCs group shows that there is a lack of consideration of users' impact criteria in these countries. Regarding the inclusion of cultural heritage and health and safety criteria in tendering documents, results show low significant differences; for employment, professional ethics, and training, results revealed a moderate level of dependence. However, a strongly significant difference has been found in terms of local development criteria. As Loosemore (2015) stated, due to EU directives, Spain is currently encouraging the inclusion of employment and professional ethics, and it has started to show an unwavering commitment towards sustainability from governmental initiatives in recent years (Reverte 2015). Regarding employment criteria, Spain has mainly focused its effort on encouraging job stability and the employment of the vulnerable population. As for professional ethics, Spain is only interested in gender equality criteria, disregarding the rest of the professional ethics criteria. Both results are a consequence of the economic scenario that, in recent years, the construction industry has experienced in this country (Palomares et al. 2017). Similar behavior has been observed for Chile, who considers both employment and professional ethics at a similar percentage. However, employment criteria in Chile are focused on the creation and maintenance of employment, as well as encouraging the employment of the vulnerable population. Regarding professional ethics, the indicators are centered on gender equality**.** This behavior has been encouraged by the Chilean Government, which elaborated responsible public purchasing policies to promote the three dimensions of sustainability in 2012 (UNEP 2013). On the other hand, Argentina does not consider employment, and the percentage of inclusion of users' impact and professional ethics is lower than 10%. Furthermore, Peru only considers health and safety in their tenders, considering training and users' impact criteria at a lower level. This was claimed by AECID (2016) who noted the lack of consideration of local aspects in Peru's tenders and emphasized that, regarding social sustainability, this country is primarily focused on improving health and safety performance. This behavior is similar to Panama, which has only considered health and safety in their tenders, in line with the comments of Serpell et al. (2013) about sustainability in the construction industry of Latin America and the Caribbean countries.

4.6. Findings

The results of the analyzed tendering documents offer an international view of the current performance of public construction procurement regarding the inclusion of social criteria, explaining how procurers manage this dimension of sustainability in tendering documents. Four important implications stand out in this research as follows.

1. **Metrics are essential to achieving socially sustainable production in the construction industry:**

It is highlighted in the literature that metrics to make indicators quantifiable for bid evaluation in construction public procurement are essential to promote better practices and to demonstrate the progress. However, currently, public-works procurement is characterized by a lack of metrics and awareness of the importance of their consideration. This fact is reflected in the results of the 451 analyzed tendering documents, showing that indicators are characterized by an absence of metrics to be assessed, since less than the 20% of social indicators gathered in tendering documents had associated metrics in their definitions. Thus, there seems to be a lack of understanding regarding how to include social metrics to make indicators quantifiable, causing the current malpractice associated with the inclusion of social criteria in the tendering procedures of the construction industry.

2. **Social sustainability in public-works procurement should be more than health and safety criteria:**

As highlighted in the literature review section, Sierra et al. (2018b) claimed that the definition of the criteria that should be considered to assess social sustainability in construction projects had not been clearly established, and in many cases, only a limited number of social aspects are considered (Ekener et al. 2018). This has been observed in the analysis of the tendering documents, where only the health and safety category is globally accepted at the international level as social criteria in public-works procurement. Its inclusion is by far the most important in each of the analyzed countries and regardless of the contract size. However, the rest of the categories are included in less than 50% of the analyzed documents, and their inclusion can vary notably depending on the analyzed country and contract size. Therefore, more significant efforts are needed to increase the number of social categories in procurement procedures. Eight categories of social criteria (cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact) represent the minimum that should be included when the social dimension of sustainability is to be considered in the construction industry.

3. **The project contract size should not influence the number of social categories in procurement procedures, but the level of importance of each social criteria should be affected by the project characteristics:**

There seem to be a growing understanding of the importance of the inclusion of social criteria in public-works procurement when the project contract size is large. In this regard, the results have highlighted that the contract size variable has a strong influence on the inclusion of social criteria in the procurement procedures. This fact was already asserted by Kahlenborn et al. (2010), who highlighted that the inclusion of social performance indicators in tendering procedures increases with the contract size and with the complexity of the project. Therefore, taking into account that every social category should be considered in each construction project to achieve the maximum social performance of the construction companies in the project (UNEP 2009), only the level of attention given of each social category should be influenced by the contract size and the complexity of the project.

4. **Social criteria fitted to the country's social characteristics:**

In public-works procurement at the international level, the variable "country" highlights showing a considerable influence over the inclusion of social criteria in public procurement at the international level, since the results showed a significant dependent relationship between social criteria and countries. The context associated with the geographic area where the project is going to be developed, plays an essential role in the social assessment of processes (UNEP 2009). For that reason, numerous authors are emphasizing the consideration of location-dependent aspects in the development of methodologies to perform social assessments (UNEP 2009; Parent et al. 2010). This approach is in line with the importance of national policies to promote social sustainability in public-works procurement. Through the study of social deficiencies at the national level, public agencies would be able to define social indicators to accomplish their goals, improving at the same time the social performance of the country.

Consequently, the characterization work carried out in this chapter reveals the need to foster major efforts trying to achieve the integration of social issues in public-works procurement. Therefore, the proposal of a methodology to implement social criteria in public-works procurement is needed.

4.7. Chapter summary

The results gathered in this chapter depict the current scenario concerning the use of social criteria in public-works procurement. The results were obtained analyzing 451 tendering documents through the content analysis. After analyzing the robustness of the sample for drawing conclusions, the data extracted from these documents were analyzed by statistical techniques. These analyses identified the main drawbacks which are hindering the effective inclusion of social criteria in public-works procurement. These results are the foundations for developing the methodology which is featured in the following chapter.

CHAPTER 5

METHODOLOGY TO INCLUDE SOCIAL SUSTAINABILITY CRITERIA IN PUBLIC-WORKS PROCUREMENT

This chapter defines the methodology to include the social criteria in public-works procurement of civil engineering construction projects. For each group of social criteria, indicators to assess each social subcategory are established, as well as the methodological approach to evaluate them objectively and to define the level of importance associated with each of them in the procurement procedure. Finally, simulation analyses are performed to check the suitability of the methodology according to the established goals.

5.1. Introduction

The objective of this chapter is defining a methodology to include social criteria in public-works procurement, overcoming the existing weaknesses that have been identified after analyzing 451 tendering documents from ten countries. The goal of this methodology is to assess the social performance of the construction companies involved in public contracting through the inclusion of social criteria in public procurement procedures. This methodology needs to be developed in a way that ensures the transparency, objectivity, and equitability in the bid-selection processes. The scope has been defined to focus on assessing the social sustainability of construction companies in the construction phase of the civil engineering project life-cycle at the international level.

Three groups of criteria have been differentiated to address the inclusion of social sustainability criteria in public procurement: 1) human rights; 2) corporate social responsibility; and, 3) social commitment within the project.

- <u>Human rights (G1):</u>

This group comprises the subcategories related to fundamental universal rights:

- Child labor
- Forced labor
- Freedom of association and collective bargaining
- Corruption
- Respect of indigenous rights
- Respect for intellectual property rights

- <u>Corporate social responsibility (G2):</u>

This group comprises those subcategories that are focused on assessing the social performance of each company and, thus, linked to its daily social performance considering the entire company. This group is comprised of these subcategories:

- Employment creation
- Job stability
- Occupational health and safety performance
- Social benefits and social security
- Social value
- Non-discrimination and equal opportunities
- Fair wages and fair income distributions
- Technical training
- Sustainability training

- <u>Social commitment in the project (G3):</u>

This group refers to assess the social commitment that construction companies intend to assume in the project on which it is bidding. It comprises these subcategories:

- Cultural heritage appraisal and management plan
- Collaboration with historical or cultural preservationists
- Industry participation plan
- Work health and safety management officer
- Workplace health and safety management plan
- Community relations program
- Effects on neighbors.

To address the definition of a methodology for each group of social criteria, three sections have been established based on the methodological approaches that have been defined in chapter 3 for each one of these groups. The specific objectives, defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures (O4), and determining a methodology to include the social sustainability criteria in public-works procurement procedures (O5), were addressed in these methodologies.

5.2. Human rights (G1)

The goal of the methodology associated with the human rights' group is guaranteeing that every procurement procedure considers requirements related to the human rights subcategories, and ensuring that every construction company who is involved in the process knows and complies with each of these subcategories. Therefore, first, the subcategories were defined; and, second, a comprehensive definition was established, gathering each of these subcategories, and allowing its adjustment to each procurement procedure, depending on the normative framework of each country.

5.2.1. Definition of subcategories of the human rights group

Six subcategories have been gathered in the human rights group (G1). These subcategories are: (1) child labor; (2) forced labor; (3) freedom of association and collective bargaining; (4) corruption; (5) respect of indigenous rights; and, (6) respect of intellectual property rights. All these subcategories belong to the professional ethics category. A comprehensive definition of each subcategory is presented as follows.

5.2.1.1. Child labor

GRI (2016d) defined the term "child labor" as work that deprives children of their childhood, their potential, and their dignity; and that is harmful to physical and mental development. Benoit-Norris et al. (2013) established that the term "child labor" refers to work that is mentally, physically, socially, or morally dangerous and harmful to children; work that deprives children of the opportunity to attend school, forcing them to leave school prematurely or requiring them to attempt to combine school attendance with excessively long and heavy work. Child labor is subject to ILO Conventions 138 'Minimum Age Convention' (ILO Convention 138) and 182 'Worst Forms of Child Labor Convention' (ILO Convention 182). The minimum age for working differs by country (GRI 2016d). Benoit-Norris et al. (2013) and ILO Convention 138 determined that an activity constitutes child labor if the child is below the age of 15 years. However, this age could be modified depending on the national set minimum age for employment or the age of completion of compulsory education. Thus, in countries where economies and educational facilities are insufficiently developed, a minimum age of 14 years might apply. GRI (2016d) also highlights that child labor results in under-skilled and unhealthy workers for tomorrow and perpetuates poverty across generations; thus, the abolition of child labor is necessary for both economic and human development.

5.2.1.2. Forced labor

According to Benoit-Norris et al. (2013, p. 106), forced or compulsory labor is defined as "all work or service which is exacted from any person under the menace of any penalty and for which the said person has not offered himself voluntarily". GRI (2016e) stated that some of the most common forms of forced labor include human trafficking for forced labor, coercion in employment, forced labor linked to exploitative labor contract systems, and debt-induced forced labor. Benoit-Norris et al. (2013) established a wide list of different ways to detect forced labor in practice, in order to identify aspects which can lead to forced labor or can be the cause of workers continuing to workin forced labor. Therefore, GRI (2016e) claimed that the due diligence is expected of an organization to prevent and combat all forms of forced or compulsory labor within its activities; being essential to avoid contributing to or becoming linked to the use of forced or compulsory labor through its relationships with suppliers, clients, etc.

5.2.1.3. Freedom of association and collective bargaining

On the one hand, according to GRI (2016f, p. 4), freedom of association refers to "the right of employers and workers to form, to join and to run their own organizations without prior authorization or interference by the state or any other entity". On the other hand, collective bargaining refers to "all negotiations which take place between one or more employers, employers' organizations, or trade unions for determining working conditions and terms of employment or for regulating relations between employers and workers" (GRI 2016f, p.7). Both are recognized as human rights by International Conventions and Agreements (Benoit-Norris et al. 2013).

5.2.1.4. Corruption

GRI (2011) defined corruption as 'the abuse of entrusted power for private gain' and declares that it can be instigated by individuals in the public or private sector. Benoit-Norris et al. (2013) identified the following types of corruption: bribery, embezzlement, theft and fraud, extortion, abuse of discretion, favoritism, nepotism and clientelism, conduct creating or exploiting interests, and improper political contributions. Corruption and bribery imply serious moral and political concerns, undermines good governance and economic development, and distorts international competitive conditions. Avoiding corruption and bribery is an important component that organizations need to guarantee.

5.2.1.5. Respect of indigenous rights

GRI (2016g, p.4) established the following definition of indigenous people:

"Indigenous people are tribal peoples in independent countries whose social, cultural and economic conditions distinguish them from other sections of the national community, and whose status is regulated wholly or partially by their own customs or traditions or by special laws or regulations. Additionally, Indigenous people can be people in independent countries who are regarded as indigenous on account of their descent from the populations which inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonization or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions."

Benoit-Norris et al. (2013) determined, according to international conventions and agreements, that the respect of indigenous rights must include their right to lands, resources, cultural integrity, self-determination and self-government.

5.2.1.6. Respect of intellectual property rights.

WIPO (2004) defined intellectual property as the legal rights which result from intellectual activity in the industrial, scientific, literary and artistic fields. UNEP (2013) claimed that organizations must respect and safeguard the moral and economic rights of the creators of intellectual property. Benoit-Norris et al. (2013) highlighted that licensing of intellectual property rights should respect and contribute to the long-term development of the community.

5.2.2. Human rights proposal

An organization can impact human rights directly, through its own actions and operations and indirectly, through its interactions and relationships with others (GRI 2016h). Thus, a broad approach to the inclusion of human rights in public procurement procedures is needed. Additionally, it is essential to take into account that the legislation in each country may already cover many of human rights subcategories, and the application of the law may be excellent (UNEP 2009).

On the other hand, based on IHRB (2015), there are two main paths where non-compliance with social or labor law obligations can lead to action within the procurement process under the overarching social clause:

- Exclusion: Procurers may exclude a bidder due to non-compliance with social or labor law obligations.
- Award: Procurers may choose not to award a contract, due to non-compliance with social or labor law obligations.

Based on the premises previously defined, the subcategories in the human rights group should be included as exclusion ground in the procurement procedures of civil engineering construction projects.

The following wording has been defined based on the European Commission (2018) and tendering documents from Spain and Australia. This should be adapted to the legal requirements of each country:

"The company declares its awareness that companies who have been convicted of one of the following legal offenses must be excluded from any procurement procedure: participation in a criminal organization; corruption; fraud; terrorism; money laundering; child labor or human trafficking. In addition, economic operators who have not properly paid taxes and social security contributions in their Member State must also be excluded from any procurement procedure. Where the period of exclusion was not set in a final judgment, the period of exclusion cannot exceed 5 years from the date of the conviction."

"The company declares its awareness that to comply with all present and future provisions which are established in labor legislation, social security, workplace health and safety, intellectual, industrial and commercial property, protection of the national industry, corruption, etc."

"The company declares its awareness that the contracted company acquires, during the contract, the obligation to guarantee the respect of basic labor rights throughout the production chain. Being mandatory to comply with the fundamental conventions of the International Labor Organization, especially those focused on freedom of association and collective bargaining, the elimination of forced or compulsory labor, the elimination of discrimination with respect to employment and occupation based on race, color, sex, religion, political opinion, national ascendancy or social origin and the abolition of child labor."

In cases of joint tendering where several economic operators form a consortium to submit a joint tender, the exclusion grounds apply to all tenderers.

The definition of the period of exclusion 'x' depends on country regulations. For example, for the the European countries, the European Commission (2018, p.13) stated that "the period of exclusion cannot exceed 5 years from the date of the conviction in cases of mandatory exclusion grounds or 3 years from the date of the relevant event in cases of optional exclusion grounds".

5.3. Corporate social responsibility (G2)

Corporate social responsibility group (G2) gathers those subcategories that can be defined to assess the corporate social responsibility of the construction companies. According to the methodological approach, the goal of the G2's methodology is setting a composite indicator to evaluate the corporate social features of each company that participates in the tendering procedure. The result of the corporate social responsibility assessment of each construction company involved in the procurement procedure will be the basis to perform a comparison between these companies, allowing giving preference in the procurement procedure to those companies with the highest scores. Therefore, the following composite indicator has been established to assess the corporate social responsibility of the construction companies involved in the procurement procedure (see Equation 5-1).

$$CI_{G2\ jc} = \sum_{i=1}^{n} I'_{ij} \cdot w_{ic} \tag{5-1}$$

with:

- $CI_{G2\ j}$: Composite indicator defined to assess the corporate social responsibility of the construction company j in the country c where the project is procured.
- I'_{ij}: Company indicator. Value of the company indicator I'_i for construction company j
- w_{ic}: Weight assigned to the indicator $\mathrm{I'_i}$ in the model for the country c. The weights must be between 0 and 1 ($0 \leq \mathrm{w_i} \leq 1$), and the sum of the weights must be equal to 1 ($\sum_{\mathrm{i=1}}^{\mathrm{n}} w_i = 1$).

According to this equation, the two main elements to define the composite indicator are the indicators and the weights. Based on the methodological approach, these elements need to satisfy the following principles:

- The company indicators (I'_i) to assess the corporate social responsibility of the companies have to be quantitative, reliable, and verifiable to guarantee the robustness of the methodology.
- The weights (w_{ic}) have to be addressed to minimize the social weaknesses of each country over time.

Based on these principles, the goal of G2's methodology is promoting the reduction of the social weaknesses that exist in the country where the project is going to be developed, assigning the maximum weights to the worst social performance indicators in the country. Seen in this light, construction companies involved in procurement procedures will have to make an effort to improve these social issues to increase their better chances to win the contract, encouraging, at the same time, the transformation of the industry toward social sustainability. To satisfy these principles, two sub-elements need to be defined in order to obtain both the company indicators (I'_i) and the weights (w_{ic}) of the G2's composite indicator: (1) Basic indicators (I_i); and, (2) Proxi indicators (V_{ic}).

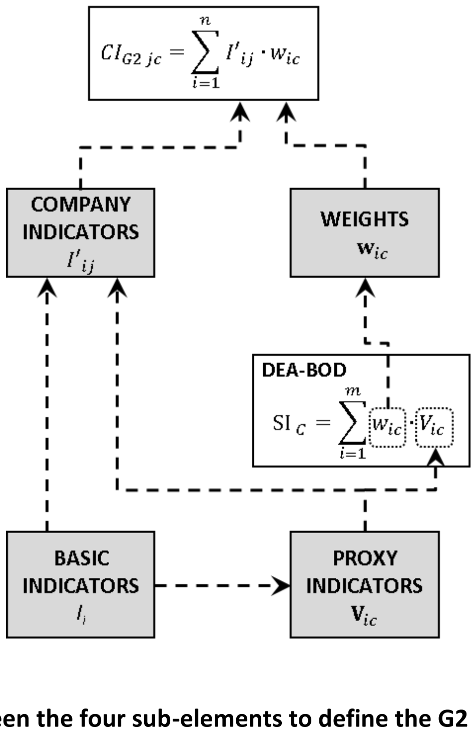
- Basic indicators ($\mathrm{I_i}$):

Basic indicators (I_i) are the sub-elements defined to assess each one of the subcategories gathered in corporate social responsibility group (G2). These subcategories should referred to a company level. A basic requirement to determine the indicators is ensuring their reliability and verifiability in the procurement procedure. This is a key aspect in case the procurer considers the need for auditing and verifying the truthfulness of the data provided by the construction companies involved in the procedure. For that reason, after collecting a pool of indicators from the literature review, which satisfy the quality criteria: simple, understandable, easy to reproduce, comparable, cost-effective data collection, useful as a management tool, relevant and reliable (defined in chapter 3), the collaboration with the focus group was essential to determine which of them should be considered for the model.

- Proxy indicators (V_{ic}):

A proxy variable is generally used to stand in for variables that cannot be directly measured (Benini and Sala 2016). In this regard, the use of proxy indicators in the definition of composite indicators has been proposed in numerous studies with good results (Nardo et al. 2005; UNEP 2009; Cook et al. 2017). Proxy indicators are needed to develop the composite indicator because of the second principle, which requires that the weights of the composite indicator have to be addressed to minimize the social weaknesses of each country over time. To satisfy this principle, the data envelopment analysis based on the benefit of the doubt approach (DEA-BOD) was selected as the optimal weighting methodology (defined in chapter 3). The DEA-BOD approach with its pessimistic version allows assigning the maximum weights to the worst performance indicators in a country. Thus, to define the weights, indicators at a country level must be used. However, most of the basic indicators ($\mathrm{I_i}$), defined to assess the corporate social responsibility of the companies, cannot be found at a country level. Consequently, proxy indicators (V_{ic}) must be defined as approximations of these basic indicators ($\mathrm{I_i}$) within the national context.

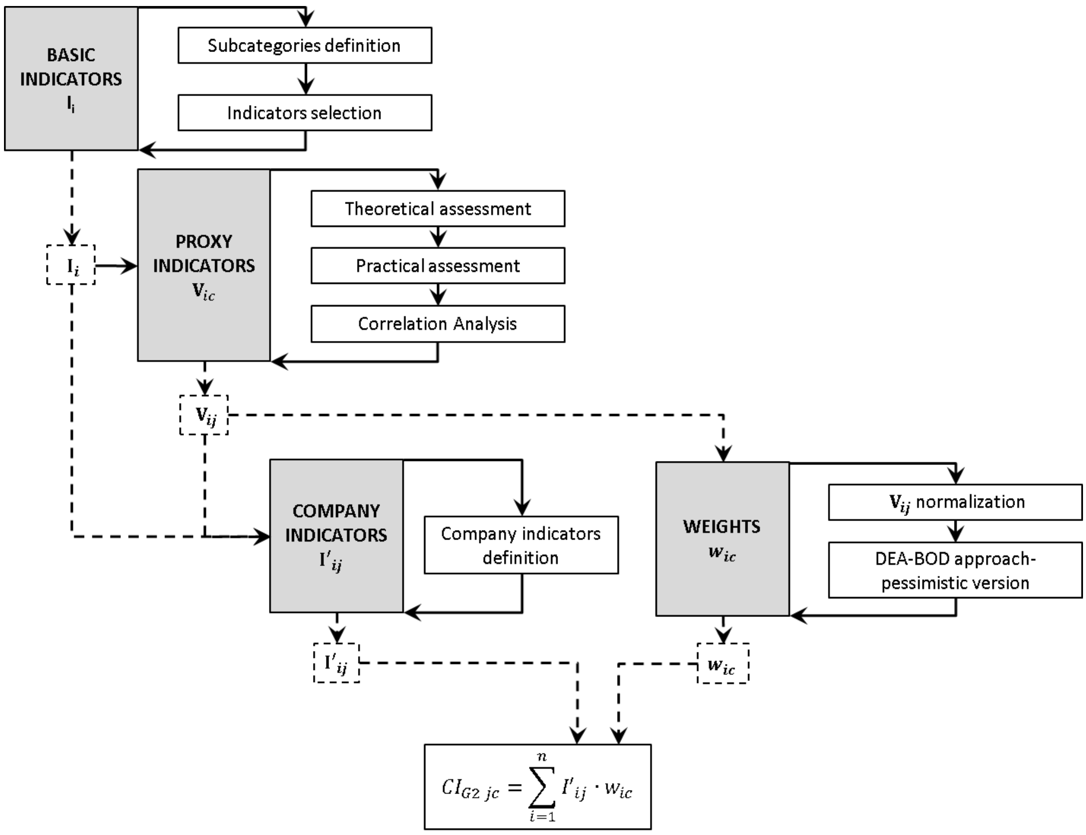
Based on these sub-elements, the company indicators (I'_i) are obtained from the normalization of the basic indicators ($\mathrm{I_i}$) and clustered taking into account the established proxy indicators (V_{ic}). Additionally, the weights (w_{ic}) of the G2's composite indicator have to be included in the composite indicator to assign the level of importance of each company indicator depending on the social weaknesses that exist in the country. These weights are defined by the proxy indicators through the DEA-BOD approach with its pessimistic version. The relationship between them is displayed in Figure 5-1.



SOURCE: Own elaboration

Figure 5-1: Relationship between the four sub-elements to define the G2 group composite indicator

The process to develop the composite indicator is displayed in Figure 5-2. The first step was based on establishing basic indicators. To that end, the subcategories of the corporate social responsibility group were defined, and the existing indicators were collected from the literature review. Based on this information, basic indicators were proposed by the focus group. In the second step, proxy indicators were selected. Databases were analyzed and national indices were chosen following a theoretical assessment and a practical assessment. The proxy indicators, proposed by the focus group in the practical assessment, were reduced avoiding multicollinearity through a correlation analysis. Once the basic indicators and the proxy indicators were defined, the company indicators to be used in the composite indicator were determined (third step). Subsequently, the weights were obtained through the DEA-BOD approach based on the pessimistic version (fourth step). The proxy indicators were the basis of the definition of the weight. Finally, a simulation process was performed to analyze how the model works to compare construction companies. The aim of this last step was examining whether the proposed model was feasible and applicable not only for the assessment of one individual company, but also for the evaluation and comparison of two or more companies, regardless of their size.



SOURCE: Own elaboration

Figure 5-2: Process to define the composite indicator of the corporate social responsibility group (G2)

5.3.1. Basic indicators

The aim of this section is defining the indicators to assess each one of the subcategories gathered in corporate social responsibility group (G2). A wide number of indicators can be found in the literature review. Thus, in this section, two tasks were established to define the indicators. This process was based on a top-down approach (Puig et al. 2014).

The first task focused on defining each G2's subcategory from a corporate point of view. This task sought to explain the most important aspects associated with each subcategory to understand what indicators should be the most relevant to assess them. Once the definition of each subcategory was established, the social indicators that exist in the literature review were gathered. In order to select only those indicators that may be appropriate to be used in a public-works procurement, the selection of the indicators from the literature review was performed taking into account the principles established by Székely and Knirsch (2005), and considering three of the four quality criteria defined by the United Nations (2008a): comparability, relevance and understandability.

After these were collected, the aim of the second task was determining the indicators that should be included in G2's methodology to assess the corporate social responsibility performance of the construction companies involved in the procurement procedure. The most important feature of a procurement procedure is guaranteeing a fair, transparent, and objective competition (Schöttle and Arroyo 2017). Thus, it is essential to ensure their reliability and verifiability in the procurement procedure. To satisfy this, collaboration with the group of experts was required. The focus group reviewed the definition of each subcategory and, based on the collected social indicators, they determined, by consensus among the experts, the basic Indicators to be included in corporate social responsibility group methodology.

5.3.1.1. Definition of each subcategory of corporate social responsibility group

Five social categories and nine subcategories are gathered in the corporate social responsibility group:

- Employment category: collects the subcategories employment creation and job stability.
- Occupational health and safety category: gathers the subcategories occupational health and safety performance, and social benefits and social security.
- Local development category: encompasses the subcategory social value.
- Professional ethics category: considers the subcategories non-discrimination and equal opportunities, and fair wages and fair income distributions.

- Training category: gathers the subcategories technical training and sustainability training.

The definition of these subcategories is shown below. The information has been organized by categories.

5.3.1.1.1. Employment

The construction industry is characterized by generating employment through increasing workforce casualization and self-employment, contributing to social problems (Loosemore 2015). For that reason, literature review highlights that the essential social issues to assess the performance of a company socially are those focused on creation and maintenance of employment (McCrudden 2004) and the enhancement of employment stability (Pellicer et al. 2016b; Shiau and Chuen-Yu 2016).

- <u>Employment creation:</u>

The United Nations (2008a, p. 27) stated that "one of the most significant positive economic and social contributions an enterprise can make to the country in which it operates comes through the creation of jobs". Similar to this, GRI (2016i) highlighted the importance of analyzing the ratio of employee hires in an organization because it allows showing the effort made by the organization to enhance and revitalize the area where they operate (Veleva and Ellenbecker 2001). Additionally, the number, age, gender, and region of an organization's new employee hires can indicate its strategy to implement inclusive recruitment practices (United Nations 2008a; GRI 2016i).

- <u>Job stability:</u>

Two sub-subcategories have been defined with regard to job stability: (1) employee turnover; and (2) quality of employment. On the one hand, employee turnover is an important indicator to assess the levels of uncertainty and dissatisfaction among employees (United Nations 2008a; GRI 2016i). Frequent layoffs can lead to lower employee morale and commitment and higher stress (CIRIA 2001; Popovic et al. 2018). High rates of employee turnover can also signal a fundamental change in the structure of an organization's core operations, and it can be reflected in high replacement costs, demanding training requirements, and loss of learning and experience effects (Veleva and Ellenbecker 2001; GRI 2016i). Contrarily, a high ratio of years of service in an organization can indicate knowledge accumulation and staff loyalty to the organization (Popovic et al. 2018).

On the other hand, the quality of employment depends on aspects such as: the average working hours per day, which can define the company's commitment to obey the law; the level of efficiency of their workers or the lack of employees that exist in the company; and the type of contract, discerning between full-time employees and temporary or part-time employees (Popovic et al. 2018). An increased number of temporary employees can show weak psychological bonds between the workforce and an organization and a lack of employee welfare. Vacations can have a positive effects on employees' health and well-being, and improving employees' well-being and health, as well as increase employee satisfaction (Veleva and Ellenbecker 2001; DVFA 2009; Popovic et al. 2018).

The indicators collected about employment creation and job stability are displayed in Table 5-1.

Table 5-1: Indicators to assess employment creation and job stability subcategories

Subcategories	Sub-subcategories	Indicators	Source
Employment creation	Employment opportunities	Rate of new employee hires during the reporting period, by age group, gender and region.	Azapagic and Perdan (2000); United Nations (2008a); GRI (2016i); Nikolaou et al. (2019);
		Number of employees per dollar sales	Veleva and Ellenbecker (2001)
Job stability	Employee turnover	Rate of employee turnover during a reporting period	Azapagic and Perdan (2000); CIRIA (2001); Veleva and Ellenbecker (2001); United Nations (2008a); DVFA (2009); Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016); GRI (2016i); Popovic et al. (2018); Nikolaou et al. (2019)
		Employee layoffs in a year, calculated as a ratio between laid off employees and the total number of employees.	Popovic et al. (2018)
	Quality employment	Percentage of part-time workers	CIRIA (2001); GRI (2016i); Popovic et al. (2018)
		Percentage of temporary workers	CIRIA (2001); GRI (2016i)
		Working hours as the ratio of the average number of working hours and working hours regulated by the company or by public law	Popovic et al. (2018)
		Age structure/distribution (number of employees per age group, 10 year intervals)	Singh et al. (2007); DVFA (2009); Popovic et al. (2018)
		Percentage of employees declining offers of employment	CIRIA (2001)
		Percentage of staff involved in ongoing surveys of job satisfaction	CIRIA (2001); Veleva and Ellenbecker (2001); Singh et al. (2007)
		Percentage of staff expressing satisfaction with the way the company treats them	Azapagic and Perdan (2000); CIRIA (2001); Popovic et al. (2018)

Subcategories	Sub-subcategories	Indicators	Source
Job stability	Quality employment	Percentage of staff working with flexible hours	CIRIA (2001)
		Percentage of staff offered flexible benefits	CIRIA (2001)
		Percentage of staff working more than 48 hours per week	CIRIA (2001)
		Flexible working arrangements and family benefit	Rahdari and Rostamy (2015)
		Vacation percentage of vacation days available calculated as the number of vacation days available in relation to the regulations indicated in the law of the country in which the entity operates, or in the contract/collective bargaining.	Popovic et al. (2018)

SOURCE: Own elaboration

5.3.1.1.2. Health and safety

Construction is a hazardous industry (CIRIA 2001). Analyzing the initiative of the company to implement a responsible health and safety culture is a key aspect in the corporate social responsibility of construction companies (CIRIA 2001; United Nations 2008a). In this respect, two main aspects have been identified. On the one hand, Popovic et al. (2018) and GRI (2018) claimed the importance of assessing the employer-provided health insurance, since it can show the employer's concern about the health of the employees. On the other hand, monitoring the quality of working conditions and monitoring potential health and safety risks is important to assess if the employer is taking care of employees' safety in an effective way (Popovic et al. 2018). These aspects are encompassed and defined in the following subcategories.

- <u>Social Benefits and Social Security:</u>

Employee health and safety represent one of the most important corporate responsibility issues confronting organizations (United Nations 2008a). An organization can promote workers' health by offering healthcare services or voluntary health promotion services and programs for preventing harm (Popovic et al. 2018); Nevertheless, GRI (2018) considers that these additional services and programs have to be added to the occupational health and safety programs, services and systems that prevent harm and protect workers from work-related injuries and ill health. On the other hand, another important aspect to be assessed is parental leave. Many countries have introduced legislation to provide parental leave. However, aspects related to allowing employees to take leave and to return to work in the same or a comparable position, or offering equitable gender choice for maternity and paternity leave are key social issues in that, addressing them can boost employee morale and productivity, as well as improving women's career path (GRI 2018).

- Occupational health and safety performance:

The United Nations (2008a) stated that occupational accidents lower employee productivity and could be symptomatic of poor management quality and lack of adequate internal management systems. Thus, GRI (2018) claimed that a way to demonstrate the organization's commitment to workers' health and safety is to analyze their development of, implementation of, and performance evaluation of occupational health and safety policies, management systems and programs according to the organization's size and activities. Consequently, the assessment of occupational health and safety management systems, worker training, and incidents in the company are crucial to evaluating their performance. Popovic et al. (2018) and CIRIA (2001) highlighted the importance of reporting accidents or time lost in the company, to increase transparency about the efficiency of their occupational health and safety systems. This information allows evaluating the quality of work conditions and the level of involvement of the company in ensuring a safe and healthy environment (United Nations 2008a; Dočekalová and Kocmanová 2016).

Based on the definitions of the subcategories social benefits and social security, and occupational health and safety performance, the indicators found in the literature are shown in Table 5-2.

Table 5-2: Indicators to assess social benefits and social security occupational health and safety performance subcategories

Subcategories	Sub-subcategories	Indicators	Source
Social benefits and social security	Benefits	Benefits which are standard for full-time employees of the organization but are not provided to temporary or part-time employees, by significant locations of operation. These include, as a minimum: i. life insurance; ii. health care; iii. disability and invalidity coverage; iv. parental leave; v. retirement provision; vi. stock ownership	Azapagic and Perdan (2000); CIRIA (2001); Azapagic (2004); United Nations (2008a); Popovic et al. (2018); GRI (2018)
		Total compensation in US$/Total employees	Rahdari and Rostamy (2015)
		Cost of employee health and safety	CIRIA (2001)
	Parental leave	Total number of employees that were entitled to parental leave, by gender	CIRIA (2001)
		Total number of employees that took parental leave, by gender	CIRIA (2001)
		Total number of employees that returned to work in the reporting period after parental leave ended, by gender	Rahdari and Rostamy (2015)
		Total number of employees that returned to work after parental leave ended and were still employed 12 months after their return to work, by gender	United Nations (2008a)

Subcategories	Sub-subcategories	Indicators	Source
Social benefits and social security	Parental leave	Return to work and retention rates of employees that took parental leave, by gender	GRI (2018)
Occupational health and safety performance	Health and safety training	Total expenditure on health and safety training over the total number of employees	Azapagic and Perdan (2000); Veleva and Ellenbecker (2001); GRI (2018)
		Total number of hours in the reporting period devoted to training on occupational health and safety/total number of employees	GRI (2018)
	Health and safety management	Percentage of total workforce represented in formal joint management-worker health and safety committees that help monitor and advice on occupational health and safety programs	GRI (2015)
		Certificates to demonstrate the occupational health and safety performance of companies	Rahdari and Rostamy (2015); GRI (2018)
	Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization	The rate of fatalities as a result of work-related injury (1) [(Number of fatalities as a result of work-related injury/Number of hours worked)*(200,000 or 1,000,000)]	CIRIA (2001); Singh et al. (2007); Rahdari and Rostamy (2015); GRI (2018); SASB (2018)
		The rate of high-consequence work-related injuries (2) (excluding fatalities) [(Number of high-consequence work related injuries (excluding fatalities)/number of hours worked) *(200,000 or 1,000,000))	Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016); GRI (2018); SASB (2018); Popovic et al. (2018); Nikolaou et al. (2019)
		The rate of recordable work-related injuries [(Number of recordable work-related injuries/Number of hours worked)*(200,000 or 1,000,000)	Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016); GRI (2018); SASB (2018); Nikolaou et al. (2019)
	Occupational diseases	Number of reported occupational diseases in a given period (year)/average number of employees in a given period (year)] × 100	Rahdari and Rostamy (2015); GRI (2018)
		Percent of workers with work-related disease	Veleva and Ellenbecker (2001)
	Absence rate	[working time lost in a given period (year)/working time available in a given period (year)] × 100	Singh et al. (2007); United Nations (2008a); Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016); GRI (2018); SASB (2018); Popovic et al. (2018); Nikolaou et al. (2019)

Note:
(1) Negative impacts on health arising from exposure to hazards at work.
(2) Work-related injury that results in a fatality or in an injury from which the worker cannot, does not, or is not expected to recover fully to pre-injury health status within 6 months".
(3) Work-related injury or ill health that results in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, or loss of consciousness; or significant injury or ill health diagnosed by a physician or other licensed healthcare professional, even if it does not result in death, days away from work, restricted work or job transfer, medical treatment beyond first aid, or loss of consciousness"

SOURCE: Own elaboration

5.3.1.1.3. Local development

Regarding the local development category, only the social value subcategory has been included in the corporate social responsibility group.

- Social Value:

Social value is based on: (1) promoting social responsibility on the contractors and subcontractors to commit to acting in a socially responsible way (Landorf 2011; Petersen and Kadefors 2016); and, (2) boosting the public commitments to social issues through enhancing skills and knowledge among the professional community, as well as training and raising community awareness in relation to the sustainable development (GRI 2011; ISI 2015; Abdel-Raheem and Ramsbottom 2016).

Regarding promoting social responsibility on contractors and subcontractors, the role of organizations to prevent and mitigate negative social impacts in the supply chain has been claimed (CIRIA 2001; Veleva and Ellenbecker 2001; Rahdari and Rostamy 2015; GRI 2016j; Popovic et al. 2018). GRI (2016j) recommended the following: assessment of suppliers for a range of social criteria, including human rights (such as child labor and forced or compulsory labor); employment practices; health and safety practices; industrial relations; incidents (such as of abuse, coercion or harassment); wages and compensation; and working hours. On the other hand, associated with enhancing public commitments to social issues, the United Nations (2008a) and Popovic et al. (2018) highlighted the importance of the support of the organizations for the communities in which they operate through the voluntary donation of cash, goods, and services. Popovic et al. (2018) emphasized the development of programs to boost the operations with the local community, increasing the capability of the organizations for considering social issues in operations. Finally, Labuschagne et al. (2005), Dočekalová and Kocmanová (2016) and Popovic et al. (2018) declared that the communication with stakeholder and developing systems to manage the complaints of the community are essential aspects to increase the social value in the companies' operations. Table 5-3 shows the indicators to assess the social value.

Table 5-3: Indicators to assess social value subcategory

Subcategories	Sub-subcategories	Indicators	Source
Social value	Suppliers' social impact	Percentage of suppliers that were screened using social criteria	CIRIA (2001); Veleva and Ellenbecker (2001); Rahdari and Rostamy (2015); GRI (2016j); Popovic et al. (2018)
		Number of suppliers identified as having significant actual and potential negative social impacts	GRI (2016j)
	Suppliers' health and safety	Number of contracts canceled because of non-compliance with Occupational Health and Safety standards	Veleva and Ellenbecker (2001)
		Percent of suppliers receiving Health and safety training	Veleva and Ellenbecker (2001)
	Operations with local community engagement, impact assessments, and development programs	Percentage of operations with implemented local community engagement, impact assessments, and/or development programs. This operations could include: a) social impact assessments,; b) public disclosure of results of social impact assessments; c) local community development programs based on local communities' needs; d) stakeholder engagement plans based on stakeholder mapping; e) broad based local community consultation committees and processes that include vulnerable groups; f) works councils, occupational health and safety committees and other worker representation bodies to deal with impacts;and, g) formal local community grievance processes.	Veleva and Ellenbecker (2001); GRI (2016j)
		Number of community forums, such as web forum for announcing information open for community (open for comments of stakeholders), organised in the whole supply chain per year	Labuschagne et al. (2005); Popovic et al. (2018)
	Complaints	Number of complaints received from the community	Dočekalová and Kocmanová (2016)
		Number of channels where stakeholders can complain (Labuschagne et al., 2005)	Labuschagne et al. (2005); Popovic et al. (2018)
		Average number of days needed to answer to all requests	Popovic et al. (2018)
	Corporate citizenship	Average number of hours spent for voluntary activities per entity per year	Lee and Saen (2012); Popovic et al. (2018)
		Total number of hours per year that employees have spent for voluntary activities during workng hours	GRI (2015)
		Value of charitable donation in money or time as a proportion of profits (companies freely donate staff time or money to causes from which there is no direct business benefit)	CIRIA (2001); Veleva and Ellenbecker (2001); Lee and Saen (2012)
		Number of programs for local community	Nikolaou et al. (2019)
		Number of beneficiaries	Nikolaou et al. (2019)
		Percentage of social in- novations in relation to the total number of innovations	Popovic et al. (2018)

SOURCE: Own elaboration

5.3.1.1.4. Professional ethics

In the corporate social responsibility group, two subcategories have been included within the professional ethics category: (1) non-discrimination and equal opportunities; and (2) fair wages and fair income distributions.

- Non-discrimination and equal opportunities:

The United Nations (2008a) claimed that the efforts of each enterprise towards eliminating discrimination develop into a positive social contribution to the country in which it operates. GRI (2016k) stated that the organization that actively promotes diversity and equality at work can directly generate significant benefits for both the workers and organization; and, additionally, it remarked that comparisons between broad employee diversity and management team diversity and the total number of employees in each employee category by gender offer information on the equal opportunity that exists in a company. Additionally, Popovic et al. (2018) highlighted that an equal number of female and male employees is not enough to show gender equality, since wages may significantly vary for males and females.

On the other hand, GRI (2016a) defined discrimination on the grounds of race, color, sex, religion, political opinion, national extraction, and social origin; and also occurring based on factors such as age, disability, migrant status, HIV and AIDS, gender, sexual orientation, genetic predisposition, and lifestyles, among others. Popovic et al. (2018) declared that the percentage of disabled employees in the company concerning the total number of employees reflects the company's commitment to respect human rights to provide equal opportunities to all employees regardless of disability. In addition to that, Popovic et al. (2018) stated that each company should encourage their workers to report on every type of discrimination that occurs in the workplace, to control and monitor the discrimination in the company.

- Fair wages and fair income distributions:

According to Benoit-Norris et al. (2013, p.98), “to meet the Universal Declaration of Human Rights, a fair salary is necessary”. Because of this, these authors claimed that fair wages in a company are one of the most important aspects to be assessed in corporate social responsibility; with the aim of ensuring that workers are capable to providing for their own needs and there of their families, and guaranteeing a minimum wage to contribute to stability and prosperity in communities and attract more skilled, productive and loyal employees (Popovic et al. 2018).

With reference to these subcategories, the indicators found in the literature are shown in Table 5-4.

Table 5-4: Indicators to assess non-discrimination and equal opportunities, and fair wages and fair income distributions subcategories

Subcategories	Sub-subcategories	Indicators	Source
Non-discrimination and equal opportunities	Diversity of governance bodies	Percentage of individuals within the organization's governance bodies in each of the following diversity categories:i. Gender; ii. Age group: under 30 years old, 30-50 years old, over 50 years old; iii. Other indicators of diversity where relevant such as vulnerable groups(ethnic minorities, young people, disabled)	CIRIA (2001); GRI (2016a); Nikolaou et al. (2019)
	Diversity of employees	Percentage of employees per employee category in each of the following diversity categories: i. gender; ii. age group: under 30 years old, 30-50 years old, over 50 years old; iii. other indicators of diversity where relevant such as vulnerable groups(ethnic minorities, young people, disabled)	CIRIA (2001); Singh et al. (2007); Rahdari and Rostamy (2015); GRI (2016a); Popovic et al. (2018)
	Ratio of basic salary and remuneration of women to men	Ratio of the basic salary and remuneration of women to men for each employee category, by significant location.	United Nations (2008a); Dočekalová and Kocmanová (2016); GRI (2016a); Popovic et al. (2018)
	Incidents of discrimination and corrective actions taken	Total number of incidents of discrimination during the reporting period. (include incidents of discrimination on grounds of race, color, sex, religion, political opinion, national extraction, or social origin as defined by the ILO)	Dočekalová and Kocmanová (2016); GRI (2016a); Popovic et al. (2018)
	Equal opportunities	Percentage of employees who believe that company offers equal opportunities to its staff.	Veleva and Ellenbecker (2001)
Fair wages and fair income distributions	Fair income distribution	CEO-to-average worker pay	Rahdari and Rostamy (2015)
		CEO Compensation/average compensation for all firm employees	Rahdari and Rostamy (2015)
		Report the ratio of the annual total compensation for the organization's highest-paid individual in each country of significant operations to the median annual total compensation for all employees (excluding the highest-paid individual) in the same country	Azapagic and Perdan (2000); GRI (2015)
		Report the ratio of percentage increase in annual total compensation for the organization's highest-paid individual in each country of significant operations to the median percentage increase in annual total compensation for all employees (excluding the highest-paid individual) in the same country	GRI (2015)
		Employee wages and benefits with breakdown by employment type and gender	United Nations (2008a)

SOURCE: Own elaboration

5.3.1.1.5. Training

Promoting the training of employees in companies is an important aspect to assess corporative social responsibility (GRI 2016c). Regarding this category, two subcategories have been included in corporate social responsibility group: (1) technical training; and (2) sustainability training.

- Technical training:

The personal development of individual employees contributes to skills management and to the development of human capital within the organization (GRI 2016c). On the one hand, workers' promotion or career advancement depends on the company's structure and policy for motivating employees (CIRIA 2001). These represent the practices of the company to internally promote employees to higher-ranking jobs, and directly influence the morale and loyalty of employees (United Nations 2008a; Popovic et al. 2018). Additionally, on the other hand, training of employees reflects in their skills, capabilities, improving their performance and productivity (CIRIA 2001; Veleva and Ellenbecker 2001, Popovic et al. 2018).

- Sustainability training:

CIRIA (2001) highlighted the importance of training to improve the sustainability of construction. In this respect, the United Nations (2008a), DVFA (2009) and Popovic et al. (2018), emphasized that creating more innovative technical solutions is one of the best methods to boost sustainability in business. Additionally, Popovic et al. (2018) claimed the need to invest in research and development to foster social progress in organizations. However, GRI (2016h) remarked that, to boost the organization's capacity to implement its human rights policies and procedures, specialized training has to be implemented in organizations to identify, prevent and mitigate their negative human rights impacts.

According to these subcategories, the indicators found in the literature are displayed in Table 5-5.

Table 5-5: Indicators to assess technical training and sustainability training subcategories

Subcategories	Sub-subcategories	Indicators	Source
Technical training	Regular performance and career development reviews	Percentage of employees receiving regular performance and career development reviews	Azapagic and Perdan (2000); CIRIA (2001); GRI (2016c); Popovic et al. (2018)
		Percentage of staff expressing satisfaction with the appraisal system	CIRIA (2001)
	Expenditure on education and training	Total annual expenditure on education and training/total annual gross value added] × 100	Azapagic and Perdan (2000); United Nations (2008a); DVFA (2009); Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016)
		Percentage of staff undertaking structured training	CIRIA (2001); Singh et al. (2007); GRI (2016c); Nikolaou et al. (2019)
		Average training hours per employee = (Total number of training hours provided to employees/ Total number of employees)	Veleva and Ellenbecker (2001); United Nations (2008a); DVFA (2009); Rahdari and Rostamy (2015); Dočekalová and Kocmanová (2016); GRI (2016c); Nikolaou et al. (2019); Popovic et al. (2018)
		Average training hours per employee category = (Total number of training hours provided to each category of employees/Total number of employees in category)	Veleva and Ellenbecker (2001); GRI (2016c)
Sustainability training	Employee training on human rights policies or procedures	Total number of hours in the reporting period devoted to training on human rights policies or procedures concerning aspects of human rights that are relevant to operations (anti-corruption, corporate social responsibility, social aspects of construction, etc.)	GRI (2016h); Nikolaou et al. (2019)
		Percentage of employees trained during the reporting period in human rights policies or procedures concerning aspects of human rights that are relevant to operations (anti-corruption, corporate social responsibility, social aspects of construction, etc.)	GRI (2016h); Nikolaou et al. (2019)
		Total number and percentage of significant investment agreements and contracts that include human rights clauses or that underwent human rights screening	GRI (2016h)
		Expenses to train and promote CSR internally	Lee and Saen (2012)
	Technology and human resource development	Expenditure on research and development	United Nations (2008a); DVFA (2009); Rahdari and Rostamy (2015); Popovic et al. (2018)
		Scientific publications as the percentage of scientific publications in relation to the total number of the publications of any kind	Popovic et al. (2018)

SOURCE: Own elaboration

5.3.1.2. Selection of the basic indicators to be included in G2's methodology

Once the indicators of each subcategory were identified, the identification of the basic indicators that should be included in the corporate social responsibility group (G2) methodology was undertaken by the focus group defined in section 3.4.3. The main aim was to try to cover each sub-subcategory, provided that the basic indicators satisfied the criteria of reliability and verifiability (United Nations 2008a). The selection of the basic indicators was determined by consensus among the experts in the focus group. The result of the focus group is displayed in Table 5-6. As can be seen in this table, although basic indicators were defined for each subcategory of this group, the experts decided not to assign basic indicators to assess the following sub-subcategories:

- In social value: suppliers' social impact, suppliers' health and safety, operations with local community engagement, impact assessments, and development programs, and complaints.
- In non-discrimination and equal opportunities: incidents of discrimination and corrective actions taken, and equal opportunities.
- In technical training: regular performance and career development reviews.

The reason why indicators were not selected to assess these sub-subcategories was that experts considered that the reliability and the validity of these indicators could not be ensured; features that are essential to guarantee a fair, transparent and objective procurement procedure. Although extending the social requirements beyond the main subcontractor to their subcontractors is a recommendation of EU Public Procurement Directives (IHRB 2015), the focus group decided to refuse this option because nowadays the quality of this type of information can not be guaranteed.

Table 5-6: Basic indicators to assess the corporate social responsibility of construction companies in the procurement procedure

Subcategories	Sub-subcategories	Basic Indicators
Employment creation	Employment opportunities	The rate of new employee hires during the reporting period, considering the level of education or the time that was as unemployed.
Job stability	Employee turnover	Rate of employee turnover during a reporting period
	Quality employment	Percentage of temporary workers
Social benefits and social security	Benefits	Annual investment in the health of employees over the last year
	Parental leave	The ratio of employees that returned to work after finishing the entire parental leave and were still employed 12 months after their return to work with respect to the number of employees that were entitled to parental leave.
Occupational health and safety performance	Health and safety training	Total number of hours in the reporting period devoted to training on occupational health and safety with respect to the total number of worked hours
	Health and safety management	Certificates to demonstrate the occupational health and safety performance of companies

Subcategories	Sub-subcategories	Basic Indicators
Occupational health and safety performance	Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization	The number of fatalities as a result of work-related injury with respect to the number of hours worked
		The number of accidents involving sick leave for every 100,000,000 hours worked
	Occupational diseases	Number of reported occupational diseases in a given period (year) for every 200,000 hours worked. An occupational disease is a disease arising from the work situation or activity (such as stress or regular exposure to harmful chemicals), or a work-related injury
	Absence rate	The number of working days lost due to sick leave accidents registered for every 1,000 hours worked
Social Value	Corporate citizenship	Total number of hours per year that employees have spent on voluntary activities during working hours
Non-discrimination and equal opportunities.	Diversity of governance bodies	Percentage of individuals within the organization’s governance bodies in each of the following diversity categories: i. gender
	Diversity of employees	Percentage of employees following diversity categories: i. gender; ii. foreign people; iii. young people; and ix. disabled.
	Ratio of basic salary and remuneration of women to men	Ratio of the basic salary and remuneration of women to men for each employee category, by significant location.
Fair wages and fair income distributions	Fair income distribution	Ratio of the annual total compensation for the organization’s highest-paid individual in each country of significant operations to the median annual total compensation for all employees (excluding the highest-paid individual) in the same country
Technical training	Expenditure on education and training	Annual investment in workers technical training in the company over the last year divided by total employees in the company
Sustainability training	Employee training on human rights policies or procedures	Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, Social awareness, human rights and social aspects of construction
	Technology and human resource development	Annual investment in research and innovation project

SOURCE: Own elaboration

5.3.2. Proxy indicators

According to the methodological approach, to define the weights based on the social weaknesses that exist in a country, indicators at a country level should be used. However, most of the basic indicators defined to assess the corporate social responsibility of the companies cannot be found at a country level. Therefore, proxy variables must be defined as approximations of these basic indicators within the national context.

To define the proxy indicators, national indices related to the defined basic indicators have to be identified. It is important to highlight that, identifying the social weaknesses in a country will be largely determined by the appropriateness of the national indices used. For that reason, three aspects are particularly relevant to guarantee their suitability: (1) the scope; (2) the database; and, (3) the selection method.

- The scope:

The DEA-BOD approach, which is going to be used to determine the weights, is characterized mainly by two aspects: first, this weighting methodology rests on using the country as the unit of measure; and, second, it is based on defining a benchmark within a selected sample of countries to identify the social weaknesses of each one of these countries. The social performance of each country can vary significantly depending on aspects such as the country size, its level of development, the culture, etc. (Joint Research Centre-European Commission 2008). Thus, the selection of the countries to be included in the sample has a significant impact on the results, being highly relevant for the reliability of the method (Cherchye et al. 2007).

Based on these facts, this research has decided to clearly delimit the scope to the European Union countries. The European Commission establishes common sustainability policies and programs for the member states of the European Union. Consequently, the definition of a methodology where the weights of the social indicators are defined through a cross-country comparison of the member states of the European Union will give robustness to both the method and the results. The 28 member countries of the European Union are: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom. They represent the sample to be analyzed.

- Data base:

A large number of organizations have been working to define national indices for different social topics such as education, gender, health, infrastructure, labor and social protection, poverty, social development, etc. In fact, the World Bank's databank collects the national indices defined by more than 70 different organizations. Additionally, in order to contribute significantly to the development of sustainable development indicators at the national level (Yli-Viikari et al. 2007), organizations such as Eurostat, the Organization for Economic Co-operation and Development, the Sustainable Governance Indicators, the International Labor Organization or the United Nations Conference on Sustainable Development, among others, have a wide sample of national indices in different fields. As has been highlighted above, the quality of the method to determine the social weaknesses will mainly depend on the appropriateness of the national indices used; therefore, data sources possessing a

Quality Assurance Framework, such as those belonging to the Eurostat database (Cook et al. 2017), will be preferred wherever practicable.

- The selection method:

A top-down approach has been defined to evaluate, screen, and filter national indices. First, a ‘theoretical’ assessment was undertaken in which national indices were evaluated following a set of quality criteria; secondly, a ‘practical’ assessment was performed by a focus group defined in section 3.4.3. The focus group chose the national indices to be used as proxy indicators of the basic indicators; finally, a ‘statistical analysis’ was performed to avoid possible multicollinearity between proxy indicators. The methodology and the results of the selection method are shown below.

5.3.2.1. Theoretical assessment

To perform the ‘theoretical’ assessment, different quality criteria exist in the literature review to assess national indices. Cook et al. (2017) proposed the following quality criteria to select indices to measure countries’ environmental sustainability performance: policy relevance, utility, soundness, interpretability, and data availability and quality. Nardo et al. (2005) highlighted that national indices should be selected based on their analytical soundness, measurability, country coverage, and relevance to the phenomenon being measured. The International Monetary Fund uses the following criteria: assurance of integrity, methodological soundness, accuracy and reliability, serviceability, and accessibility (Joint Research Centre-European Commission 2008). Puig et al. (2014) stated that effective indicators should comply with the following set of criteria: policy relevant, informative, measurable, representative and practicable to monitor. Based on the aforementioned literature review, six criteria were defined to assess the national indices:

1) Relevance, to select the indices which can be related to some company indicator.
2) Utility, to judge if the indices were easily understandable.
3) Measurable, to asses if the index was defined at the national scale.
4) Countries coverage, to select the indices which were available for all the European countries.
5) Time coverage, to screen indices with data available for some of the years 2014, 2015 and 2016.
6) Soundness, to filter only those indices with metadata available.

The first step was choosing the national indices which satisfied the criteria (1) and (2). After this first filter, in the second step, national indices were assessed according to the criteria, (3), (4), (5), and (6). Once the national indices, which met the six criteria, were gathered, redundant indices were rejected, leaving the indices that belonged to the Eurostat database or a source with Quality Assurance Framework.

Thus, following this process, the databases of Eurostat (2017), ILO (2017), OECD (2017), SDG (2017), UNCSD (2017), and the World Bank (2017) were analyzed and national indices were selected only in case where these satisfied two criteria: (1) relevance, selecting the indices which were closely related to some subcategory of corporate social responsibility group (G2); and, (2) utility, to judge if the indicators were easily understandable. In this first filter, 153 indexes were collected. These were subjected to a second screening to guarantee their appropriateness to be used in G2's methodology. This second screening was based on the following criteria: a) measurable, to asses if the index was defined on a national scale; b) countries coverage, to select the indices available for all the European countries; c) time coverage, to screen indices with data available for some of the years 2014, 2015 and 2016; and, d) soundness, to filter only those indices with metadata available. This analysis resulted in 68 national indices. After rejecting redundant indices, 37 national indices were selected.

5.3.2.2. Practical assessment

Once the 'theoretical' assessment was finished, the aim of the 'practical' assessment was selecting the proxy indicator for each basic indicator. To choose the proxy indicators, Cook et al. (2017) and the Joint Research Centre-European Commission (2008) strongly recommended the involvement of experts in this process. Therefore, in order to minimize the subjectivity of this task, the proxy indicators were chosen by the focus group. From the 37 national indices that satisfied the six quality criteria, the focus group had to choose the proxy indicators for each basic indicator. The task was performed in only one session and the proxy indicators were defined by consensus.

The process that they followed in selecting the national indices was: first, experts had to assign individually national indices for each basic indicator; second, the results of this first task were shared and the national indices assigned to each indicator were discussed in the focus group. Finally, a proposal of national indices was defined by consensus. These national indices were the proxy indicators proposed for each one of the basic indicators. Table 5-7 shows the result of the focus group; furthermore, Appendix B provides a brief description of each proxy indicator, with their sources and values. Regarding the values of each proxy indicator, the focus group suggested defining a method that should be updated every three years. Additionally, to bring stability to the method, the experts proposed that the values considered for each proxy indicator should be the average of the three years collected (2014, 2015 and 2016).

Table 5-7: Basic Indicators and proposal of proxy indicators for each sub-subcategory by the focus group.

Sub-subcategories	Basic indicators	Proposal of proxy indicators
Employment opportunities	The rate of new employee hires during the reporting period, considering the level of education or the time that was as unemployed.	Unemployment with advanced education
		Unemployment with basic education
		Unemployment with intermediate education
		Unemployment rate
		Long-term unemployment rate
		Youth unemployment rate
Employee turnover	Rate of employee turnover during a reporting period	Job tenure
Quality employment	Percentage of temporary workers	Temporary employment
Benefits	Annual investment in the health of employees over the last year	Public health expenditure
Parental leave	The ratio of employees that returned to work after finishing the entire parental leave and were still employed 12 months after their return to work with respect to the number of employees that were entitled to parental leave.	
Health and safety training	Total number of hours in the reporting period devoted to training on occupational health and safety with respect to the total number of worked hours	Death rate due to chronic diseases
		Fatal accidents at work
		Non-fatal accidents at work
Health and safety management	Certificates to demonstrate the occupational health and safety performance of companies	Death rate due to chronic diseases
		Fatal accidents at work
		Non-fatal accidents at work
Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization	The number of fatalities as a result of work-related injury with respect to the number of hours worked	Fatal accidents at work
	The number of accidents involving sick leave for every 100,000,000 hours worked	Non-fatal accidents at work
Occupational diseases	Number of reported occupational diseases in a given period (year) for every 200,000 hours worked. An occupational disease is a disease arising from the work situation or activity (such as stress or regular exposure to harmful chemicals), or a work-related injury	Death rate due to chronic diseases
Absence rate	The number of working days lost due to sick leave accidents registered for every 1,000 hours worked	Non-fatal accidents at work
Public commitments: Corporate citizenship	Total number of hours per year that employees have spent on voluntary activities during working hours	Human Development Index
Diversity of governance bodies	Percentage of individuals within the organization’s governance bodies in each of the following diversity categories: i. gender	Employed women being in managerial positions
Diversity of employees	Percentage of employees following diversity categories: i. gender; ii. foreign people; iii. young	Ratio of female to male labor force participation rate

Sub-subcategories	Basic indicators	Proposal of proxy indicators
Diversity of employees	people; and ix. disabled.	Unemployment, female
		Unemployment rate of disabled people
		Unemployment rate by Foreign-born
		Youth unemployment rate
Ratio of basic salary and remuneration of women to men	Ratio of the basic salary and remuneration of women to men for each employee category, by significant location.	Ratio of female to male salary
Fair income distribution	Ratio of the annual total compensation for the organization’s highest-paid individual in each country of significant operations to the median annual total compensation for all employees (excluding the highest-paid individual) in the same country	Employed persons At-risk-of poverty rate
Expenditure on education and training	Annual investment in workers technical training in the company over the last year divided by total employees in the company	Employed persons participating in job-related non-formal education and training in the past 12 months
Employee training on human rights policies or procedures	Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, Social awareness, human rights and social aspects of construction	Corruption Perception Index
Technology and human resource development	Annual investment in research and innovation project	Patent applications
		Research and development expenditure

SOURCE: Own elaboration

The focus group, trying not to duplicate information, selected all those national indices that were related to the general concept of each basic indicator. The focus group tried not to limit excessively the number of national indices in this stage. The reason was based on allowing the correlation analysis to reject the national indices with multicollinearity.

Six national indices were considered as proxy indicators in the sub-subcategory ‘employment opportunity’: (1) unemployment rate; (2) long-term unemployment rate; (3) youth unemployed rate; (4) rate of unemployed people with basic education; (5) rate of unemployed people with intermediate education; and, (6) rate of unemployed people with advanced education. Regarding the subcategories ‘Benefits’ and ‘Parental leave’, the focus group decided to cover the basic indicators with the same proxy indicator: public health expenditure. They considered that both basic indicators depend on the law of each country and the national policies with respect to the investment of governments in public health (CIRIA 2001; United Nations 2008a; GRI 2018).

On the other hand, according to the different concepts encompassed in the sub-subcategory ‘diversity of employees’, five national indices were selected as proxy indicators: (1) ratio of female to male labor force participation; (2) unemployment rate of females; (3) unemployment rate of disabled people; (4) unemployment rate of foreign-born; and, (5) youth unemployment rate (CIRIA 2001; Singh et al. 2007; Rahdari and Rostamy 2015; GRI 2016a; Popovic et al. 2018). Finally, the focus group decided that the national indices 'death rate due to chronic diseases', 'fatal accidents at work', and 'non-fatal accidents at work' may be proxy indicators of the sub-subcategories: a) health and safety training; b) health and safety management; c) work-related injuries for all employees and workers under control; d) occupational diseases; and e) absence rate. Thus, according to the three national indices, and taking into account that, occupational health and safety performance is a reflection of the health and safety management and training systems that exist in an organization (GRI 2018), the experts proposed that these five sub-subcategories may be clustered into three company indicators:

- Fatal accidents at work, whose proxy indicator could be the national index 'fatal accidents at work'; and, this company indicator should encompass health and safety training, health and safety management, and fatal accidents in the company.
- Non-fatal injuries at work, the proxy indicator would be 'non-fatal accidents at work'; and, this company indicator should encompass health and safety training, health and safety management, the number of accidents in the company, and the number of working days lost.
- Chronic disease, the proxy indicator would be 'death rate due to chronic diseases'; and this company indicator should be defined by health and safety training, health and safety management, and the number of reported occupational diseases.

5.3.2.3. Correlation analysis

The analysis of the dataset formed through the proposed proxy indicators by the focus group was necessary to study its suitability. The statistical analysis of the set of proxy indicators was based on correlation analysis. A correlation analysis allows identifying those proxy indicators that provide identical information about the performance of the country. Through this method, multicollinearity can be detected, and redundant indices can be excluded (Joint Research Centre-European Commission 2008). Multicollinearity is identified through the correlation matrix. The multicollinearity corresponds to those indicators most highly correlated (coefficient correlation above 0.80). According to Field (2013), three types of correlation coefficients can be calculated to define the correlation matrix:

- Pearson's correlation coefficient, which requires a normally distributed sample to assess the significance of the correlation.
- Spearman's correlation coefficient, which is a non-parametric statistics and can be used when the data do not present a normal distribution.
- Kendall's tau, which is another non-parametric correlation. This is recommended rather than Spearman's coefficient when the data set is small, offering, in small samples, a better estimate of the correlation.

These tests assume as null hypothesis that the correlation coefficient between variables is not significantly different from zero, being satisfied with this condition when the p-value is less than 0.5 (Hair et al. 2014). Additionally, these correlation coefficients (r) represent the standardized covariance. The coefficients go from -1 to +1. A coefficient of +1 indicates that the two variables are perfectly positively correlated; a coefficient of -1 indicates a perfect negative relationship and; a coefficient of zero indicates no linear relationship. To measure the size of an effect, values of ±0.1 represent a small effect, ±0.3 a medium effect, and ±0.5 a large effect (Field 2013).

Thus, to determine the correlation analysis to be performed, the normality of the sample was analyzed. Taking into account that the sample includes 28 countries, The Shapiro-Will test of normality was applied because the sample size was small (less than 50) (Hair et al. 2014). This test compares the scores in the sample to a normally distributed set of scores with the same mean and standard deviation. If the test is non-significant ($p > 0.05$), the distribution of the sample is not significantly different from a normal distribution; however, if the test is significant ($p < 0.05$) then the distribution in question is significantly different from a normal distribution (Field 2013). Therefore, after analyzing the normality of the sample, the method of the correlation analysis was chosen and, through the analysis of the correlation matrix, the indices most highly correlated (coefficient correlation above 0.80) were deleted, resulting in the final list of proxy indicators was.

According to the established method, first, the Shapiro-Will test was performed on the proxy indicators proposed by the focus group. The results of the Shapiro–Wilk normality tests are summarized in Table 5-8. This shows that only 13 indicators were normally distributed (p-value>0.05). Therefore, the correlation matrix was calculated through Kendall's tau test.

Table 5-8: Shapiro-Wilk normality test results

	Shapiro-Wilk		
Proxy indicators	**Statistic**	**df**	**Sig.**
Corruption perception index	0.969	28	0.562
Death rate due to chronic disease	0.843	28	0.001
Employed persons at-risk-of poverty rate	0.933	28	0.074
Employed persons participating in job-related non-formal education and training in the past 12 months	0.948	28	0.181
Employed women being in managerial positions	0.985	28	0.955
Fatal accidents at work	0.945	28	0.150
Human development index	0.955	28	0.264
Job tenure	0.961	28	0.366
Long-term unemployment rate	0.736	28	0.000
Non-fatal accidents at work	0.877	28	0.003
Patent applications	0.785	28	0.000
Public health expenditure	0.984	28	0.924
Ratio of female to male labor force participation rate	0.933	28	0.073
Ratio of female to male salary	0.959	28	0.336
Research and development expenditure	0.923	28	0.042
Temporary employment	0.965	28	0.456
Unemployment rate of foreign-born	0.829	28	0.000
Unemployment rate of disabled people	0.959	28	0.332
Unemployment with advanced education	0.728	28	0.000
Unemployment with basic education	0.936	28	0.089
Unemployment with intermediate education	0.798	28	0.000
Unemployment, female	0.736	28	0.000
Unemployment, total	0.805	28	0.000
Youth unemployment rate	0.869	28	0.002

Note: df: degress of freedom; Sig: p-value>0.05.

SOURCE: Own elaboration

The correlation analysis was carried out using IBM SPSS Statistics 23.0. Table 5-9 shows only Kendall's correlations characterized by multicollinearity (Kendall's correlations > 0.8). As it can be observed, the proxy indicator 'unemployment total' is highly correlated with the indicators: 'long-term unemployment rate' (0.801), 'unemployment female' (0.887), 'youth unemployment rate' (0.820), 'unemployment rate by foreign-born' (0.802), 'unemployment with advanced education' (0.836), 'unemployment with intermediate education' (0.819), and 'unemployment with basic education' (0.855). Similarly, the proxy indicator 'patent applications' is highly correlated to 'Research and development expenditure' (0.814). Consequently, the indicators 'unemployment total' and 'research and development expenditure' were considered, and the rest of the indicators characterized by multicollinearity were rejected.

Table 5-9: Kendall's correlations of proxy indicators characterized by multicollinearity

Kendall's correlations		Unemployment, total	Research and development expenditure
Long-term unemployment rate	Correlation coefficient	0.801	
	Sig. (2-tailed)	.000	
	N	28	
Unemployment, female	Correlation coefficient	0.887	
	Sig. (2-tailed)	.000	
	N	28	
Youth unemployment rate	Correlation coefficient	0.820	
	Sig. (2-tailed)	.000	
	N	28	
Unemployment rate by Foreign-born	Correlation coefficient	0.802	
	Sig. (2-tailed)	.000	
	N	28	
Unemployment with advanced education	Correlation coefficient	0.836	
	Sig. (2-tailed)	.000	
	N	28	
Unemployment with intermediate education	Correlation coefficient	0.819	
	Sig. (2-tailed)	.000	
	N	28	
Unemployment with basic education	Correlation coefficient	0.855	
	Sig. (2-tailed)	.001	
	N	28	
Patent applications	Correlation coefficient		0.814
	Sig. (2-tailed)		.000
	N		28

SOURCE: Own elaboration

Thus, the proxy indicators to be used in the methodology of the corporate social responsibility group are displayed in Table 5-10.

Table 5-10: Final proposal of proxy indicators for each Basic indicator

Sub-subcategories	Basic indicators	Proxy indicators
Employment opportunities	The rate of new employee hires during the reporting period, considering the level of education or the time that was as unemployed.	Unemployment rate
Employee turnover	Rate of employee turnover during a reporting period	Job tenure
Quality employment	Percentage of temporary workers	Temporary employment
Benefits	Annual investment in the health of employees over the last year	Public health expenditure
Parental leave	The ratio of employees that returned to work after finishing the entire parental leave and were still employed 12 months after their return to work with respect to the number of employees that were entitled to parental leave.	
Health and safety training	Total number of hours in the reporting period devoted to training on occupational health and safety with respect to the total number of worked hours	Death rate due to chronic diseases
		Fatal accidents at work
		Non-fatal accidents at work
Health and safety management	Certificates to demonstrate the occupational health and safety performance of companies	Death rate due to chronic diseases
		Fatal accidents at work
		Non-fatal accidents at work

Sub-subcategories	Basic indicators	Proxy indicators
Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization	The number of fatalities as a result of work-related injury with respect to the number of hours worked	Fatal accidents at work
	The number of accidents involving sick leave for every 100,000,000 hours worked	Non-fatal accidents at work
Occupational diseases	Number of reported occupational diseases in a given period (year) for every 200,000 hours worked. An occupational disease is a disease arising from the work situation or activity (such as stress or regular exposure to harmful chemicals), or a work-related injury	Death rate due to chronic diseases
Absence rate	The number of working days lost due to sick leave accidents registered for every 1,000 hours worked	Non-fatal accidents at work
Public commitments: Corporate citizenship	Total number of hours per year that employees have spent on voluntary activities during working hours	Human Development Index
Diversity of governance bodies	Percentage of individuals within the organization's governance bodies in each of the following diversity categories: i. gender	Employed women being in managerial positions
Diversity of employees	Percentage of employees per gender	Ratio of female to male labor force participation rate
	Percentage of disabled employees	Unemployment rate of disabled people
Ratio of basic salary and remuneration of women to men	Ratio of the basic salary and remuneration of women to men for each employee category, by significant location.	Ratio of female to male salary
Fair income distribution	Ratio of the annual total compensation for the organization's highest-paid individual in each country of significant operations to the median annual total compensation for all employees (excluding the highest-paid individual) in the same country	Employed persons At-risk-of poverty rate
Expenditure on education and training	Annual investment in workers technical training in the company over the last year divided by total employees in the company	Employed persons participating in job-related non-formal education and training in the past 12 months
Employee training on human rights policies or procedures	Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, Social awareness, human rights and social aspects of construction	Corruption Perception Index
Technology and human resource development	Annual investment in research and innovation project	Research and development expenditure

SOURCE: Own elaboration

5.3.3. Company indicators

Company indicators were defined based on the proxy indicators assigned to each basic indicator. Since these are expressed in different units, to be integrated into a composite indicator, company indicators require being normalized. According to Tokos et al. (2012) and Zhou et al. (2012), normalization using benchmarks ensures that all indicators are transformed in a transparent and comparable manner. Thus, to normalize the company indicators, the normalized value was calculated as the ratio between the indicator and an external benchmark. The external benchmark can be defined based on the values of measurements and standards in the construction industry, local legal regulations, GRI reports for the construction industry, and other relevant documents (Zhou et al. 2012). In this regard, this study recommended the use of GRI reports to define the benchmark because:

- The GRI guideline is the most widely used standardized sustainability reporting framework in the world (Roca and Searcy 2012; Tokos et al. 2012).
- Currently, social assessment is not an important issue for the construction industry, especially for small companies, which find it too complex. Thus, having available and reliable data about the social performance of construction companies is a difficult task. However, some construction companies are aware of the importance of sustainability, paying more attention to improve their performance in these issues (Tokos et al. 2012). An example of these companies is those that publish GRI reports. Consequently, it can be assumed that their performances about social sustainability are better than the average of all companies in the construction industry. Therefore, the best value of their performances may be defined as the benchmark.

To normalize the different components of each company indicator, the distance to a reference method was used. In this method, the normalized value was calculated as the ratio between the indicator and an external benchmark (Equation 5-2).

$$I' = \frac{I}{\lambda} \tag{5-2}$$

with:

- I : Value of an indicator.
- I' : Value of I normalized.
- λ : Benchmark for the indicator.

Based on this, the company indicators 'I'_i' are defined taking into account each basic indicator and its respective benchmark (λ) defined through GRI reports. The definitions of the company indicators are exposed from Figure 5-3 to Figure 5-18. The explanation about the definition of the normalization parameters (λ) of each company indicator can be seen at the end of this section. It is important to highlight that the normalization parameters should be updated over time.

Company Indicator	$I_1{}'$: New staff hiring
Category	Employment
Subcategory	Employment creation
Sub-Subcategory	Employment opportunities
Definition	The equation to assess the company indicator "New staff hiring" ($I_1{}'$) is: If $I_1 \leq \lambda_1$, $I_1{}' = I_1 \cdot \frac{1}{\lambda_1}$; else $I_1{}' = 1$ $I_1 = \frac{A}{B}$ $I_1{}'$: Company indicator I_1: Basic indicator λ_1: Normalization parameter Social parameters: • A: Total number of new staff hiring in the company over the last year (part-time and full-time staff) • B: Maximum number of workers in the company over the last year (part-time and full-time staff)
Normalization parameter for Spain	$\lambda_1 = 0.35$

Note: Only the information of the company in the country where the project is going to be developed must be considered.

SOURCE: Own elaboration

Figure 5-3: Definition of the company indicator "New staff hiring"

Company Indicator	$I_2{}'$: Temporary contracts
Category	Employment
Subcategory	Job stability
Sub-Subcategory	Quality employment
Definition	The equation to assess the company indicator "Temporary contracts" ($I_2{}'$) is: If $I_2 \leq \lambda_2$, $I_2{}' = 1 - I_2 \cdot \frac{1}{\lambda_2}$; else $I_2{}' = 0$ $I_2 = \frac{C}{B}$ $I_2{}'$: Company indicator I_2: Basic indicators λ_2: Normalization parameters Social parameters: • C: Total number of temporary workers in the company over the last year • B : Maximum number of workers in the company over the last year (part-time and full-time staff)
Normalization parameter for Spain	$\lambda_2 = 0.71$

Note: Only the information of the company in the country where the project is going to be developed must be considered.

SOURCE: Own elaboration

Figure 5-4: Definition of the company indicator "Temporary contracts"

Company Indicator	$I_3{}'$: Employee turnover
Category	Employment
Subcategory	Job stability
Sub-Subcategory	Employee turnover
Definition	The equation to assess the company indicator "Employee turnover" ($I_3{}'$) is: If $\mathrm{I}_3 \leq \lambda_3$, $\mathrm{I}_3{}' = 1 - \mathrm{I}_3 \cdot \frac{1}{\lambda_3}$; else $\mathrm{I}_3{}' = 0$ $\mathrm{I}_3 = \frac{\mathrm{D}}{\mathrm{B}}$ $I_3{}'$: Company indicator I_3: Basic indicators λ_3: Normalization parameters Social parameters: • D: Maximum number of leaving over the last year (part-time and full-time staff) • B : Maximum number of workers in the company over the last year (part-time and full-time staff)
Normalization parameter for Spain	$\lambda_3 = 0.13$

Note: Only the information of the company in the country where the project is going to be developed must be considered.

SOURCE: Own elaboration

Figure 5-5: Definition of the company indicator "Employee turnover"

Company Indicator	$I_4{}'$:Benefits
Category	Health and safety
Subcategory	Social benefits and social security
Sub-Subcategory	Benefits
Definition	The equation to assess the company indicator "Benefits" ($I_4{}'$) is: $\mathrm{I}'_4 = \frac{1}{2}(\mathrm{I}'_{41} + \mathrm{I}'_{42})$ $\mathrm{I}_{41} = \frac{\mathrm{E}_0}{\mathrm{E}_1}$; If $\mathrm{I}_{41} \leq \lambda_4$, $\mathrm{I}'_{41} = \mathrm{I}_{41} \cdot \frac{1}{\lambda_{41}}$; else $\mathrm{I}'_{41} = 1$ $\mathrm{I}_{42} = \frac{\mathrm{E}_2}{\mathrm{E}_3}$; If $\mathrm{E}_3 > 0$, $\mathrm{I}'_{42} = \mathrm{I}_{42} \cdot \frac{1}{\lambda_{42}}$; else $\mathrm{I}'_{42} = 1$ I'_4: Company indicator I'_{41}, I'_{42}: Standardized indicators I_{41}, I_{42}: Basic indicators $\lambda_{41}, \lambda_{42}$: Normalization parameters Social parameters: • E_0 : annual investment in health of employees over last year; considering social security, medical insurance, dental insurance, paramedical insurance including preventive medicine, medicine insurance, wage insurance, paid maternity and paternity leave, paid sick leave • E_1: Revenue over last year • E_2: the number of employees who, over last two years, returned to work after parental leave ended who were still employed twelve months after their return to work • E_3: the number of employees that were entitled to parental leave over last two years
Normalization parameter for Spain	$\lambda_{41} = 0.06$ $\lambda_{42} = 1$

Note: Only the information of the company in the country where the project is going to be developed must be considered.

SOURCE: Own elaboration

Figure 5-6: Definition of the company indicator "Benefits"

Company Indicator	$I_5{}'$: Chronic disease
Category	Health and safety
Subcategory	Occupational health and safety performance
Sub-Subcategory	Health and safety training
	Health and safety management
	Occupational diseases
Definition	The equation to assess the company indicator "Chronic disease" ($I_5{}'$) is: $\mathrm{I}_5{}' = \frac{1}{4}(\mathrm{I'}_{51} + \mathrm{I'}_{52} + \mathrm{I'}_{53} + \mathrm{I}_{54})$ $\mathrm{I}_{51} = \frac{\mathrm{F}_0}{\mathrm{F}_1}$; If $\mathrm{I}_{51} \leq \lambda_{51}$, $\mathrm{I'}_{51} = 1 - \mathrm{I}_{51} \cdot \frac{1}{\lambda_{51}}$; else $\mathrm{I'}_{51} = 0$ $\mathrm{I}_{52} = \frac{\mathrm{F}_2}{\mathrm{F}_3} \cdot$ 200,000; If $\mathrm{I}_{52} \leq \lambda_{52}$, $\mathrm{I'}_{52} = 1 - \mathrm{I}_{52} \cdot \frac{1}{\lambda_{52}}$; else $\mathrm{I'}_{52} = 0$ $\mathrm{I}_{53} = \frac{\mathrm{F}_4}{\mathrm{F}_3}$; If $\mathrm{I}_{53} \leq \lambda_{53}$, $\mathrm{I'}_{53} = \mathrm{I}_{53} \cdot \frac{1}{\lambda_{53}}$; else $\mathrm{I'}_{53} = 1$ I_{54} : If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $\mathrm{I}_{54} = 1$; else $I_{54} = 0$ $I_5{}'$: Company indicator $I'_{51}, I'_{52}, I'_{53}$: Standardized indicators $I_{51}, I_{52}, I_{53}, I_{54}$: Basic indicators $\lambda_{51}, \lambda_{52}, \lambda_{53}$: Normalization parameters Social parameters: • F_0: The number of days missed due to illness over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_1: Total number of workers in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_2: The number of occupational disease over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_3: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_4: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment An occupational disease is a disease arising from the work situation or activity, or from a work-related injury
Normalization parameter for Spain	$\lambda_{51} = 7.15$ $\lambda_{52} = 0.04$ $\lambda_{53} = 0.004$

Note: Only the information of the company in the country where the project is going to be developed must be considered.
* equivalent certificate to be determined by the procurer.

SOURCE: Own elaboration

Figure 5-7: Definition of the company indicator "Chronic disease"

Company Indicator	$I_6{}'$: Fatal accidents at work
Category	Health and safety
Subcategory	Occupational health and safety performance
Sub-Subcategory	Health and safety training
	Health and safety management
	Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization
Definition	The equation to assess the company indicator "Fatal accidents at work" ($I_6{}'$) is: $\mathrm{I}_6{}' = \frac{1}{3}(\mathrm{I'}_{61} + \mathrm{I'}_{53} + \mathrm{I}_{54})$ $\mathrm{I}_{61} = \frac{\mathrm{G}}{\mathrm{F}_3}$; If $\mathrm{I}_{61} \leq \lambda_6$, $\mathrm{I'}_{61} = 1 - \mathrm{I}_{61} \cdot \frac{1}{\lambda_6}$; else $\mathrm{I'}_{61} = 0$ $\mathrm{I}_{53} = \frac{\mathrm{F}_4}{\mathrm{F}_3}$; If $\mathrm{I}_{53} \leq \lambda_{53}$, $\mathrm{I'}_{53} = \mathrm{I}_{53} \cdot \frac{1}{\lambda_{53}}$; else $\mathrm{I'}_{53} = 1$ I_{54} : If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $\mathrm{I}_{54} = 1$; else $I_{54} = 0$ $I_6{}'$: Company indicator I'_{61}, I'_{53}: Standardized indicators I_{61}, I_{53}, I_{54} : Basic indicators λ_6, λ_{53}: Normalization parameters Social parameters: • G: Number of fatalities over last year considering total staff and supervised workers to whom the organization is liable for the general safety of the working environment • F_3: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_4: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment A Fatality is the death of a worker occurring in the current reporting period, arising from an occupational injury or disease sustained or contracted while are employed in the organization
Normalization parameter for Spain	$\lambda_6 = 3.65\,\mathrm{E} - 8$ $\lambda_{53} = 0.004$

Note: Only the information of the company in the country where the project is going to be developed must be considered.

* equivalent certificate to be determined by the procurer.

SOURCE: Own elaboration

Figure 5-8: Definition of the company indicator "Fatal accidents at work"

Company Indicator	$I_7{}'$: Non-fatal injuries at work
Category	Health and safety
Subcategory	Occupational health and safety performance
Sub-Subcategory	Health and safety training
	Health and safety management
	Work-related injuries for all employees and workers who are not employees but whose work and/or workplace is controlled by the organization
Definition	The equation to assess the company indicator "Non-fatal injuries at work" ($I_7{}'$) is: $\mathrm{I_7}' = \frac{1}{4}(\mathrm{I'_{71}} + \mathrm{I'_{72}} + \mathrm{I'_{53}} + \mathrm{I_{54}})$ $\mathrm{I_{71}} = \frac{\mathrm{H_0}}{\mathrm{F_3}} \cdot$ 100,000,000; If $\mathrm{I_{71}} \leq \lambda_{71}$, $\mathrm{I'_{71}} = 1 - \mathrm{I_{71}} \cdot \frac{1}{\lambda_{71}}$; else $\mathrm{I'_{71}} = 0$ $\mathrm{I_{72}} = \frac{\mathrm{H_1}}{\mathrm{F_3}} \cdot$ 1,000; If $\mathrm{I_{72}} \leq \lambda_{72}$, $\mathrm{I'_{72}} = 1 - \mathrm{I_{72}} \cdot \frac{1}{\lambda_{72}}$; else $\mathrm{I'_{72}} = 0$ $\mathrm{I_{53}} = \frac{\mathrm{F_4}}{\mathrm{F_3}}$; If $\mathrm{I_{53}} \leq \lambda_{53}$, $\mathrm{I'_{53}} = \mathrm{I_{53}} \cdot \frac{1}{\lambda_{53}}$; else $\mathrm{I'_{53}} = 1$ $\mathrm{I_{54}}$: If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $\mathrm{I_{54}} = 1$; else $I_{54} = 0$ $I_7{}'$: Company indicator $I'_{71}, I'_{72}\ I'_{53}$: Standardized indicators $I_{71}, I_{72}, I_{53}, I_{54}$: Basic indicators $\lambda_{71}, \lambda_{72}, \lambda_{53}$: Normalization parameters Social parameters: • $\mathrm{H_0}$: The number of accidents involving sick leave over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment. • $\mathrm{H_1}$: The number of working days lost due to sick leave accidents registered over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • $\mathrm{F_3}$: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • $\mathrm{F_4}$: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
Normalization parameter for Spain	$\lambda_{71} = 20$ $\lambda_{72} = 0.57$ $\lambda_{53} = 0.004$

Note: Only the information of the company in the country where the project is going to be developed must be considered. * equivalent certificate to be determined by the procurer.

SOURCE: Own elaboration

Figure 5-9: Definition of the company indicator "Non-fatal injuries at work"

Company Indicator	$I_8{}'$: Social value
Category	Local
Subcategory	Social value
Sub-Subcategory	Public commitments: Corporate citizenship
Definition	The equation to assess the company indicator "Social value" ($I_8{}'$) is: If $\mathrm{I}_8 \leq \lambda_8$, $\mathrm{I}_8{}' = \mathrm{I}_8 \cdot \frac{1}{\lambda_8}$; else $\mathrm{I}_8{}' = 1$ $\mathrm{I}_8 = \frac{\mathrm{K}_0}{\mathrm{K}_1}$ $I_8{}'$: Company indicator I_8: Basic Indicator λ_8: Normalization parameter Social parameters: • K_0: Total number of hours that employees have spent with social programs and voluntary activities during working hours of the last year, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)
Normalization parameter for Spain	$\lambda_8 = 2.81\mathrm{E}-4$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-10: Definition of the company indicator "Social value"

Company Indicator	$I_9{}'$: Female labor force participation
Category	Professional ethics
Subcategory	Non-discrimination and equal opportunities
Sub-Subcategory	Diversity of employees
Definition	The equation to assess the company indicator "Female labor force participation" ($I_9{}'$) is: If $\mathrm{I}_9 \leq \lambda_9$, $\mathrm{I}_9{}' = \mathrm{I}_9 \cdot \frac{1}{\lambda_9}$; else $\mathrm{I}_9{}' = 1$ $\mathrm{I}_9 = \frac{\mathrm{L}}{\mathrm{B}}$ $I_9{}'$: Company indicator I_9: Basic indicator λ_9: Normalization parameter Social parameters: • L: Total number of women employees in the company over the last year (part-time and full-time staff) • B: Maximum number of workers in the company over the last year (part-time and full-time staff)
Normalization parameter for Spain	$\lambda_9 = 0.5$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-11: Definition of the company indicator "Female labor force participation"

Company Indicator	$I_{10}{}'$: Wage gap
Category	Professional ethics
Subcategory	Non-discrimination and equal opportunities.
Sub-Subcategory	Ratio of basic salary and remuneration of women to men
Definition	The equation to assess the company indicator "Wage gap" ($I_{10}{}'$) is: If $\mathrm{I}_{10} = 0$, $\mathrm{I'}_{10} = 1$; else $\mathrm{I'}_{10} = 1 - \mathrm{I}_{10}$ $\mathrm{I}_{10} = \frac{1}{\mathrm{n}} \cdot \sum_{\mathrm{i}=1}^{\mathrm{n}} \left(\frac{\max(\mathrm{a},\mathrm{b})_{\mathrm{i}} - \min(\mathrm{a},\mathrm{b})_{\mathrm{i}}}{\max(\mathrm{a},\mathrm{b})_{\mathrm{i}}} \right)$ $I_{10}{}'$: Company indicator I_{10}: Basic indicator Social parameters: $\mathrm{a} = \mathrm{S_{W\,i}}/\mathrm{H_{w\,i}}$ • $\mathrm{S_{W\,i}}$: Total of basic salary and remuneration of women employees in "i" job category, over the last year • $\mathrm{H_{w\,i}}$: Number of worked hours by women employees in "i" job category, over the last year $\mathrm{b} = \mathrm{S_{M\,i}}/\mathrm{H_{M\,i}}$ • $\mathrm{S_{Mi}}$: Total of basic salary and remuneration of men employees in "i" job category, over the last year • $\mathrm{H_{M\,i}}$: Number of worked hours by men employees in "i" job category, over the last year i: job categories in the company. Only the "n" categories where are both women and men employed must be considered. (Categories: (1) senior management; (2) executive and managers; (3) graduates; (4) administrative; (5) operatives)
Normalization parameter for Spain	$\lambda_{10} = 1$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-12: Definition of the company indicator "Wage gap"

Company Indicator	$I_{11}{}'$: Women in executive management positions
Category	Professional ethics
Subcategory	Non-discrimination and equal opportunities.
Sub-Subcategory	Diversity of governance bodies
Definition	The equation to assess the company indicator "Women in executive management positions" ($I_{11}{}'$) is: If $\mathrm{I}_{11} \leq \lambda_{11}$, $\mathrm{I}_{11}{}' = \mathrm{I}_{11} \cdot \frac{1}{\lambda_{11}}$; else $\mathrm{I}_{11}{}' = 1$ $\mathrm{I}_{11} = \frac{\mathrm{N}_0}{\mathrm{N}_1}$ $I_{11}{}'$: Company indicator I_{11}: Basic indicator λ_{11}: Normalization parameter Social parameters: • N_0: Number of women in executive management positions in the Company over the last year • N_1: Number of workers in executive management positions in the company over the last year Executive management position refers to company directors, vice president, senior vice president, C-level executive (Chief Accounting Officer-CAO, Chief Operating Officer-COO, Chief Financial Officer-CFO and Chief Technology Officer-CTO) and Chief Executive Officer (CEO)
Normalization parameter for Spain	$\lambda_{11} = 0.5$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-13: Definition of the company indicator "Women in executive management positions"

Company Indicator	$I_{12}{}'$: Disabled
Category	Professional ethics
Subcategory	Non-discrimination and equal opportunities.
Sub-Subcategory	Diversity of employees
Definition	The equation to assess the company indicator "Disabled" ($I_{12}{}'$) is: If $\mathrm{I}_{12} \leq \lambda_{12}$, $\mathrm{I}_{12}{}' = \mathrm{I}_{12} \cdot \frac{1}{\lambda_{12}}$; else $\mathrm{I}_{12}{}' = 1$ $\mathrm{I}_{12} = \frac{\mathrm{P}}{\mathrm{K}_1}$ $I_{12}{}'$: Company indicator I_{12}: Basic indicator λ_{12}: Normalization parameter Social parameters: • P: Total number of workers in the company over the last year, registered as disabled (part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)
Normalization parameter for Spain	$\lambda_{12} = 0.04$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-14: Definition of the company indicator "Disabled"

Company Indicator	$I_{13}{}'$: Salary distribution
Category	Professional ethics
Subcategory	Fair wages and fair income distributions
Sub-Subcategory	Fair income distribution
Definition	The equation to assess the company indicator "Salary distribution" ($I_{13}{}'$) is: If $\mathrm{I}_{13} \leq \lambda_{13}$, $\mathrm{I'}_{13} = 1 - \mathrm{I}_{13} \cdot \frac{1}{\lambda_{13}}$; else $\mathrm{I'}_{13} = 0$ $\mathrm{I}_{13} = \frac{\mathrm{Q}_1}{\mathrm{Q}_2}$ $I_{13}{}'$: Company indicator I_{13}: Basic indicator λ_{13}: Normalization parameter Social parameters: • Q_1: Annual total compensation of the highest-paid individual in the company, over last year, considering total staff (temporal, part-time and full-time staff) • Q_2 : Median annual total compensation for all employees except the highest-paid individual, over last year, considering total staff (temporal, part-time and full-time staff) Total compensation compiles: - Base salary: guaranteed, short term, non-variable cash compensation - Cash compensation: sum of base salary + cash allowances + bonuses + commissions + cash profit-sharing + other forms of variable cash payments - Direct compensation: sum of total cash compensation + total fair value of all annual long-term incentives (such as stock option awards, restricted stock shares or units, performance stock shares or units, phantom stock shares, stock appreciation rights, and long-term cash awards)
Normalization parameter for Spain	$\lambda_{13} = 28.83$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-15: Definition of the company indicator "Salary distribution"

Company Indicator	$I_{14}{}'$: Technical training
Category	Training
Subcategory	Technical training
Sub-Subcategory	Expenditure on education and training
Definition	The equation to assess the company indicator "Technical training" ($I_{14}{}'$) is: If $\mathrm{I}_{14} \leq \lambda_{14}$, $\mathrm{I}_{14}{}' = \mathrm{I}_{14} \cdot \frac{1}{\lambda_{14}}$; else $\mathrm{I}_{14}{}' = 1$ $\mathrm{I}_{14} = \frac{\mathrm{T}}{\mathrm{K}_1}$ $I_{14}{}'$: Company indicator I_{14}: Basic indicator λ_{14}: Normalization parameter Social parameters: • T : Annual investment in workers technical training in the company over the last year, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)
Normalization parameter for Spain	$\lambda_{14} = 840.32$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-16: Definition of the company indicator "Technical training"

Company Indicator	$I_{15}{}'$: Social ethics, social awareness and human rights
Category	Training
Subcategory	Sustainability training
Sub-Subcategory	Employee training on human rights policies or procedures
Definition	The equation to assess the company indicator "Social ethics, social awareness and human rights" ($I_{15}{}'$) is: If $\mathrm{I}_{15} \leq \lambda_{15}$, $\mathrm{I}_{15}{}' = \mathrm{I}_{15} \cdot \frac{1}{\lambda_{15}}$; else $\mathrm{I}_{15}{}' = 1$ $\mathrm{I}_{15} = \frac{\mathrm{S}}{\mathrm{K}_1}$ $I_{15}{}'$: Company indicator I_{15}: Basic indicator λ_{15}: Normalization parameter Social parameters: • S: Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, social awareness, human rights and social aspects of construction, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)
Normalization parameter for Spain	$\lambda_{15} = 4.75\mathrm{E}-4$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-17: Definition of the company indicator "Social ethics, social awareness and human rights"

Company Indicator	$I_{16}{}'$: Research and Development
Category	Training
Subcategory	Sustainability training
Sub-Subcategory	Technology and Human Resource Development
Definition	The equation to assess the company indicator "Research and Development" ($I_{16}{}'$) is: If $\mathrm{I}_{16} \leq \lambda_{16}$, $\mathrm{I}_{16}{}' = \mathrm{I}_{16} \cdot \frac{1}{\lambda_{16}}$; else $\mathrm{I}_{16}{}' = 1$ $\mathrm{I}_{16} = \frac{\mathrm{R}}{\mathrm{E}_1}$ $I_{16}{}'$: Company indicator I_{16}: Basic indicator λ_{16}: Normalization parameter Social parameters: • R: Annual investment in research and innovation projects over the last year • E_1: Revenue over last year
Normalization parameter for Spain	$\lambda_{16} = 2.7\mathrm{E}-2$

Note: Only the information of the company in the country where the project is going to be developed must be considered

SOURCE: Own elaboration

Figure 5-18: Definition of the company indicator "Research and Development"

Regarding the definition of the normalization parameters, a total of eight GRI reports of Spanish construction companies were identified and reviewed. These were the most recent reports of Spanish construction companies from 2016 to 2017. To identify the data of each basic indicator, the pages of each report were read, and indicators presented in the text or performance scorecards were recorded. Additionally, the information that was explained in charts, tables, framed or bold characters was reviewed, and data associated with the indicators were collected. This led to the development of a database of all basic indicators. The information of the eight Spanish construction companies, with respect to these indicators, is displayed in Table 5-11. As can be seen, not all the information about each indicator in each company was found in the reports. This happened because GRI guidelines are recommendations to assess the sustainability of a company through the use of a set of indicators. But, the use of this indicators is not mandatory to assess the sustainability of the company; thus, indicators can be excluded or not considered, if the company decides not to measure them (Tokos et al. 2012). This is the reason why a great number of cells in this table are empty.

Table 5-11: Values extracted from GRI reports of Spanish construction companies for each basic indicator

Basic Indicator (I_i)	Values for each Spanish construction company								Normalization parameter (λ)
	Firm 1 (MNE)	Firm 2 (Large)	Firm 3 (Large)	Firm 4 (Large)	Firm 5 (Large)	Firm 6 (Large)	Firm 7 (Large)	Firm 8 (SME)	
I_1	0.35	0.01	0.10	0.25	0.01	0.05	0.04	0.00	0.35
I_2	0.18	0.71	0.56	0.23	0.34	0.23	0.26	0.00	0.71
I_3	0.05	0.06	-	0.13	0.05	0.04	0.03	0.00	0.13
I_{41}	-	0.06	-	0.04	-	-	-	-	0.06
I_{42}	-	-	-	-	-	-	-	-	1.00
I_{51}	7.15	2.30	4.03	5.16	-	-	-	0.00	7.15
I_{52}	0.04	-	-	-	-	-	-	0.00	0.04
I_{53}	1.54E-03	-	-	4.15E-03	1.7E-03	-	5.30E-04	1.90E-03	0.004
I_{61}	0.00E+00	-	-	1.10E-08	-	1.89E-08	3.65E-08	0.00E+00	3.65E-08
I_{71}	3.90	18.56	8.34	20.00	13.50	5.15	2.00	0.00	20.00
I_{72}	0.57	0.50	0.34	0.43	0.40	0.54	-	0.00	0.57
I_8	-	2.32E-06	-	-	2.8E-04	-	-	-	2.81E-04
I_9	0.68	0.80	0.26	0.58	0.65	0.95	0.69	0.40	0.5
I_{10}	0.95	-	-	-	-	-	-	0.91	1.00
I_{11}	0.31	0.11	0.36	0.29	0.17	-	0.20	0.33	0.50
I_{12}	0.04	0.03	-	-	0.03	0.03		0.00	0.04
I_{13}	-	-	-	28.83	-	-	-	1.24	28.83
I_{14}	840.32	513.10	233.54	-	-	-	-	-	840.32
I_{15}	3.19E-04	4.75E-04	-	-	3.9E-04	-	-	-	4.75E-04
I_{16}	2.76E-02	1.58E-03	3.61E-03	4.09E-03	2.0E-03	2.97E-03	3.13E-03	0.00E+00	2.76E-02

Note: MNE: multinational enterprise; Large: large enterprise; SME: small and medium-sized enterprise.

SOURCE: Own elaboration from GRI reports

Following the recommendations of Tokos et al. (2012) and Zhou et al. (2012), to define the normalization parameter, the maximum value for each indicator has been selected, except for I_{42}, I_9, I_{10}, and I_{11}. For these four indicators, the normalization parameters were defined as follows:

- I_{42} represents the percentage of the workers entitled to parental leave and, after the parental leave ended, returned to work and were employed twelve months after their return. Although this indicator is proposed by the GRI guidelines (GRI 2011), none of the analyzed reports offers this data. Therefore, the maximum has been fixed as 1.00. Using 1.00 as the normalization parameter represents that every man and woman entitled to parental leave, take leave and return to work to the same or a comparable position, securing, thus, their employment, remuneration and career path (GRI 2011).

- I_9 represents the ratio of women to men in the company. The maximum value obtained for this indicator in the GRI reports is 0.48. Thus, taking into account that the goal of the European Union is to achieve equality between women and men in the workforce, the normalization parameter has been fixed as 0.50 (European Commision 2014; European Comission 2016).
- I_{10} represents the wage gap between women and men. The maximum value obtained for this indicator in the GRI reports is 0.95. Thus, taking into account that the goal of the European Union is to achieve equality between women and men workforce, the normalization parameter has been fixed as 1.00 (European Commision 2014).
- I_{11} represents the percentage of women in executive management positions. The maximum value obtained for this indicator in the GRI reports is 0.36. Similarly to the previous indicators, in order to achieve equality between women and men workforce, the normalization parameter has been fixed as 0.50 (European Comission 2016).

5.3.4. Weights

To define the weights of the composite indicator in the corporate social responsibility group, the DEA-BOD approach based on the pessimistic version was selected. The DEA-BOD approach is a method to assign the weights in a composite indicator. As it was defined in the methodological approach (chapter 3), the DEA-BOD approach is a well established non-parametric technique that defines an efficiency frontier, through a mathematical programming model, and uses this frontier as a benchmark to measure the performance of a given set of entities (such as countries, companies, projects, etc.) (Nardo et al. 2005; Joint Research Centre-European Commission 2008). Then, a set of weights is assigned to each entity looking for its maximum/or minimum efficiency (depending on the optimistic or pessimistic approach of the model). Thus, the weights assigned to each entity will be different from the other entities if their performances are different (Cherchye et al. 2008).

In the pessimistic version, the worst social performance of a country can be identified through the comparison of this country to an established sample of countries. The idea is to identify the social weaknesses of each country, and focusing efforts to try to alleviate these social shortcomings. In this regard, if the maximum weights in the composite indicator are given to the worst performance indicators in a country, construction companies involved in procurement procedures will have to make an effort in these social issues to achieve better chances to win the contract, promoting, at the same time, the transformation of the industry toward social sustainability.

In this section, first, the DEA-BOD approach based on the pessimistic version is presented. Second, the normalization of the proxy indicators is performed. Finally, the weights for each country included in the sample were obtained, and a simulation process was performed to check the suitability of the composite indicator.

5.3.4.1. DEA-BOD approach based on the pessimistic version

The conceptual starting point of the DEA-BOD approach based on the pessimistic version is going to be presented based on Zhou et al. (2007), Cherchye et al. (2008), Zhou (2008), and Rogge (2018).

The goal of the DEA-BOD approach based on the pessimistic version is minimizing the efficiency, assigning the maximum weights in the composite indicator to the worst performance indicators in a country. The worst performance indicators need to be identified through the comparison of the country with other countries in the sample. Consider that the following composite indicator (CI_c) represents the general performance of the specific country ‘c’ (see Equation 5-3).

$$CI_c = \sum_{i=1}^{n} w_{ic} \cdot y_{ic} \qquad (5\text{-}3)$$

With:

- CI_c: Result of the composite indicator. It shows the social performance of the country ‘c’.
- y_{ic}: Value for country ‘c’ on the indicator ‘i’ (i=1,…, n; n is the number of indicators in the model).
- w_{ic}: Weight assigned to the indicator ‘i’ for the country ‘c’.

However, the purpose of the DEA-BOD approach based on the pessimistic version is comparing a country ‘c’ relative to the other countries in the sample to: (1) identify the worst performance indicators of the country ‘c’; and (2) assign the maximum weights to the worst performance indicators, seeking to achieve the minimum efficiency of this country. To achieve this purpose, the composite indicator should be defined as in Equation 5-4.

$$CI_c = \frac{\sum_{i=1}^{n} w_{ic} \cdot y_{ic}}{\sum_{i=1}^{n} w_{ic} \cdot y_{iB}} \qquad (5\text{-}4)$$

With:

- $\mathrm{CI_c}$: Result of the composite indicator. It shows the social performance of the country 'c'.
- $\mathrm{y_{ic}}$: Value for country 'c' on the indicator 'i' (i=1,…, n; n is the number of indicators in the model).
- $\mathrm{w_{ic}}$: Weight assigned to the indicator 'i' in the country 'c'.
- $\mathrm{y_{iB}}$: Value for the benchmark 'B' on the indicator 'i' (i=1,…, n; n is the number of indicators in the model).

Thus, the result of the composite indicator is not given by a weighted sum of its indicators. According to Equation 5-4, the result of the composite indicator for country 'c' is obtained as the ratio between the weighted sum of its indicators and weights, and the weighted sum applying its weights to the indicators of the benchmark. This analyzes the performance of country 'c' compared to the performance of the benchmark when the weights are applied to the benchmark. Thus, a value of 1.00 implies the same performance for both countries (the country 'c' and the benchmark 'B'), and a value less than 1.00 shows a worse performance for country 'c' with respect to 'B'.

Taking into account that in a sample of countries, the benchmark has to be selected from this sample and it varies for each specific country in the sample, the benchmark of country 'c' will be the country that, having applied the weights of country 'c', obtains the minimum value of the composite indicator (see Equation 5-5). It is important to note that the calculation problem has to be performed for each country independently since the benchmark varies for each country.

$$CI_c = \frac{\sum_{i=1}^{n} w_{ic} \cdot y_{ic}}{\min(\sum_{i=1}^{n} w_{ic} \cdot y_{ij})} \qquad (5\text{-}5)$$

With:

- $\mathrm{CI_c}$: Result of the composite indicator and it shows the social performance of the country 'c'.
- $\mathrm{y_{ic}}$: Value for country 'c' on the indicator 'i' (i=1,…, n; n is the number of indicators in the model).

- w_{ic} : Weight assigned to the indicator ‘i’ in the country ‘c’.
- y_{ij} : Value for the country ‘j’ on the indicator ‘i’ (j= 1,…,m; m is the number of countries in the sample)

Additionally, as the aim of the pessimistic version is to achieve the minimum efficiency for each country in the sample, the goal is defining the minimum weights for ‘c’ to achieve the minimum value of $\sum_{i=1}^{n} y_{ic} \cdot w_{ic}$ (see Equation 5-6). Moreover, two conditions have to be satisfied: (1) a normalization constraint defined to guarantee that no other country in the sample obtains a value in the weighted sum lower than one when the optimum weights of country ‘c’ are applied (see Equation 5-7); and, (2) establishing a limit to the weights to be non-negative (see Equation 5-8). With these conditions, the value of the composite indicator for each country is going to be greater than 1.00 ($CI_c \geq 1$).

$$CI_c = \frac{\min_{w_{ic}} \sum_{i=1}^{n} y_{ic} \cdot w_{ic}}{\min(\sum_{i=1}^{n} y_{ij} \cdot w_{ic})} \tag{5-6}$$

Subject to

$$\sum_{i=1}^{n} y_{ij} \cdot w_{ic} \geq 1 \tag{5-7}$$

$$w_{ic} \geq 0 \tag{5-8}$$

With:

- CI_c: Result of the composite indicator and it shows the social performance of the country ‘c’.
- y_{ic}: Value for country ‘c’ on the indicator ‘i’ (i=1,…, n; n is the number of indicators in the model).
- w_{ic} : Weight assigned to the indicator ‘i’ in the country ‘c’.
- y_{ij} : Value for the country ‘j’ on the indicator ‘i’ (j= 1,…,m; m is the number of countries in the sample)

Taking into account that the composite indicator for each country is going to be greater than 1.00 ($1 \leq CI_c$), higher values of CI_c indicate better overall performances, or in other words, when a country obtaining a CI_c equal to 1.00 represents that there are probably no or only a few underlying performance indicators on which the evaluated country performs significantly weaker compared to the other countries (Rogge 2012). Finally, taking into account that the benchmark observation will obtain the minimum composite indicator value of 1.00, the problem can be expressed as indicated in Equation 5-9.

$$CI_c = \min_{w_{ic}} \sum_{i=1}^{n} y_{ic} \cdot w_{ic} \tag{5-9}$$

Subject to

$$\sum_{i=1}^{n} y_{ij} \cdot w_{ic} \geq 1 \tag{5-7}$$

$$w_{ic} \geq 0 \tag{5-8}$$

Additionally, a new prescription can be added to guarantee that the sum of the weights is equal to 1.00 (see Equation 5-10).

$$\sum_{i=1}^{n} w_{ic} = 1 \tag{5-10}$$

Once the model has been defined, an additional restriction was included to avoid a possible shortcoming. Note that, according to the definition of the model, the weights used may be such that a number of indicators would be ignored in aggregation, since the model may assign maximum weights to the worst indicators and undervalue the indicators associated with medium or good performances. However, this is definitely not the expected case of the model, because all the indicators of the model are considered essential to be included to assess the social performance of the construction companies; thus, it may not be appropriate to ignore any of them. To overcome this problem, different alternatives exist to include restrictions in the model (Cherchye et al. 2008). Following the recommendations of Zhou et al. (2007), Zhou (2008), Cherchye et al. (2008), and Rogge (2018), etc., weighting restrictions were included to guarantee a minimum weight for each indicator. The most recommended restrictions are the 'proportional share restrictions'; thus, this was included in the model as displayed in Equation 5-11.

$$\alpha_j \leq \frac{y_{ij} \cdot w_{ij}}{\sum_{i=1}^{n} y_{ij} \cdot w_{ij}} \leq \beta_j \tag{5-11}$$

α_j and β_j are respectively denoted the lower and upper limits for the contribution of the j-th indicator in CI_j and satisfy $0 \leq \alpha_j < \beta_j \leq 1$ (Zhou 2008). Cherchye et al. (2008) argued that this type of restrictions facilitates decision-making, being easier and more practical to let experts agree on the maximum and minimum weights to be assigned to the indicators (Zhou 2008). Thus, the model was revised, adding this constraint.

5.3.4.2. Normalization of the proxy indicators

Most of the selected proxy indicators are expressed in ratio scales or are defined in different measurement units, with orders of magnitude that vary widely. To avoid these shortcomings, the proxy indicators need to be normalized to be used in the DEA-BOD model. Two normalization techniques are highly recommended for the DEA-BOD approach: (1) the minimum–maximum normalization method; and, (2) the 'distance to a reference' method (Zhou et al. 2012). However, to assign the 'distance to a reference' values, benchmark values for each proxy indicators must be directly determined. These benchmarks have not been established in the European Commission, and their definition by the researcher would imply the introduction of a high level of subjectivity in the model. For that reason, the minimum–maximum normalization method was the selected method, using the minimum or maximum value of each indicator in the sample to carry out the normalization technique.

Through this method, proxy indicators were normalized within a unitless interval scale of 1.00 and 2.00. The reason why proxy indicators were defined as between 1.00 and 2.00, was to avoid problems with the model with respect to the established 'proportional share restrictions'; because if some indicator has a value of zero, the model could give wrong results, not satisfying the lower limit of the 'proportional share restrictions'.

To perform the minimum-maximum normalization method, first, the proxy indicators were classified depending on their positive or negative impact. The proxy indicators with a positive impact are those with the higher value; This indicates better performance because it represents that the associated social weakness decreases. These proxy indicators are: public health expenditure, human development index, ratio of female to male labor force participation rate, ratio of female to male salary, employed women being in managerial positions, employed persons participating in job-related non-formal education and training in the past 12 months, corruption perception index, and research and development expenditure.

On the other hand, the proxy indicators with a negative impact are those where the higher value indicates the worse performance, because it represents that the associated social weakness increases. These proxy indicators are: unemployment rate, temporary employment, job tenure, death rate due to chronic diseases, fatal accidents at work, non-fatal accidents at work, unemployment rate of disabled people, and employed person at-risk-of-poverty rate.

According to this classification, each indicator with a positive impact was transformed into a normalized form by Equation 5-12, and the indicators with a negative impact were normalized by Equation 5-13 (Zhou et al. 2012):

$$I_{Ni,j}^{+} = 1 + \frac{I_{i,j}^{+} - I_{Ni}^{MIN}}{I_{Ni}^{MAX} - I_{Ni}^{MIN}} \qquad (5\text{-}12)$$

$$I_{Ni,j}^{-} = 2 - \frac{I_{i,j}^{-} - I_{Ni}^{MIN}}{I_{Ni}^{MAX} - I_{Ni}^{MIN}} \qquad (5\text{-}13)$$

- $I_{i,j}^{+}$ and $I_{i,j}^{-}$: Values for the proxy indicator i from the country j, with positive and negative impact on social aspects, respectivey.
- $I_{Ni,j}^{+}$ and $I_{Ni,j}^{-}$: Normalized indicators, respectively.
- I_{Ni}^{MAX} : The highest value for the indicador i in the sample.
- I_{Ni}^{MIN} : The lowest value for the indicador i in the sample.

Then, indicators are normalized from 1.00 to 2.00, with 1 for the worst performance and 2.00 for the best performance. Additionally, it should be noted that the values which have been considered for each indicator represent the average of the three years collected (2014, 2015 and 2016). Thus, the transformation is time-dependent, which implies an adjustment of the values of each indicator and the normalization method at least every three years. The weights must be re-calculated at least every three years to define a model that is flexible yet robust, being able to adapt to the changing social conditions of each country.

Table 5-12 gathers the proxy indicators normalized according to Equations 5-9 and 5-10. The minimum value of each proxy indicator (1) has been highlighted in red, and the maximum value has been highlighted in green.

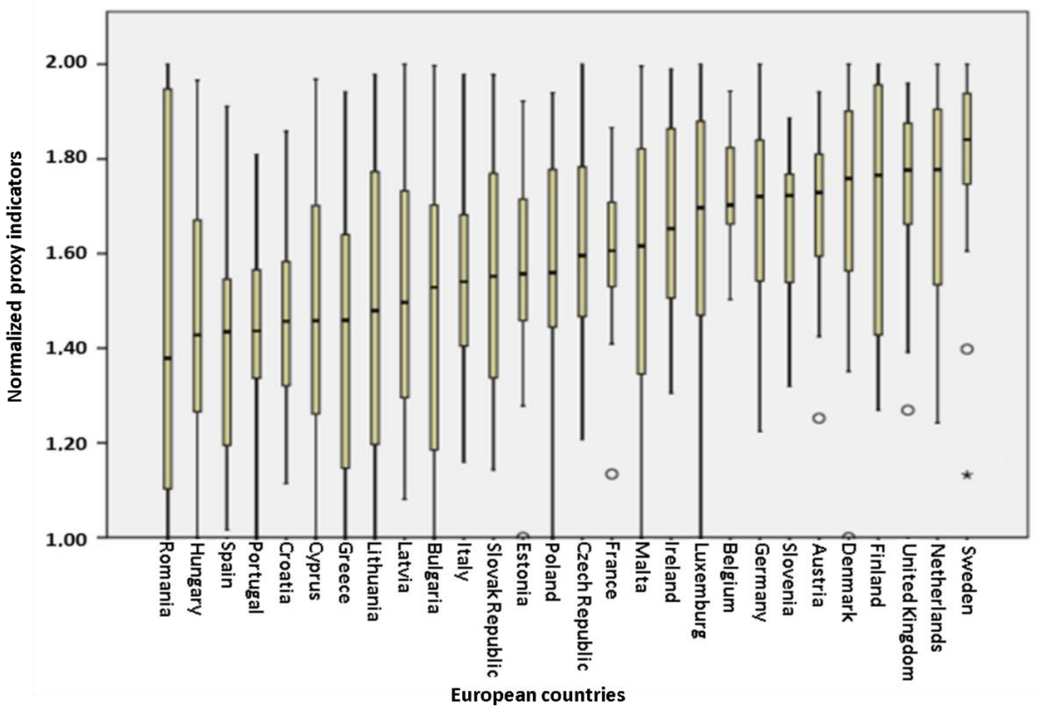
Table 5-12: Normalized proxy indicators

Country	Normalized proxy indicators															
	V1	V2	V3	V4	V5	V6	V7	V8	V9	V10	V11	V12	V13	V14	V15	V16
Austria	1.92	1.70	1.42	1.66	1.84	1.78	1.53	1.77	1.74	1.25	1.47	1.94	1.72	1.75	1.70	1.85
Belgium	1.81	1.68	1.67	1.57	1.87	1.67	1.50	1.78	1.67	1.94	1.54	1.72	1.92	1.84	1.72	1.65
Bulgaria	1.83	1.88	1.68	1.25	1.30	1.22	2.00	1.00	1.64	1.56	1.72	1.50	1.62	1.15	1.00	1.10
Croatia	1.52	1.23	1.50	1.48	1.43	1.58	1.86	1.27	1.58	1.84	1.38	1.39	1.85	1.37	1.17	1.11
Cyprus	1.54	1.41	1.08	1.00	1.97	1.43	1.89	1.49	1.84	1.59	1.22	1.72	1.69	1.30	1.33	1.01
Czech Republic	2.00	1.66	1.68	1.55	1.64	1.52	1.89	1.64	1.47	1.21	1.31	1.42	1.98	1.95	1.46	1.51
Denmark	1.89	1.60	1.00	1.69	1.83	1.93	1.43	2.00	1.91	1.53	1.35	1.68	1.89	1.63	2.00	1.89
Estonia	1.87	1.92	1.34	1.45	1.56	1.53	1.79	1.56	1.64	1.00	1.61	1.28	1.55	1.87	1.60	1.47
Finland	1.76	1.44	1.27	1.36	1.88	1.89	1.40	1.74	1.95	1.42	1.55	1.78	2.00	2.00	1.97	2.00
France	1.70	1.41	1.58	1.61	1.87	1.47	1.13	1.78	1.77	1.53	1.53	1.60	1.72	1.69	1.58	1.62
Germany	2.00	1.55	1.53	1.89	1.81	1.84	1.30	2.00	1.73	1.22	1.41	1.61	1.60	1.71	1.82	1.84
Greece	1.00	1.61	1.69	1.18	1.78	1.62	1.94	1.60	1.44	1.66	1.33	1.48	1.35	1.00	1.09	1.11
Hungary	1.94	1.67	1.43	1.19	1.00	1.47	1.97	1.34	1.42	1.57	1.79	1.22	1.68	1.36	1.13	1.31
Ireland	1.81	1.72	1.45	1.44	1.88	1.57	1.84	1.99	1.56	1.60	1.63	1.30	1.90	1.91	1.67	1.41
Italy	1.61	1.49	1.68	1.46	1.96	1.59	1.69	1.67	1.16	1.98	1.35	1.83	1.49	1.47	1.18	1.29
Latvia	1.72	1.92	1.42	1.17	1.18	1.74	1.98	1.28	1.68	1.45	2.00	1.33	1.68	1.55	1.31	1.08
Lithuania	1.79	1.98	1.22	1.40	1.16	1.03	1.96	1.42	1.78	1.59	1.76	1.00	1.65	1.54	1.36	1.18
Luxembourg	1.89	1.69	1.55	1.46	1.95	1.82	1.16	1.79	1.71	1.99	1.00	2.00	1.48	1.87	1.66	1.31
Malta	1.96	1.78	1.63	1.61	1.88	1.28	1.48	1.45	1.00	1.75	1.39	2.00	1.86	1.64	1.30	1.14
Netherlands	1.91	1.24	1.51	2.00	1.90	2.00	1.68	1.99	1.75	1.50	1.30	1.80	1.88	1.90	1.70	1.56
Poland	1.89	1.00	1.64	1.23	1.54	1.71	1.94	1.44	1.44	1.90	1.84	1.65	1.53	1.58	1.50	1.17
Portugal	1.64	1.20	1.44	1.35	1.81	1.00	1.00	1.36	1.76	1.46	1.60	1.49	1.53	1.37	1.44	1.33
Romania	1.90	2.00	2.00	1.40	1.14	1.00	2.00	1.07	1.26	2.00	1.51	1.83	1.00	1.22	1.36	1.00
Slovak Republic	1.70	1.66	1.55	1.33	1.35	1.76	1.98	1.41	1.78	1.34	1.55	1.25	1.83	1.83	1.19	1.14
Slovenia	1.80	1.37	1.58	1.56	1.72	1.32	1.65	1.72	1.52	1.89	1.80	1.73	1.81	1.74	1.40	1.74
Spain	1.21	1.05	1.18	1.52	1.91	1.48	1.15	1.70	1.68	1.57	1.47	1.02	1.40	1.50	1.33	1.28
Sweden	1.84	1.40	1.13	1.86	2.00	1.96	1.84	1.92	2.00	1.60	1.78	1.75	1.74	1.79	1.90	1.97
United Kingdom	1.96	1.82	1.39	1.67	1.82	1.95	1.85	1.90	1.75	1.27	1.65	1.70	1.68	1.90	1.81	1.44

Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure

SOURCE: Own elaboration

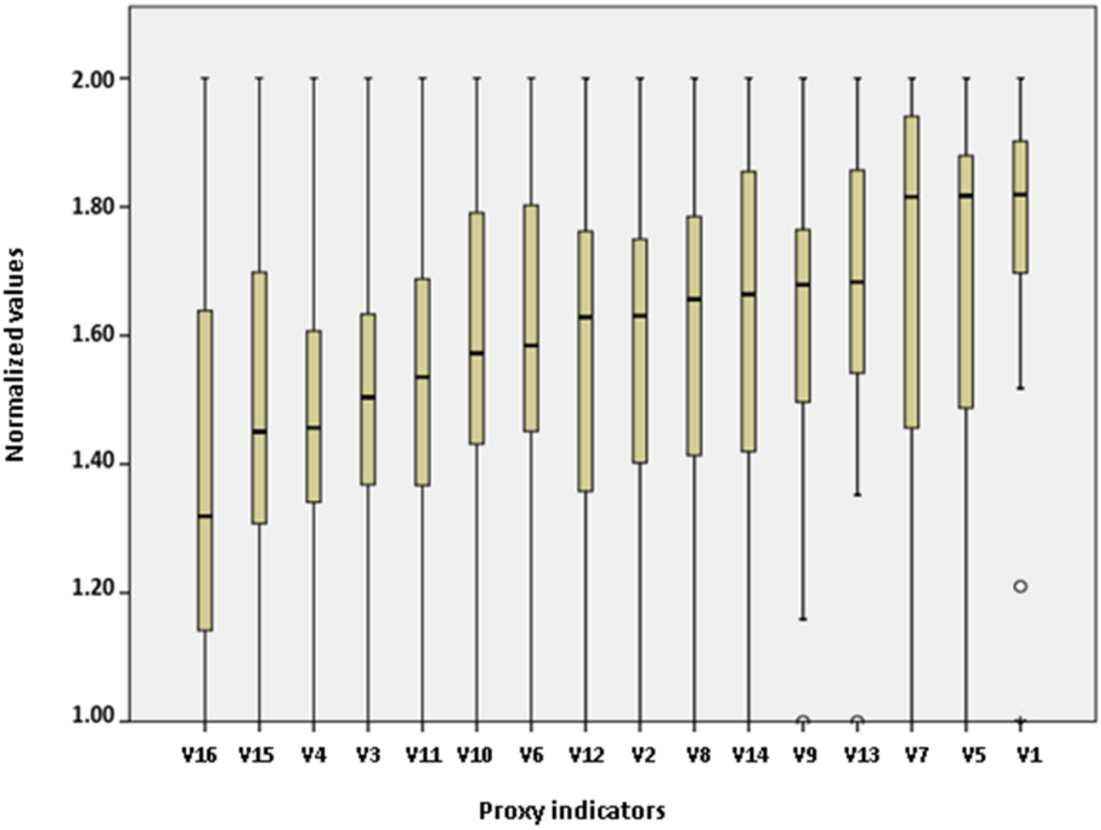
Figure 5-19 shows the distribution of the normalized proxy indicators for each country. As can be seen, wide variability in the social performance of the European countries exists. In fact, the values of the proxy indicators of countries such as Romania, Lithuania, Bulgaria, Malta, or Luxemburg can vary from 1.00 to 2.00 depending on the social issue. On the other hand, Belgium, United Kingdom, Sweden, and Austria presents an overall performance above the rest of the European countries.



SOURCE: Own elaboration

Figure 5-19: Distribution of normalized proxy indicators for each country.

Figure 5-20 shows the distribution of each proxy indicator taking into account the values associated with the 28 countries in the sample. The proxy indicators are arranged in increasing order according to the median of each indicator. The ratio of female to male labor force participation rate (V9), employed person at risk of poverty rate (V13), and unemployment rate (V1), are characterized by having outliers. This happens in the unemployment rate (V1) because Greece and Spain show values lower than 1.5 times the lower quartile in this indicator. The same happens in V9 with Malta, and in V13 with Romania. These outliers were not eliminated because these represent the current situation of European countries concerning these social indicators.



Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure.

SOURCE: Own elaboration

Figure 5-20: Distribution of each normalized proxy indicator in the sample, ranked by the median

5.3.4.3. Definition of weights for each country

Once the proxy indicators were normalized, the weighting methodology was performed according to the DEA-BOD approach based on the pessimistic version, as shown in Equations from 5-4 to 5-19. The basic idea of the DEA-BOD approach is putting the data of the country indices in a relative perspective by comparing them to a benchmark (Rogge 2018). The weighting problem is performed for each country independently, and the benchmark of each country will be taken from the observed sample itself. Therefore, the benchmark of the country ‘c’ will be the country ‘j’ that, having applied the weights of the country ‘c’, obtains the maximum value of the composite indicator SI_c. The goal of this optimization problem is achieving the minimum efficiency of each country. Equation 5-14 seeks to define the weights in the country 'c' for each proxy indicator 'i' to achieve the minimum value of SI_c. Additionally, two conditions have to be satisfied. Equation 5-15 is a normalization constraint, defined to guarantee that, when the weights defined for country 'c' are applied to any other country in the sample, none of these countries can obtain a value in the weighted sum lower than one. On the other hand, Equation 5-16 limits the weights to be non-negative, and the sum of these weights has to be equal to 1.00 (Equation 5-17). Additionally, 'proportional share restrictions' were included in the model to ensure that minimum weight is assigned to every indicator for each country (see Equations 5-18 and 5-19).

$$SI_c = \underset{w_{ic}}{min} \left(\sum_{i=1}^{m} w_{ic} \cdot V_{ic}\right) \quad (5\text{-}14)$$

Subject to

$$\sum_{i=1}^{n} w_{ic} \cdot V_{ij} \geq 1 \quad (5\text{-}15)$$

$$w_{ic} \geq 0 \quad (5\text{-}16)$$

$$\sum_{i=1}^{n} w_{ic} = 1 \quad (5\text{-}17)$$

$$\alpha_j \leq \frac{V_{ij}.w_{ij}}{\sum_{i=1}^{n} V_{ij}.w_{ij}} \leq \beta_j \quad (5\text{-}18)$$

$$0 \leq \alpha_j < \beta_j \leq 1 \quad (5\text{-}19)$$

With:

- $\mathrm{SI_c}$: Result of the composite indicator. It shows the social performance of the country 'c'.
- $\mathrm{w_{ic}}$: Weight assigned to the indicator 'i' in the country 'c'.
- $\mathrm{V_{ic}}$: Value for country 'c' on the proxy indicator 'i' (i=1, …., n; n is the number of indicators in the model).
- $\mathrm{V_{ij}}$: Value for the country 'j' on the proxy indicator 'i' (j= 1,….,m; m is the number of countries in the sample).
- α_j and β_j : Lower and upper limits in the 'proportional share restrictions'.

Based on this model, the process to define the optimal weights for each country was:

1. The model was developed without the 'proportional share restrictions' to verify the proper performance of the model. In a scenario without 'proportional share restrictions', the model should assign the maximum weights to the worst

performance indicators for each country, and the rest of indicators should be assigned weights equal to zero.

2. After this, 'proportional share restrictions' were needed to ensure that none of the indicators were overlooked, guaranteeing a minimum weight for each indicator. Thus, first, the influence of α_j and β_j in the model was characterized.
3. According to the influence of α_j and β_j on the model, the weights for a particular scenario were defined. The model seeks to define the weights of each indicator based on the social weaknesses that exist in a country, but being able to adapt to the needs of each procurer, agency or government. Thus, to guarantee the development of a flexible and robust model, the α_j and β_j should be defined to ensure a minimum weight for each indicator in each country, and to enhance the importance of a specific number of indicators in each country. Based on this, a hypothetical scenario was defined; it was established that the model should guarantee a minimum weight of 0.03 for each indicator, and at least four indicators with weights over 0.10. Under these premises, the optimal weights for each country in the sample were defined.

The results of this process are shown as follows.

1. Model without the 'proportional share restrictions'

Table 5-13 shows the weights for each indicator in each country when the model is performed without 'proportional share restrictions'. The cells highlighted in yellow represent the worst performance indicator for each country. A weight equal to one has been assigned to the worst performance indicator of each country, and zero to the rest of the indicators. Only Bulgaria, Greece and Romania distribute the weights between two or three indicators.

Table 5-13: Weights and SI result for each indicator in each country without 'proportional share restrictions'

Country	Weights																*SI*
	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	W_{14}	W_{15}	W_{16}	
Austria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.25
Belgium	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.50
Bulgaria	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	1.00
Croatia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.11
Cyprus	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Czech Republic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.21
Denmark	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Estonia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Finland	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27
France	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13
Germany	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.22
Greece	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.00	0.00	1.00
Hungary	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Ireland	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.30
Italy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.16
Latvia	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.08
Lithuania	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00
Luxembourg	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
Malta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Netherlands	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24
Poland	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Portugal	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00
Romania	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.14	1.00
Slovak Republic	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.14
Slovenia	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.32
Spain	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.02
Sweden	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13
United Kingdom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	1.27

Note: W_1: unemployment rate; W_2: temporary employment; W_3: job tenure ; W_4: public health expenditure; W_5: death rate due to chronic diseases; W_6: fatal accidents at work; W_7: non-fatal accidents at work; W_8: human development index; W_9: ratio of female to male labor force participation rate; W_{10}: ratio of female to male salary; W_{11}: employed women being in managerial positions; W_{12}: unemployment rate of disabled people; W_{13}: employed persons at-risk-of poverty rate; W_{14}: employed persons participating in job-related non-formal education and training in the past 12 months; W_{15}: corruption perception index; W_{16}: research and development expenditure; SI: Social performance of each country.

SOURCE: Own elaboration

This is because, as can be seen in Figures 5-21, 5-22 and 5-23, these countries present the worst performance (value equal to 1.00) in several indicators: Bulgaria in V15 and V8; Greece in V14 and V1; and, Romania in V16, V13 and V6. Additionally, Figure 5-24 shows how these weights are distributed satisfying the restrictions of the model.

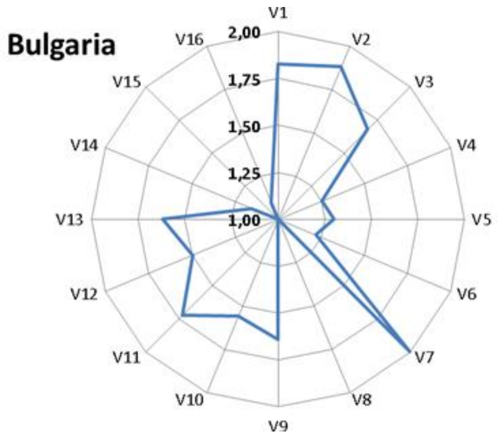


Figure 5-21: Normalized values of the proxy indicators for Bulgaria

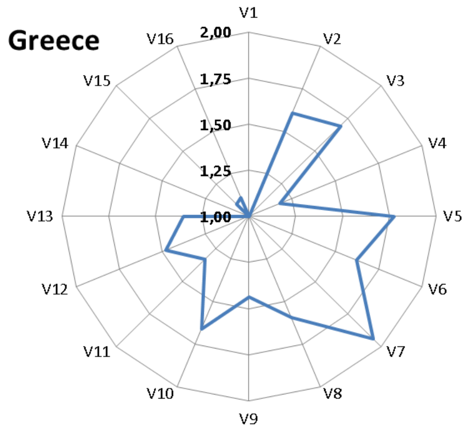


Figure 5-22: Normalized values of the proxy indicators for Greece

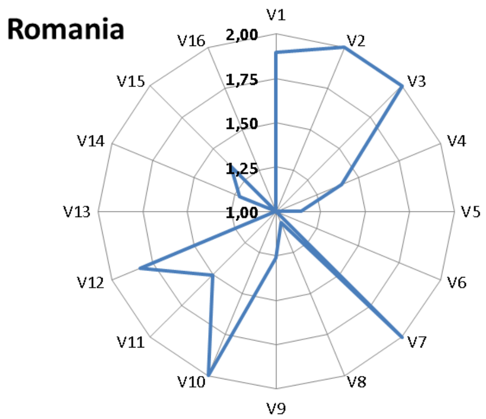


Figure 5-23: Normalized values of the proxy indicators for Romania

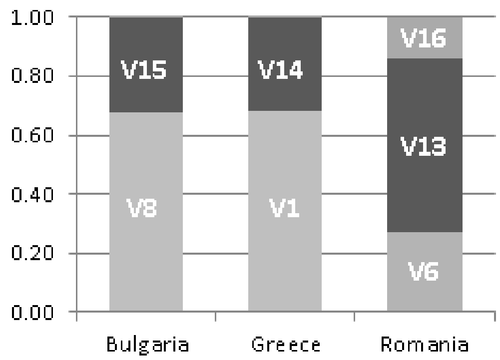


Figure 5-24: Weights for the worst performance indicators in Bulgaria, Greece and Romania

Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure.

SOURCE: Own elaboration

Therefore, according to Zhou et al. (2007), Zhou (2008), Cherchye et al. (2008), and Rogge (2018), proportionally shared restrictions are needed to guarantee that every indicator in the model is considered, and to ensure that a proper weighting scheme is established.

2. Influence of the lower (α_j) and upper (β_j) limits of the 'proportional share restrictions' on the model.

To characterize the influence of α_j and β_j on the model, these were analyzed independently. First, a β_j equal to 1.00 was established, representing that upper restriction does not exist in the model. Thus, only the influence of the lower restriction was analyzed for different scenarios of α_j (0.01, 0.02, 0.03, 0.04, 0.05, and 0.06). The maximum value of α_j was fixed to 0.06 because, if the model has 16 indicators, the maximum weight that can be assigned to each indicator is 0.062; although the restrictions were defined based on proportion constraints and these are not direct restrictions on weights, it was considered that a higher value of α_j could unduly limit the flexibility of the model. The analysis of these 7 scenarios of α_j shows the increment of the minimum weights assigned to each indicator and, thus, the reduction of the maximum weights. Table 5-14 shows the minimum and maximum weights considering all countries and indicators. In this table, it can be seen that for α_j equal to 0.01 and 0.02, the minimum weight assigned to the indicators is 0.01. This value changes to 0.02 for α_j equal to 0.03 and 0.04. Finally, for α_j equal to 0.05 and 0.06, the minimum weights are 0.04. Additionally, the maximum weights also change to satisfy the restrictions of the model, from 0.59 (α_j=0.00) to 0.10 (α_j=0.06).

Table 5-14: Minimum and maximum weights in the sample for each scenario of α_j

Scenarios	Weights in α_j scenarios	
α_j = 0.00	Min w_i	0.00
	Max w_i	0.59
α_j = 0.01	Min w_i	0.01
	Max w_i	0.49
α_j = 0.02	Min w_i	0.01
	Max w_i	0.46
α_j = 0.03	Min w_i	0.02
	Max w_i	0.36
α_j = 0.04	Min w_i	0.02
	Max w_i	0.29
α_j = 0.05	Min w_i	0.03
	Max w_i	0.19
α_j = 0.06	Min w_i	0.04
	Max w_i	0.10

SOURCE: Own elaboration

Found in Appendix C is a table with the results for each analyzed country in each scenario of $\boldsymbol{\alpha_j}$.

On the other hand, the way the model assigns the weights, when α_j increases, was analyzed. Table 5-15 shows the difference between the weights obtained with α_j=0.06 and the weights obtained with α_j=0.00. The aim of this table is indentifying the indicators with the broader variation. As can be seen, the cells highlighted in yellow represent the worst performance indicators for each country. These are the indicators that received weights different from zero in the first scenario without restrictions (α_j=0.00).

Table 5-15: Difference between the weights obtained with α_j=0.06 and the weights obtained in α_j=0.00

	Difference of weights															
Country	**W_1**	**W_2**	**W_3**	**W_4**	**W_5**	**W_6**	**W_7**	**W_8**	**W_9**	**W_{10}**	**W_{11}**	**W_{12}**	**W_{13}**	**W_{14}**	**W_{15}**	**W_{16}**
Germany	0.05	0.06	0.06	0.05	0.05	0.05	0.07	0.05	0.06	-0.87	0.07	0.06	0.06	0.06	0.05	0.05
Austria	0.05	0.06	0.07	0.06	0.05	0.06	0.06	0.06	0.06	-0.87	0.07	0.05	0.06	0.06	0.06	0.05
Belgium	0.06	0.06	0.06	0.07	0.05	0.06	-0.89	0.06	0.06	0.05	0.07	0.06	0.05	0.06	0.06	0.06
Bulgaria	0.05	0.04	0.05	0.07	0.06	0.07	0.04	-0.56	0.05	0.05	0.05	0.06	0.05	0.07	-0.22	0.08
Cyprus	0.05	0.06	0.08	-0.86	0.04	0.06	0.04	0.06	0.05	0.05	0.07	0.05	0.05	0.06	0.06	0.08
Croatia	0.06	0.07	0.06	0.06	0.06	0.05	0.05	0.07	0.05	0.05	0.06	0.06	0.05	0.06	0.07	-0.87
Denmark	0.05	0.06	-0.84	0.06	0.05	0.05	0.07	0.05	0.05	0.06	0.07	0.06	0.05	0.06	0.05	0.05
Slovak Republic	0.05	0.05	0.06	0.07	0.07	0.05	0.04	0.06	0.05	0.07	0.06	0.07	0.05	0.05	0.07	-0.87
Slovenia	0.05	0.07	0.06	0.06	0.06	-0.88	0.06	0.06	0.06	0.05	0.05	0.06	0.05	0.06	0.07	0.06
Spain	0.07	0.08	0.07	0.05	0.04	0.05	0.07	0.05	0.05	0.05	0.05	-0.87	0.06	0.05	0.06	0.06
Estonia	0.05	0.05	0.07	0.06	0.06	0.06	0.05	0.06	0.05	-0.85	0.06	0.07	0.06	0.05	0.06	0.06
Finland	0.06	0.07	-0.87	0.07	0.05	0.05	0.07	0.06	0.05	0.07	0.06	0.06	0.05	0.05	0.05	0.05
France	0.06	0.07	0.06	0.06	0.05	0.06	-0.86	0.05	0.05	0.06	0.06	0.06	0.05	0.06	0.06	0.06
Greece	-0.57	0.05	0.05	0.07	0.05	0.05	0.04	0.05	0.06	0.05	0.06	0.05	0.06	-0.21	0.07	0.07
Hungary	0.04	0.05	0.06	0.07	-0.86	0.06	0.04	0.06	0.06	0.05	0.05	0.07	0.05	0.06	0.07	0.06
Ireland	0.05	0.06	0.07	0.07	0.05	0.06	0.05	0.05	0.06	0.06	0.06	-0.88	0.05	0.05	0.06	0.07
Italy	0.06	0.06	0.05	0.06	0.05	0.06	0.05	0.05	-0.87	0.05	0.07	0.05	0.06	0.06	0.08	0.07
Latvia	0.05	0.05	0.06	0.07	0.07	0.05	0.04	0.07	0.05	0.06	0.04	0.07	0.05	0.06	0.07	-0.87
Lithuania	0.05	0.04	0.07	0.06	0.07	0.08	0.04	0.06	0.05	0.05	0.05	-0.86	0.05	0.05	0.06	0.07
Luxembourg	0.05	0.06	0.06	0.06	0.05	0.05	0.08	0.05	0.05	0.05	-0.85	0.05	0.06	0.05	0.06	0.07
Malta	0.05	0.05	0.05	0.06	0.05	0.07	0.06	0.06	-0.85	0.05	0.06	0.04	0.05	0.05	0.07	0.08
Netherlands	0.05	-0.87	0.07	0.05	0.05	0.05	0.06	0.05	0.06	0.07	0.08	0.06	0.05	0.05	0.06	0.06
Poland	0.05	-0.85	0.05	0.07	0.06	0.05	0.05	0.06	0.06	0.05	0.05	0.05	0.06	0.06	0.06	0.08
Portugal	0.05	0.07	0.06	0.06	0.05	0.08	-0.86	0.06	0.05	0.06	0.05	0.05	0.05	0.06	0.06	0.06
United Kingdom	0.05	0.06	0.07	0.06	0.06	0.05	0.05	0.05	0.06	-0.87	0.06	0.06	0.06	0.05	0.06	0.07
Czech Republic	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.06	0.06	-0.87	0.07	0.07	0.05	0.05	0.06	0.06
Romania	0.04	0.04	0.04	0.06	0.07	-0.17	0.04	0.08	0.06	0.04	0.05	0.04	-0.49	0.07	0.06	-0.04
Sweden	0.06	0.07	-0.85	0.05	0.05	0.05	0.06	0.05	0.05	0.06	0.06	0.06	0.06	0.06	0.05	0.05

Note: W_1: unemployment rate; W_2: temporary employment; W_3: job tenure ; W_4: public health expenditure; W_5: death rate due to chronic diseases; W_6: fatal accidents at work; W_7: non-fatal accidents at work; W_8: human development index; W_9: ratio of female to male labor force participation rate; W_{10}: ratio of female to male salary; W_{11}: employed women being in managerial positions; W_{12}: unemployment rate of disabled people; W_{13}: employed persons at-risk-of poverty rate; W_{14}: employed persons participating in job-related non-formal education and training in the past 12 months; W_{15}: corruption perception index; W_{16}: research and development expenditure; SI: Social performance of each country

SOURCE: Own elaboration

Thus, analyzing the table, it can be observed that the only objective of α_j is guaranteeing a minimum weight for each indicator, minimizing the maximum weights for each country to satisfy this condition. This can be appreciated more clearly in Figures 5-25, 5-26, and 5-27. These Figures show the distribution of the weights for the countries Belgium, Greece, and Romania in the different scenarios of α_j. These countries have been selected by having one, two, and three indicators, respectively, with the worst value (value=1.00).

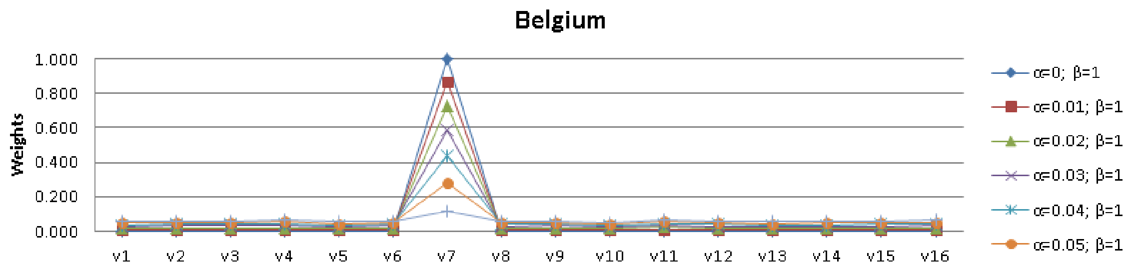


Figure 5-25: Weights distribution for Belgium according to the different scenarios of α_j

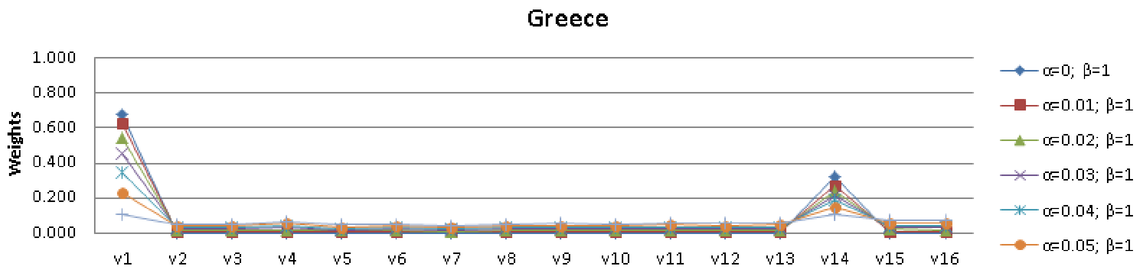


Figure 5-26: Weights distribution for Greece according to the different scenarios of α_j

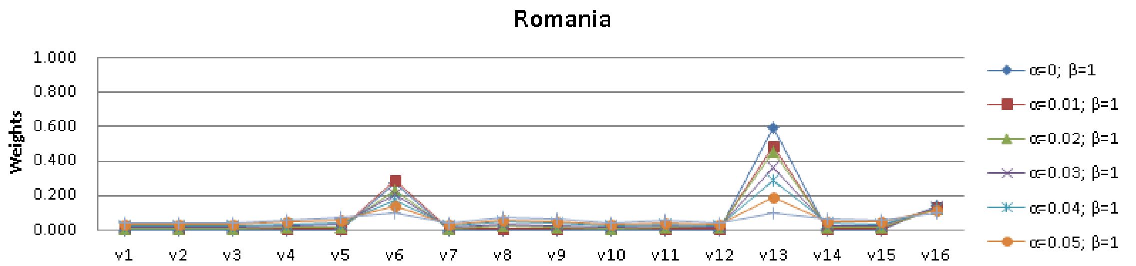


Figure 5-27: Weights distribution for Romania according to the different scenarios of α_j

Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure.

SOURCE: Own elaboration

After characterizing α_j, the second step was analyzing the role of β_j in the model. Thus, α_j =0.01 was fixed as an example, and scenarios with varying β_j were established: 1.0, 0.8, 0.6, 0.4, 0.2, 0.1. The results of these six scenarios can be shown in table 5-16.

Table 5-16: Minimum and maximum weights in the sample for each scenario of $\boldsymbol{\beta_j}$

Scenarios	Weights in β_j scenarios	
β_j= 1	Min w_i	0.01
	Max w_i	0.91
β_j=0.8	Min w_i	0.01
	Max w_i	0.87
β_j=0.6	Min w_i	0.01
	Max w_i	0.69
β_j=0.4	Min w_i	0.01
	Max w_i	0.49
β_j=0.2	Min w_i	0.01
	Max w_i	0.27
β_j=0.1	Min w_i	0.01
	Max w_i	0.15

SOURCE: Own elaboration

These results show that the maximum weights decrease with β_j in order to satisfy the restriction; however, the minimum weights in the different scenarios are not affected by β_j. The minimum weights are 0.01 in every scenario of β_j; the maximum weights change from 0.91 (β_j=1.0) to 0,15 (β_j=0.1). Found in Appendix C, a table with the results for each analyzed country in each scenario of β_j.

The following figures explain how $\beta_j$influences the model. As can be seen in Figures 5-28a and 5-28b, in the scenario of Belgium with β_j=1.0, the maximum weight focuses only on V7 because is the only indicator with the worst value (1.00); however, as β_j is reduced, the need of decreasing the maximum weights to satisfy the restrictions implies giving higher weights to those indicators that, although not the worst, are the following indicators with the worst performance (V11 in β_j=0.6; and V4, V16, and V9 in β_j=0.2). In other words, the inclusion of a more restrictive β_j in the model forces the distribution of the maximum weights between the worse indicators, instead of focusing only on the worst indicator of each country. Thus, the lower value of β_j, the more number of indicators with a weight higher than 0.1.

In Greece scenario, when β_j=1.0, only V1 and V14 have weights over 0.1; however, when β_j=0.2, the indicators V4, V15, and V16 receive weights over 0.1 (see Figures 5-29a and 5-29b). These are the following indicators with the worst performance.

The same behavior can be seen for Romania (Figures 5-30a and 5-30b). In β_j equal to 1.0 and 0.6, the weights over 0.1 focus only on V6, V13, and V16; nevertheless, when β_j is 0.2, weights over 0.1 are also assigned to V5 and V8.

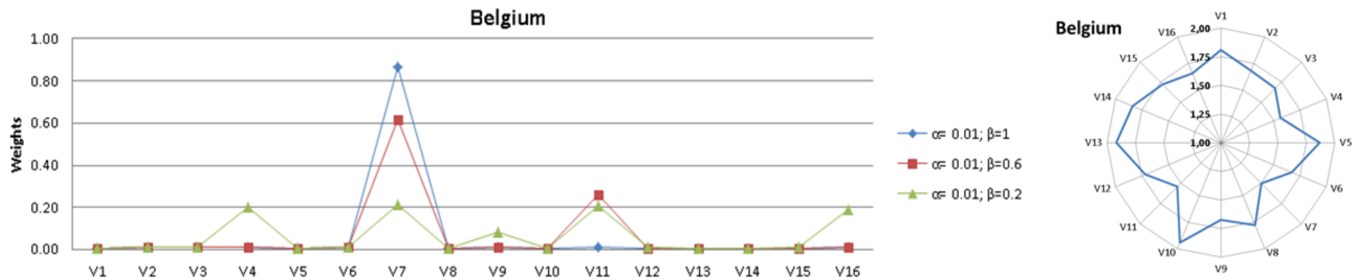


Figure 5-28: (a) Weights distribution for Belgium according to the different scenarios of β_j; (b) values of the proxy indicators for Belgium

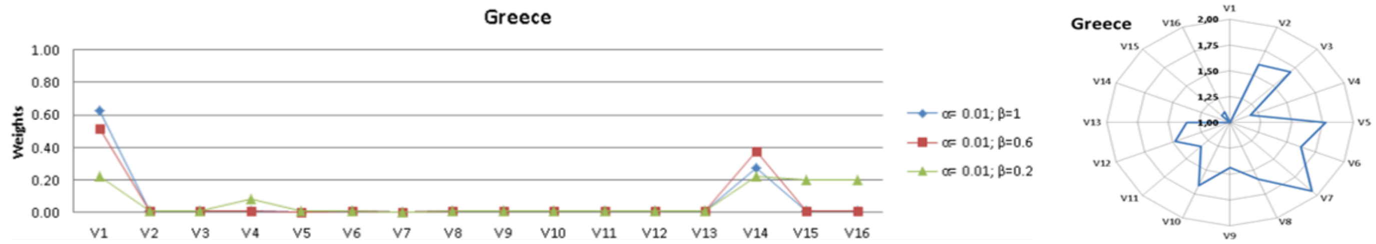


Figure 5-29: (a) Weights distribution for Greece according to the different scenarios of β_j; (b) values of the proxy indicators for Greece

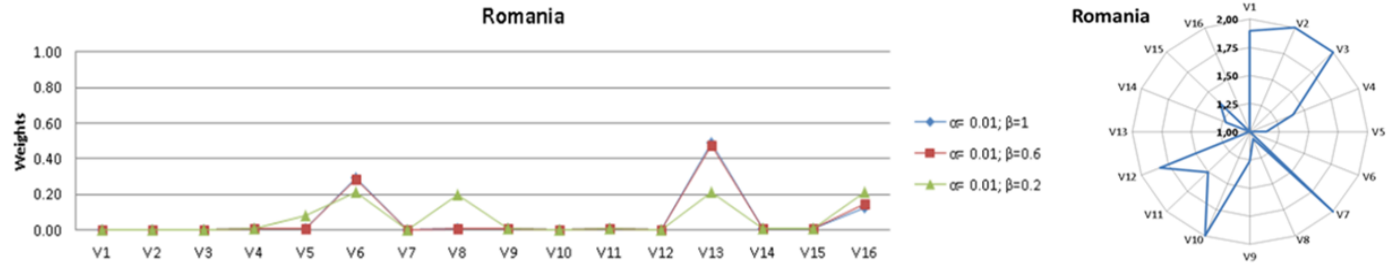


Figure 5-30: (a) Weights distribution for Romania according to the different scenarios of β_j; (b) values of the proxy indicators for Romania

Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure.

SOURCE: Own elaboration

3. Definition of the optimal weights for a specific scenario of proportional share restrictions (α_j and β_j).

After characterizing the influence of α_j and β_j in the model, the conclusion is that α_j controls the minimum weight that should be assigned to each indicator, and β_j manages the number of indicators that want should be emphasized for each country. These parameters should be determined to satisfy the needs of a procurer, agency or government. Based on this, a hypothetical scenario was defined. It was established that the model should guarantee a minimum weight of 0.03 for each indicator, and at least four indicators with weights over 0.10. Under these premises, the optimal weights for each country in the sample were defined.

α_j was defined equal to 0.05 because, based on the previous results, this is the minimum value of α_j to guarantee a minimum weight of 0.03 in each indicator for each country. Once the α_j was fixed, the β_j was analyzed to seek the scenario of β_j where at least four indicators for each country receive weights over 0.1. The scenario with α_j equal to 0.05, and β_j equal to 0.10 satisfied the conditions. The optimal weights defined in this scenario are gathered in Table 5-17. In this table, the cells highlighted in yellow represent the worst indicators for each country. As can be seen, these cells receive the maximum weights of each country. On the other hand, the cells highlighted in red, are the worst following indicators of each country. These indicators receive weights over 0.10, guaranteeing a minimum of four indicators with weights over 0.10 for each country.

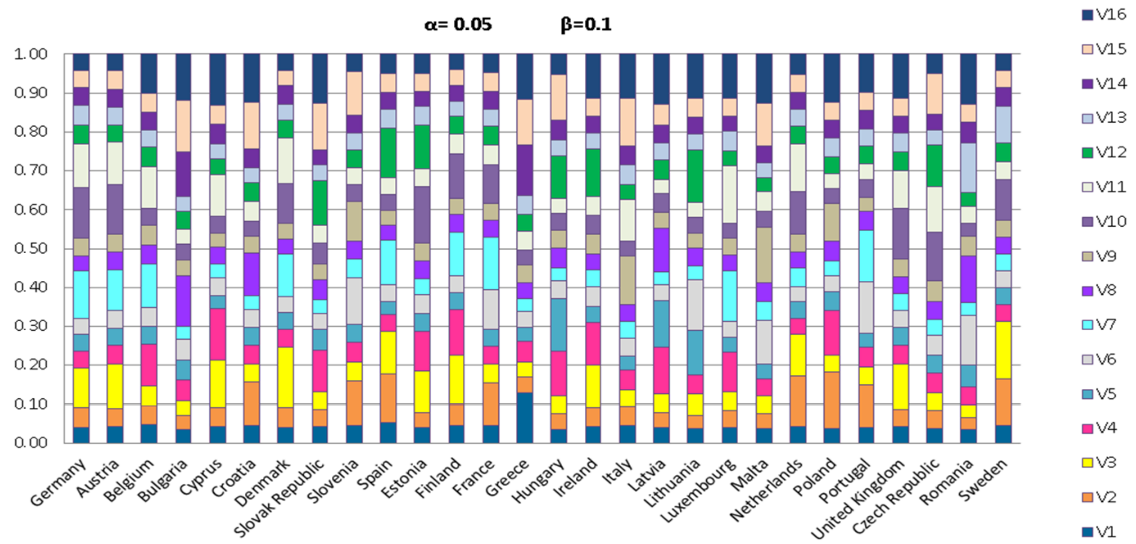
Table 5-17: Weights with α_j equal to 0.05, and β_j equal to 0.1

Country	Weights																SI
	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	W_{14}	W_{15}	W_{16}	
Austria	0.04	0.05	0.11	0.05	0.04	0.05	0.11	0.05	0.05	0.13	0.11	0.04	0.05	0.05	0.05	0.04	1.61
Belgium	0.05	0.05	0.05	0.11	0.05	0.05	0.11	0.05	0.05	0.04	0.11	0.05	0.04	0.05	0.05	0.10	1.68
Bulgaria	0.04	0.03	0.04	0.05	0.05	0.05	0.03	0.13	0.04	0.04	0.04	0.04	0.04	0.11	0.13	0.12	1.31
Croatia	0.05	0.11	0.05	0.05	0.05	0.04	0.04	0.11	0.04	0.04	0.05	0.05	0.04	0.05	0.12	0.12	1.38
Cyprus	0.04	0.05	0.12	0.13	0.03	0.05	0.04	0.04	0.04	0.04	0.11	0.04	0.04	0.05	0.05	0.13	1.32
Czech Republic	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.13	0.12	0.11	0.04	0.04	0.10	0.05	1.53
Denmark	0.04	0.05	0.16	0.05	0.04	0.04	0.11	0.04	0.04	0.10	0.12	0.05	0.04	0.05	0.04	0.04	1.56
Estonia	0.04	0.04	0.11	0.10	0.05	0.05	0.04	0.05	0.04	0.15	0.05	0.11	0.05	0.04	0.05	0.05	1.46
Finland	0.05	0.06	0.13	0.12	0.04	0.04	0.11	0.05	0.04	0.11	0.05	0.04	0.04	0.04	0.04	0.04	1.60
France	0.05	0.11	0.05	0.05	0.04	0.10	0.14	0.04	0.04	0.10	0.05	0.05	0.04	0.05	0.05	0.05	1.53
Germany	0.04	0.05	0.10	0.04	0.04	0.04	0.12	0.04	0.05	0.13	0.11	0.05	0.05	0.05	0.04	0.04	1.58
Greece	0.13	0.04	0.04	0.05	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.04	0.05	0.13	0.12	0.12	1.29
Hungary	0.03	0.04	0.05	0.11	0.13	0.05	0.03	0.05	0.05	0.04	0.04	0.11	0.04	0.05	0.12	0.05	1.35
Ireland	0.04	0.05	0.11	0.11	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.12	0.04	0.04	0.05	0.11	1.59
Italy	0.05	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.13	0.04	0.11	0.04	0.05	0.05	0.12	0.11	1.45
Latvia	0.04	0.04	0.05	0.12	0.12	0.04	0.04	0.11	0.04	0.05	0.04	0.05	0.04	0.05	0.05	0.13	1.40
Lithuania	0.04	0.03	0.06	0.05	0.12	0.13	0.03	0.05	0.04	0.04	0.04	0.13	0.04	0.04	0.05	0.11	1.34
Luxembourg	0.04	0.04	0.05	0.10	0.04	0.04	0.13	0.04	0.04	0.04	0.15	0.04	0.05	0.04	0.04	0.11	1.49
Malta	0.04	0.04	0.04	0.04	0.04	0.11	0.05	0.05	0.14	0.04	0.05	0.04	0.04	0.04	0.11	0.13	1.43
Netherlands	0.04	0.13	0.11	0.04	0.04	0.04	0.05	0.04	0.05	0.11	0.12	0.04	0.04	0.04	0.05	0.05	1.62
Poland	0.04	0.14	0.04	0.12	0.05	0.04	0.04	0.05	0.10	0.04	0.04	0.04	0.05	0.05	0.05	0.12	1.44
Portugal	0.04	0.11	0.05	0.05	0.04	0.13	0.13	0.05	0.04	0.05	0.04	0.04	0.04	0.05	0.05	0.10	1.32
Romania	0.03	0.03	0.03	0.05	0.06	0.13	0.03	0.12	0.05	0.03	0.04	0.04	0.13	0.05	0.05	0.13	1.29
Slovak Republic	0.04	0.04	0.05	0.11	0.05	0.04	0.04	0.05	0.04	0.05	0.05	0.12	0.04	0.04	0.12	0.13	1.43
Slovenia	0.04	0.12	0.05	0.05	0.05	0.12	0.05	0.05	0.10	0.04	0.04	0.05	0.04	0.05	0.11	0.05	1.58
Spain	0.05	0.12	0.11	0.04	0.03	0.04	0.11	0.04	0.04	0.04	0.04	0.13	0.05	0.04	0.05	0.05	1.30
Sweden	0.05	0.12	0.15	0.04	0.04	0.04	0.05	0.04	0.04	0.10	0.05	0.05	0.10	0.05	0.04	0.04	1.67
United Kingdom	0.04	0.04	0.12	0.05	0.04	0.04	0.04	0.04	0.05	0.13	0.10	0.05	0.05	0.04	0.05	0.11	1.63

Note: W_1: unemployment rate; W_2: temporary employment; W_3: job tenure ; W_4: public health expenditure; W_5: death rate due to chronic diseases; W_6: fatal accidents at work; W_7: non-fatal accidents at work; W_8: human development index; W_9: ratio of female to male labor force participation rate; W_{10}: ratio of female to male salary; W_{11}: employed women being in managerial positions; W_{12}: unemployment rate of disabled people; W_{13}: employed persons at-risk-of poverty rate; W_{14}: employed persons participating in job-related non-formal education and training in the past 12 months; W_{15}: corruption perception index; W_{16}: research and development expenditure; SI: Social performance of each country

SOURCE: Own elaboration

The distribution of the weights for each proxy indicator in each country can be seen in Figure 5-31. This figure can be useful in identifying the main social weaknesses that exist in each analyzed country, depending on the area highlighted by each color.



Note: V1: unemployment rate; V2: temporary employment; V3: job tenure ; V4: public health expenditure; V5: death rate due to chronic diseases; V6: fatal accidents at work; V7: non-fatal accidents at work; V8: human development index; V9: ratio of female to male labor force participation rate; V10: ratio of female to male salary; V11: employed women being in managerial positions; V12: unemployment rate of disabled people; V13: employed persons at-risk-of poverty rate; V14: employed persons participating in job-related non-formal education and training in the past 12 months; V15: corruption perception index; V16: research and development expenditure

SOURCE: Own elaboration

Figure 5-31: Weights distribution for each indicator in each country (scenario: α_j = 0.05, and β_j =0.1)

Therefore, with this methodology, the weights that should be assigned to each company indicator of the corporate social responsibility group (G2) for Spain are displayed in Table 5-18. Temporary contracts, employee turnover, non-fatal injuries at work, and percentage of disabled people in the company are the indicators socially more critical since these receive weights over 0.10. On the other hand, a minimum of 0.04 is assigned to the weights of the rest of the indicators.

Table 5-18: Weights for each company indicator in Spain

Company Indicators	Weights (w_i)
New hires	0.05
Temporary contracts	0.12
Employee turnover	0.11
Benefits	0.04
Chronic disease	0.03
Fatal accidents at work	0.04
Non-fatal injuries at work	0.11
Social Value	0.04
Ratio of female to male labor force participation	0.04
Wage gap	0.04
Women in executive management positions	0.04
Disabled	0.13
Salary distribution	0.05
Technical training	0.04
Social ethics, social awareness and human rights	0.05
Research and development	0.05

SOURCE: Own elaboration

5.3.4.4. Simulation

To analyze how the model works to compare construction companies, a simulation process was performed to examine if the model proposed here was feasible and applicable not only for the assessment of one individual company but also for the assessment and comparison of two or more companies, similar to a procurement procedure. For that reason, a simulation process was developed using the information of Spanish construction companies gathered from the eight GRI reports. The information for the eight Spanish construction companies with respect to the basic indicators (I_i) is shown in Table 5-11. To implement the composite indicator to assess the corporate social responsibility of these construction companies, first the company indicators for each company were obtained through these basic indicators; and, secondly, the corporate social responsibility performance was calculated according to Equation 5-1, and the weights for Spain (Table 5-18). The values of each company indicator for each firm are gathered in Table 5-19. In grey are highlighted the rows associated with company indicators. When the company indicator depends on standardized indicators, white rows have been included with their associated values. As can be seen, a high number of cells are empty because the information was not defined in the analyzed reports.

Table 5-19: Company indicators for each Spanish construction companies

Company indicators (I'_i)	**Spanish construction companies**							
	Firm 1 (MNE)	**Firm 2 (Large)**	**Firm 3 (Large)**	**Firm 4 (Large)**	**Firm 5 (Large)**	**Firm 6 (Large)**	**Firm 7 (Large)**	**Firm 8 (SME)**
I'_1	1.00	0.04	0.28	0.72	0.02	0.15	0.12	0.00
I'_2	0.75	0.00	0.21	0.67	0.52	0.68	0.64	1.00
I'_3	0.63	0.54	-	0.00	0.64	0.70	0.80	1.00
I'_4	-	-	-	-	-	-	-	-
I'_{41}	-	1.00	-	0.67	-	-	-	-
I'_{42}	-	-	-	-	-	-	-	-
I'_5	0.34	-	-	-	-	-	-	0.61
I'_{51}	0.00	0.68	0.44	0.28	-	-	-	1.00
I'_{52}	0.00	-	-	-	-	-	-	1.00
I'_{53}	0.37	-	-	1.00	0.41	-	0.13	0.46
I_{54}	1.00	-	-	-	-	-	-	0.00
I'_6	0.79	-	-	-	-	-	-	0.49
I'_{61}	1.00			0.70		0.48	0.00	1.00
I'_{53}	0.37	-	-	1.00	0.41	-	0.13	0.46
I_{54}	1.00	-	-	-	-	-	-	0.00
I'_7	0.54	-	-	-	-	-	-	0.61
I'_{71}	0.81	0.07	0.58	0.00	0.33	0.74	0.90	1.00
I'_{72}	0.00	0.13	0.41	0.25	0.30	0.06	-	1.00
I'_{53}	0.37	-	-	1.00	0.41	-	0.13	0.46
I_{54}	1.00	-	-	-	-	-	-	0.00
I'_8	-	0.01	-	-	1.00	-	-	-
I'_9	0.68	0.80	0.26	0.58	0.65	0.95	0.69	0.40
I'_{10}	0.95	-	-	-	-	-	-	0.91
I'_{11}	0.61	0.22	0.73	0.58	0.33	-	0.40	0.67
I'_{12}	1.00	0.85	-	-	0.85	0.85	-	0.00
I'_{13}	-	-	-	0.00	-	-	-	0.96
I'_{14}	1.00	0.61	0.28	-	-	-	-	-
I'_{15}	0.67	1.00	-	-	0.82	-	-	-
I'_{16}	1.00	0.06	0.13	0.15	0.07	0.11	0.11	0.00

Note: MNE: multinational enterprise; Large: large enterprise; SME: small and medium-sized enterprise.
Company indicators: $\boldsymbol{I_1}'$: New staff hiring; $\boldsymbol{I_2}'$: Temporary contracts; $\boldsymbol{I_3}'$: Employee turnover; $\boldsymbol{I_4}'$: Benefits; $\boldsymbol{I_5}'$: Chronic disease; $\boldsymbol{I_6}'$: Fatal accidents at work; $\boldsymbol{I_7}'$: Non-fatal injuries at work; $\boldsymbol{I_8}'$: Social value; $\boldsymbol{I_9}'$: Female labor force participation; $\boldsymbol{I_{10}}'$: Wage gap; $\boldsymbol{I_{11}}'$: Women in executive management positions; $\boldsymbol{I_{12}}'$: Disabled; $\boldsymbol{I_{13}}'$: Salary distribution; $\boldsymbol{I_{14}}'$: Technical training; $\boldsymbol{I_{15}}'$: Social ethics, social awareness and human rights; $\boldsymbol{I_{16}}'$: Research and Development.

SOURCE: Own elaboration

To overcome this limitation and to carry out the analysis, and taking into account that the basic indicators are normalized from 0 to 1, three possible values were defined to each empty cell of each company:

- 1.0 to represent the best performance.
- 0.5 to represent medium-performance.
- 0.0 to represent the worst performance.

This applies to all the indicators except I_{54} where only two options are available: 1.0 if the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent, and 0.0 otherwise. With this approach, the possible values for each company indicator were established for each firm.

By way of example, the detailed explanation of the definition of the values for Firm 1 can be seen as follows. Table 5-20 shows the results of the company indicators for Firm 1. These values are obtained by applying the equations of the composite indicators to the information extracted from the GRI report of this firm. As can be seen, the information of most of the indicators was gathered; however, the necessary information to calculate the company indicator benefits ($\mathrm{I}'_4 = \frac{1}{2}(\mathrm{I}'_{41} + \mathrm{I}'_{42})$), social value ($I_8{}'$), and salary distribution ($I_{13}{}'$) was lacking.

Table 5-20: Value of each company indicator for Firm 1.

Company indicators (I'_i)	Firm 1 (MNE)
I'_1	1.00
I'_2	0.75
I'_3	0.63
I'_4	-
I'_{41}	-
I'_{42}	-
I'_5	0.34
I'_{51}	0.00
I'_{52}	0.00
I'_{53}	0.37
I_{54}	1.00
I'_6	0.79
I'_{61}	1.00
I'_{53}	0.37
I_{54}	1.00
I'_7	0.54
I'_{71}	0.81
I'_{72}	0.00
I'_{53}	0.37
I_{54}	1.00
I'_8	-
I'_9	0.68
I'_{10}	0.95
I'_{11}	0.61
I'_{12}	1.00
I'_{13}	-
I'_{14}	1.00
I'_{15}	0.67
I'_{16}	1.00

Note: MNE: multinational enterprise. Company indicators: $\boldsymbol{I_1}'$: New staff hiring; $\boldsymbol{I_2}'$: Temporary contracts; $\boldsymbol{I_3}'$: Employee turnover; $\boldsymbol{I_4}'$: Benefits; $\boldsymbol{I_5}'$: Chronic disease; $\boldsymbol{I_6}'$: Fatal accidents at work; $\boldsymbol{I_7}'$: Non-fatal injuries at work; $\boldsymbol{I_8}'$: Social value; $\boldsymbol{I_9}'$: Female labor force participation; $\boldsymbol{I_{10}}'$: Wage gap; $\boldsymbol{I_{11}}'$: Women in executive management positions; $\boldsymbol{I_{12}}'$: Disabled; $\boldsymbol{I_{13}}'$: Salary distribution; $\boldsymbol{I_{14}}'$: Technical training; $\boldsymbol{I_{15}}'$: Social ethics, social awareness and human rights; $\boldsymbol{I_{16}}'$: Research and Development.

SOURCE: Own elaboration

Thus, to avoid the subjectivity associated with assigning a specific value to each of these indicators, three possible values were assigned to I'_{41}, I'_{42}, I'_8, and I'_{13}. In this regard, as the company indicator I'_4 depends on the standardized indicators I'_{41} and I'_{42} ($\mathrm{I}'_4 = \frac{1}{2}(\mathrm{I}'_{41} + \mathrm{I}'_{42})$), this was obtained by the combination of the three possible values for each standardized indicator, giving nine possible combinations (see Table 5-21).

Table 5-21: Values of I'_4 in Firm 1 obtained from the combination of the possible values of I'_{41} and I'_{42}

Firm 1	C1	C2	C3	C4	C5	C6	C7	C8	C9
I'_4	0.00	0.25	0.50	0.25	0.50	0.75	0.50	0.75	1.00
I'_{41}	0.00	0.50	1.00	0.00	0.50	1.00	0.00	0.50	1.00
I'_{42}	0.00	0.00	0.00	0.50	0.50	0.50	1.00	1.00	1.00

Note: C: combination

SOURCE: Own elaboration

From these nine combinations, five possible values were obtained for I'_4: 0.00, 0.25, 0.50, 0.75, and 1.00. The possible values of each company indicator in firm 1 are gathered in Table 5-22. All the company indicators have one possible value, except for I'_4 which has 5 possible values; and I'_8 and I'_{13} which are indicators with three possible values.

Table 5-22: Possible values of each company indicator in firm 1

Company Indicators (I'_i)	Possible values				
I'_1	1.00				
I'_2	0.75				
I'_3	0.63				
I'_4	0.00	0.25	0.50	0.75	1.00
I'_5	0.34				
I'_6	0.79				
I'_7	0.54				
I'_8	0.00	0.50	1.00		
I'_9	0.68				
I'_{10}	0.95				
I'_{11}	0.61				
I'_{12}	1.00				
I'_{13}	0.00	0.50	1.00		
I'_{14}	1.00				
I'_{15}	0.67				
I'_{16}	1.00				

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

This same procedure was performed for each firm. Tables with the possible values associated with each company indicator for each firm are gathered in Appendix D.

Once the possible values of each company indicator in each firm were defined, the second step was to analyze each firm with the composite indicator of the corporate social responsibility group (Equation 5-1). Thus, taking into account all the possible values of each company indicator in each firm, every possible combination of each firm was analyzed. These combinations depend on: (1) the number of company indicators which has more than one possible value; and, (2) the number of possible values of each company indicator. The combinations or scenarios for each company are defined in Table 5-23. For example, 45 combinations have been defined for firm 1, because of this firm has 13 indicators with one value, one indicator with five values, and two indicators with three values (5*3*3=45).

Table 5-23: Number of possible combinations for each firm depending on the possible values of their company indicators

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6	Firm 7	Firm 8
Combinations	45	6,615	893,025	14,58	3,78	820,125	255,15	135

SOURCE: Own elaboration

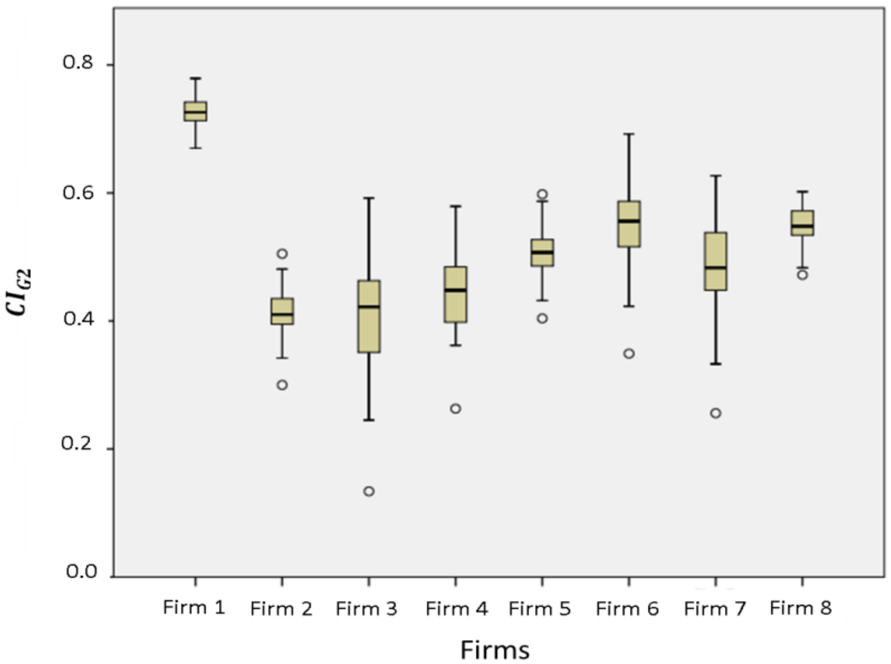
Due to the broad number of possible combinations for each firm, the method Taguchi orthogonal array method was selected to reduce the number of scenarios without affecting the outcomes significantly (Mia et al. 2018). The Taguchi orthogonal array design is a type of general fractional factorial design that allows considering a selected subset of combinations of multiple factors at multiple levels. This method is focused on defining balanced scenarios to ensure that all levels of all factors are considered equally. For this reason, the factors can be evaluated independently of each other despite the fractionality of the design (Narayana et al. 2019). This technique has been widely used in many fields such as physics, management and business, medicine, chemistry, environmental science, etc. (Bolboacă and Jäntschi 2007). The scenarios of each firm were defined using IBM SPSS Statistics 23.0. Implementing the Taguchi Orthogonal Array, the number of combinations for each firm were: 25 scenarios for firm 1; 49 scenarios for firm 2; 81 scenarios for firm 3; 27 scenarios for firm 4; 49 scenarios for firm 5; 81 scenarios for firm 6; 81 scenarios for firm 7; and, 25 scenarios for firm 8 (see Table 5-24). All these scenarios have been included in Appendix E.

Table 5-24: Number combinations implementing taguchi orthogonal array

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6	Firm 7	Firm 8
Combinations	25	49	81	27	49	81	81	25

SOURCE: Own elaboration

The goal was assessing, through the Equation 5-1, the corporate social responsibility performance of each firm in each one of their possible scenarios (see Appendix E). The results are displayed in Figure 5-32.



SOURCE: Own elaboration

Figure 5-32: Corporate social responsibility performance of each firm obtained based on the established scenarios.

As can be seen, all the scenarios of firm 1 are way ahead of the rest of the firms. This is because the firm 1 is a multinational enterprise (MNE) leader in the implementation of corporate policies tightly focused on social and environmental sustainability. On the other hand, the rest of the firms show a similar distribution of their performance. These firms are large firms, except firm 8 that is a small and medium-sized enterprise (SME). The figure shows equivalent performances for these companies, highlighting one firm over the rest of the firms depending on the social values of their indicators. Thus, analyzing this figure shows that the method is valid to compare corporate social responsibility performances of construction companies, and it allows comparing large and SME companies. However, more detail is needed to determine whether the methodology is valid to compare SME with MNE with respect to their performances.

Comparing the corporate social responsibility performance of the multinational enterprise and the small and medium-sized enterprise, firm 1 performs the best (see Table 5-25). This happens for two main reasons. On the one hand, the company indicators of the firm 1 with only one level were generally good (an average of 0.74) ensuring the distribution of its performances in the upper area. On the other hand, the values of most of the indicators with the highest weights in the composite indicator are high (I'_2: 0.75; I'_3:0.63; and, I'_{12}:1.00). Nevertheless, although firm 8 had the best results in I'_2 and I'_3, it obtained zero in I'_{12}, and the global performance of the rest of the indicators was low (an average of 0.54). The aim of the following task was assessing the effort that the SMEs should make to obtain better performances than the MNE (firm 1); concluding if these types of companies can be compared and compete in terms of corporate social responsibility through the composite indicator defined for this group of criteria (G2).

Table 5-25: Values of the company indicators for firms 1 and 8

Company indicators (I'_i)	Firm 1 (MNE)	Firm 8 (SME)
I'_1	1.00	0.00
I'_2	**0.75**	**1.00**
I'_3	**0.63**	**1.00**
I'_4	-	-
I'_5	0.34	0.61
I'_6	0.79	0.49
I'_7	**0.54**	**0.61**
I'_8	-	-
I'_9	0.34	0.20
I'_{10}	0.95	0.91
I'_{11}	0.61	0.67
I'_{12}	**1.00**	**0.00**
I'_{13}	-	0.96
I'_{14}	1.00	-
I'_{15}	0.67	-
I'_{16}	1.00	0.00
Average	**0.74**	**0.54**

Note:
MNE: multinational enterprise; SME: small and medium-sized enterprise.
Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

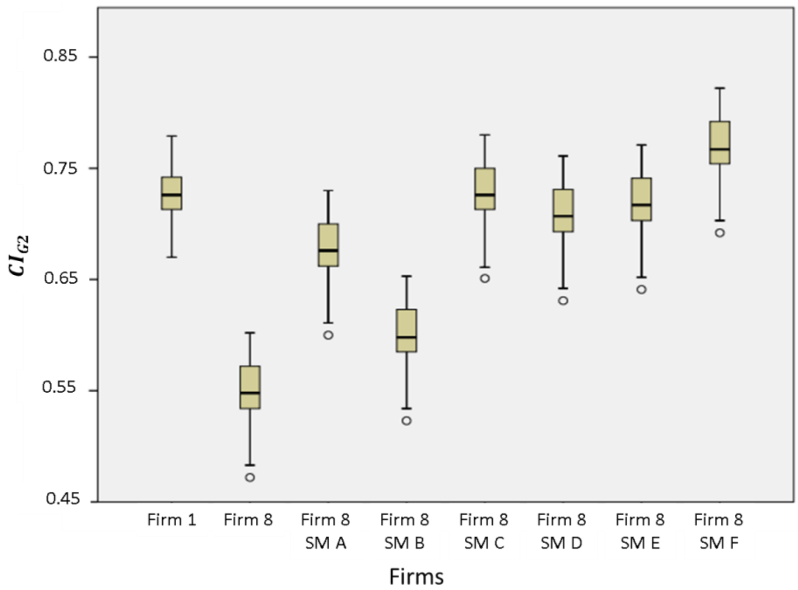
To analyze the efforts that the SMEs (firm 8) should make to overcome the results of firm 1, different social measures were defined:

- Social measure A: In case the firm 8 had one disabled worker in the workforce. As the firm has only five workers, if they had one disabled worker into the workforce, the percentage of disabled in the company would be 20% (I_{12}=0.16). According to the Equation defined to obtain the normalized indicator, if I_{12} is over 0.04, I'_{12} is 1.00. Thus, with only one disabled in the company, they would obtain the maximum value for this indicator.
- Social measure B: In case the company was currently certificated to OHSAS 18001, ISO45001:2018 or equivalent. This option would give a value of 1 to the indicator I'_{54}, affecting the indicators I'_5, I'_6, and I'_7. Thus, with this option, the values of these normalized indicators change from 0.61 to 0.86 in I'_5, from 0.49 to 0.82 in I'_6, and from 0.61 to 0.86 in I'_7.

- Social measure C: Satisfying both options A and B.
- Social measure D: The firm did not have a disabled worker in their workforce, but over the last year, the company decided to hire one. Under this scenario, I'_{12} is 1 (similar to option A), and the creation of a new hire affects the indicator I_1 that is equal to 0.2 (1/5), being the normalized value (I'_1) equal to 0.58.
- Social measure E: If the new hire defined in option D is also a woman. Thus, in addition to the new values of I'_{12} (1.00) and I'_1 (0.58), the indicator I'_9 also would change to 0.8.
- Social measure F: In case the firm satisfies the social measures defined in the option E and additionally it is currently certified by OHSAS 18001, ISO45001:2018 or equivalent.

These six social measures were compared to both the scenarios of firm 1 and the original scenarios of firm 8. The scenarios associated with each social measure can be found in Appendix F. The corporate social responsibilities of each possible scenario associated with each social measure are shown in Figure 5-33. According to the results for each social measure, the small and medium-sized enterprise (firm 8) could socially compete with the multinational enterprise (firm 1) and overcoming it when these are compared through the G2's composite indicator. This can be seen with the social measures C, D, E and F. For example, considering the option C (firm 8 has a disabled worker into the workforce and an OHSAS 18001, ISO45001 or equivalent certification) the small and medium-sized enterprise shows a corporate social responsibility performance equal to or better than firm 1.

Thus, it can be concluded that, on the one hand, the method is valid to compare the corporate social responsibility performance of construction companies, regardless of their size; on the other hand, the social behavior of the construction companies significantly influences their corporate social responsibility performance results. These are essential features of the model, considering that promoting small and medium-sized enterprises in public-works procurement is a need to improve local economies (Walker et al. 2012), and enhance corporate social awareness and responsibility among small and medium-sized enterprises in the construction sector is a crucial aspect to move the construction sector towards sustainable development (Hossain et al. 2018).



SOURCE: Own elaboration

Figure 5-33: Corporate Social Responsibility performance of firm 1 and firm 8 depending on the defined social measures

5.4. Social commitment in the project (G3)

Social commitment in the project group (G3) comprises the subindicators whose definition are linked to the subject matter of the project. The aim of these subindicators is to assess the commitment of the construction companies in the project. According to the methodological approach established, assessing the social commitment of the construction companies in the project needs to be based on the definition of a composite indicator. The goal of this composite indicator is to assess objectively the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of the project. This information will be the basis to perform a comparison between these companies, giving preference in the procurement procedure to those companies with the highest level of social commitment.

The following composite indicator is proposed to assess the social commitment of each construction company in the project, considering the information submitted in the proposals (Equation 5-20).

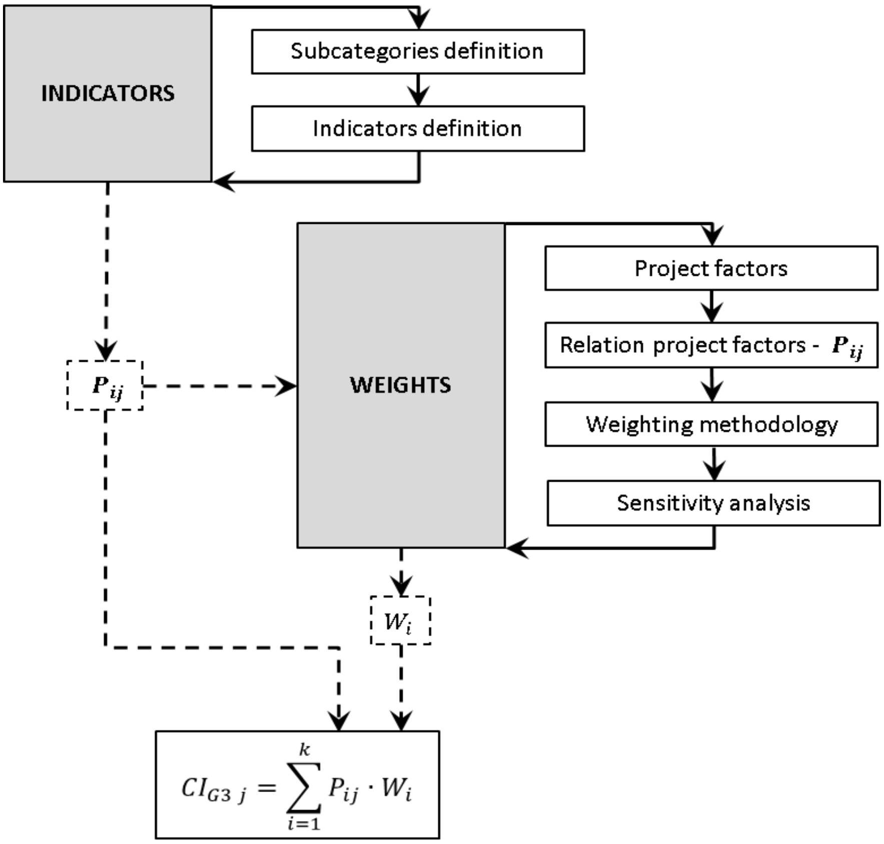
$$CI_{G3\,j} = \sum_{i=1}^{k} P_{ij} \cdot W_i \qquad (5\text{-}20)$$

With:

- $CI_{G3\,j}$: Result of the composite indicator for the bid submitted by construction company j.

- P_{ij}: Value for the construction company j on the indicator i, according to the bid submitted.
- W_i : Weight assigned to the indicator i in the model. The weights must be between zero and one ($0 \leq \mathrm{W_i} \leq 1$), and the sum of the weights must be equal to one ($\sum_{\mathrm{i=1}}^{\mathrm{k}} \mathrm{W_i} = 1$).

Thus, the crucial elements to define the composite indicator are the individual indicators and the weights associated with these indicators. In the methodological approach (chapter 3), it was established that both the definition of each indicator and their level of importance (weights) must be able to adapt to the project characteristics. To satisfy this condition, the process has been defined in Figure 5-34. The first step was based on the definition of the indicators associated with each subcategory of the social commitment in the project group (G3). To define these indicators, each G3's subcategory was defined through the review of sustainability certification systems and the 451 collected tendering documents. According to these definitions, indicators to assess each subcategory in the procurement procedure were proposed (P_{ij}). Once the indicators were defined, the weighting definition was addressed. The three project factors that influence the level of importance of each indicator were identified; as well as the different levels that each project factor can have depending on the project characteristics. A focus group established the relationship between these project factors and each indicator (P_{ij}). This was gathered in a two-dimensional array. Based on the indicators and the project characteristics, the weighting methodology was defined to obtain the weights (W_i) associated with each indicator through the two-dimensional array between project factor and indicators. Finally, a sensitivity analysis was performed to assess the suitability of the weighting method.



SOURCE: Own elaboration

Figure 5-34: Process to define the G3's composite indicator

5.4.1. Indicators

To define the indicators (P_{ij}) for the social commitment in the project group (G3), the first step was establishing a comprehensive definition of each subcategory. Through this information, the description, and the evaluation method of each indicator was defined.

5.4.1.1. Definition of subcategories of social commitment in the project group

Five social categories and seven subcategories are gathered in social commitment in the project group:

1. Cultural heritage category: comprises the subcategories cultural heritage appraisal and management plan, and collaboration with historical or cultural preservationists.
2. Employment category: considers the subcategory industry participation plan.

3. Occupational Health and Safety category: encompasses the subcategories work health and safety management officer, and workplace health and safety management plan.
4. Public participation category: considers the subcategory community relations program.
5. Users' Impact category: considers the subcategory effects on neighbors.

The definition of these subcategories is shown below. The information has been organized by categories.

5.4.1.1.1. Cultural heritage

The category 'cultural heritage' comprises those criteria focused on actions that favor the protection of the historic environment in the area impacted by the project (Arce and Gullón 2000; ISI 2015; UNESCO 2017). The historic environment covers architectural, archeological and paleontological resources as well as tribal cultural properties, historical, artistic and civil heritage. Currently, historic environment assets are protected by numerous national legislations**;** however, a large proportion of the historic environment may not be specifically protected by legislation (CEEQUAL 2010; ISI 2015). According to CEEQUAL (2010), the surviving historic environment is fragile and highly susceptible to damage and destruction. Thus, defining requirements to protect these types of resources is of vital importance.

Two subcategories have been defined within Cultural heritage: (1) cultural heritage appraisal and management plan; and, (2) collaboration with historical or cultural preservationists. The definitions of these subcategories referred to the construction stage of the infrastructure's life cycle are only based on the CEEQUAL (2010) and Muench et al. (2011) certification systems; because, although the ISI (2015) and FHWA (2012) certification systems (CSs) consider this social category, these CSs define the different aspects of cultural heritage focused only on the feasibility and/or the design stages. Additionally, cultural heritage criteria were considered in the analyzed tendering documents; thus, their definitions have been considered to establish a comprehensive definition of these subcategories.

- Cultural heritage appraisal and management plan:

CEEQUAL (2010) recommended that a historic environment management plan should be defined if there are historic-environment aspects to the site or its vicinity. Within this historic environment management plan, the definition of mitigation strategies and monitoring the implementation of the plan is key activities to ensure the protection of the cultural heritage. Based on the requirements defined by

CEEQUAL (2010) and Muench et al. (2011), the historic environment management plan should gather:

- Evidence about how the mitigation designs are going to be implemented, managed, and monitored.
- Protection measures to put in place to avoid accidental damage on the cultural heritage; as well as instructions that the site staff is going to receive to guarantee the correct protection.
- A training plan, customized to the project, to protect the historic environment, and a training plan about conservation skills to provide construction personnel with the knowledge to identify historic environmental issues and the best practice methods to minimize environmental impacts.
- A plan to address unanticipated historic resources or archaeological discoveries.

Additionally, according to tendering documents from Canada, the plan should describe the means of communication between the General Contractor's personnel and the Departmental Representative. On the other hand, Muench et al. (2011) established that the training plan should include:

- A list of the types of project personnel to be trained, defining the list by job-type or by employer need (without defining employee names).
- A description of the types and objectives of training to be given in the project.
- The method to track training efforts, including dates, means (online, classroom, field training,…), topics, the identification of those participating in training, and attendance numbers.
- The process to measure training effectiveness and productivity measurement.

Finally, CEEQUAL (2010) highlighted that if a report on the archaeological or historic environment recording work carried out has been produced, this should be available to the public. Furthermore, there should be active publicity for this report to ensure the public knows about it. Public access should be limited if archaeological or other appropriate experts working on the find advises that public access is inappropriate or advises against publicity.

- <u>Collaboration with historical or cultural preservationists:</u>

CEEQUAL (2010) recommended including appropriate historical environment professionals (archaeologist, conservation architect, or historic buildings specialist) on the project team to manage and inspect the mitigation effort. In countries such as Chile and Spain, the requirements about the level of expertise of the professional are established. Aspects such as years of experience in similar projects, to the one that is going to be procured, and the definition of responsibilities are demanded as award criteria in the procurement procedure.

5.4.1.1.2. Employment

Construction projects can have direct and indirect benefits for the community. According to CEEQUAL (2010)**,** enhancing the participation of SMEs in construction can have a positive impact on the community from an economic perspective. Only CEEQUAL (2010) and ISI (2015) defined aspects related to the participation of local firms in the project. This issue can be improved through the information gathered in the analyzed tendering documents. Countries such as Australia, the USA, the UK, and Spain tend to include criteria to enhance the participation of local firms in the projects. In social commitment in the project group, only one subcategory has been defined within the employment category: Industry participation plan.

- Industry participation plan:

ISI (2015) claimed that the company needs to determine the expected degree to which the project will contribute to local firms' employment. Thus, the company should define:

- How the project team identified community employment needs.
- Plans and commitments for local firms.
- The ratio of participation of local firms in the project.

The term 'local' depends on the location and the nature of the project. CEEQUAL (2010, p. 114) defined that "in a remote area 'local' may be within the range of the nearest town or major settlement, whereas in a heavily built-up area it could be as close as being within the borough".

Regarding the tendering documents, Australia is the country which includes criteria related to industry participation plans the most. In most of its tendering documents, tenderers are required to demonstrate their commitment to local participation, concerning the works to be completed, and assisting project proponents and developers in maximizing opportunities to utilize local suppliers, services, and labor (AG 2001).

According to NTG (2019), an industry participation plan should address the full, fair, and reasonable opportunity for local businesses, industry, and labor to participate in the development of the project. It should also include all tiers of the supply chain, including subcontractors, and suppliers. The essential elements of an industry participation plan are:

1. How services, suppliers, and labor will be utilized:
    - What goods or services industry can tender for prequalification and tender criteria.
    - Opportunities for local participation through all tiers of the supply chain (i.e. include potential sub-contractors).
2. Enhancements to business and industry capability:
    - Opportunities for networks and alliances.
    - Integration of local industry into global supply chains.
3. Communication strategy:
    - Outlining how the proponent will inform local industry about particular opportunities.
    - Including structural tender documents to ensure local suppliers are provided the same chance as existing supply chain partners to participate in the project.
4. Reporting methodology:
    - A proposed framework for reporting against key elements of the industry participation plan.
    - A schedule of report submissions.

5.4.1.1.3. Health and safety

The construction sector is characterized by the highest rates of accidents of any major industry (Oswald et al. 2018). For that reason authors such as Reyes et al. (2014) emphasized that the incorporation of health and safety concepts in a construction project is crucial to minimizing accident rates and reducing project costs.

In social commitment in the project group, two subcategories have been defined within the health and safety category: (1) workplace health and safety management plans; and, (2) work health and safety management officers. ISI (2015) is the only certification system which takes into account aspects related to occupational health and safety applied at construction stage. However, regarding analyzed tendering documents, results showed the important consideration of health and safety criteria in the procurement procedures at the international level. For that reason both sources have been considered to define the subcategories:

- <u>Workplace health and safety management plan:</u>

The project team must define in place health and safety plans and programs based on health and safety requirements and considerations (ISI 2015)**.** This workplace health and safety management plan (WH&SMP) must be defined according to the characteristics and complexity of the project. Based on the information gathered in the tendering documents from Australia, Chile, New Zealand, Canada, Spain, the USA, and the UK, the different concepts a WH&SMP should include are:

- A WH&S risk assessment method that identifies project-specific high risks construction activities.
- Details of the management structure and responsibilities.
- Control measures used to mitigate risks and hazards identified.
- A proposal of the regular WH&S inspections at worksites.
- A proposal of standard workplace inspection checklists.
- Procedures by which contractors and employees can report hazards in the workplace.
- Procedures for informing other contractors and employees of health and safety hazards.
- Procedures for communications between the project team, other contractors and site operatives.
- A system for recording and analyzing health and safety performance statistics.
- Procedures by which information on company health and safety performance is regularly provided to employees

- <u>Work health and safety management officer:</u>

Tendering documents from Australia, the USA, and Spain require that the contractor hire a competent person authorized as a safety officer. Based on the requirements established in the analyzed documents, this person should be liable for the following:

- Having site-related work experience specific to the activities associated with the project.
- Having working knowledge of occupational health and safety regulations in the workplace.
- Being responsible for completing contractor's health and safety training sessions and ensuring that personnel not completing required training are not permitted to enter the construction site to perform work.
- Being responsible for implementing, enforcing in detail, and monitoring a site-specific contractor's health and prevention program.
- Being at the construction site at all times during the execution of work, reporting directly to the site supervisor and acting according to his instructions.

5.4.1.1.4. Public participation

Per the literature review, the project team should work closely with community stakeholders to identify and address issues and concerns, to avoid project failures, and to create values of public opinions (ISI 2015; Abdel-Raheem and Ramsbottom 2016; Li et al. 2018). In line with this, the following subcategory has been defined in social commitment in the project group regarding public participation: Community relations program.

- Community relations program

Certification systems defined by CEEQUAL (2010), ISI (2015), Muench et al. (2011), IDOT (2012) and FHWA (2012) defined the aspects that should be considered when assessing a community relations program. Regarding the analyzed countries, only Canada, Colombia, Peru, and the UK established in tendering documents specific requirements to boost public participation in the development of the projects.

CEEQUAL (2010) emphasized that the views of stakeholders can be actively considered in the construction stage of the project through an appropriate community relations program during the project, and it established the following stakeholders to be considered in this program:

- Neighbors who are close to but not adjacent to the project site.
- Local interest groups.
- The wider community (people, schools, businesses, etc.) who may be affected by, or have an interest in, the project.

Additionally, this certification system recommended having a member of the project team as responsible for ongoing community consultation, even if it is merely to handle inquiries from interested parties.

According to Muench et al. (2011), FHWA (2012), IDOT (2012), and ISI (2015) and taking into account the requirements gathered in Colombia's tendering documents, the community relations program should define:

- Lists of stakeholder groups.
- A person from the Project team who works to communicate with the stakeholder groups.
- Procedures and periodicity for communicating with the stakeholder groups.
- Methods to include the opinion of the stakeholders in project decision-making processes.

5.4.1.1.5. Users' impact

Possible disturbances of human communities need to be addressed during the construction process (Ugwu et al. 2006), to avoid inconvenience and stress amongst neighboring communities (CEEQUAL 2010). As the contractor shall not unnecessarily impact on the general operations or functionality of any infrastructure, one subcategory has been defined in Group 2a regarding users' impact: effects on neighbors.

- Effects on neighbors

CEEQUAL (2010), FHWA (2012), IDOT (2012), and ISI (2015), as well as tendering documents from Australia, Canada, the UK, Colombia, the USA, and Spain, requires a traffic management plan to limit the impact on users during the construction period. Canada and the UK defined the following aspects to be included in the traffic management plan during construction:

- Construction materials delivery.
- Construction waste removal.
- Construction lift or crane locations, set-up and operations.
- Coordination between pedestrian access and construction traffic.
- Requirements for construction traffic control measures such as temporary barriers, temporary signage, flagmen, etc.

Additionally, CEEQUAL (2010) required the definition of control measures to put in place to minimize noise, dust, and pollution during the construction works. Finally, ISI (2015) claimed the definition of measures to improve user safety during construction.

5.4.1.2. Definition of the indicators to assess each subcategory of social commitment in the project group

The indicators to assess each subcategory are presented in this section. According to UNEP (2009), social aspects are not always quantifiable and, although indicators should be quantitative whenever possible, some aspects of social sustainability qualitative descriptions may be more appropriate (Azapagic 2004). This is the case of the subcategories in social commitment in the project group. For that reason, the definition of each indicator encompasses a description of the information that each indicator should gather, as well as the evaluation method to minimize the subjectivity of the process.

5.4.1.2.1. Cultural heritage appraisal and management plan

Indicator P_1: Cultural heritage appraisal and management plan.

Description: The aim of this indicator is to preserve and protect cultural and historic environments. The cultural and historic environment covers architectural, archeological and paleontological resources as well as tribal cultural properties, historical, artistic and civil heritage.

The company should prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{11}: Review of previous cultural environment investigations.
- P_{12}: Scope of cultural environment mitigation.
- P_{13}: Methodology of archaeological mitigation defining how the mitigation works are going to be implemented managed and monitored.
- P_{14}: Definition of protection measures and instruction to be put in place to avoid accidental damage.
- P_{15}: A plan to address unanticipated cultural resource or archaeological discoveries.
- P_{16}: Means of communication between the general contractor's personnel and the departmental representative.
- P_{17}: A training plan customized to the project, including to conservation skills needed to protect the cultural environment, that provides construction personnel with the knowledge to identify historic environmental issues; and the best practice methods to minimize environmental impacts. The training plan must contain:
    - A list of the types of project personnel to be trained, defining the list by job-type or by employer need (without specifying employee names).
    - A description of the types, goals, and objectives of training to be given in the project.
    - The method to track training efforts, including dates, means (online, classroom, field training, etc.), topics, the identification of those participating in training, and attendance numbers.
    - The process to measure training effectiveness and productivity measurement.
- P_{18}: In case a cultural environment recording is produced during the project, the company commits to making this report available to the public and advertising its availability. Public access should be limited if archaeological or other appropriate experts working on an archeological or historic find advises that public access is inappropriate or advises against publicity.

Evaluation: Each sub-indicator has to be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are in Table 5-26. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-26: Criteria to assess each sub-indicator of the indicator P_1

Sub-indicators	Level	Definition	Score
$P_{11.}$ Review of previous cultural environment investigations	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the review performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The review is poor and need major improvements	0.00
	None	None shown	X
$P_{12.}$ Scope of cultural environment mitigation	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{13.}$ Methodology of archaeological mitigation	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{14.}$ Protection measures	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{15.}$ Plan to address unanticipated cultural resource or archaeological discoveries	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{16.}$ Means of communication	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{17.}$ Training plan	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{18.}$ Commitment about the publicity of reports on cultural environment recording work	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.2. Collaboration with cultural preservationists

Indicator P_2: Cultural environment professional

Description: The aim of this indicator is managing and inspecting the mitigation effort, guaranteeing the protection of the cultural environment.

The company has to prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{21}: Curriculum vitae of the cultural environment professional that is going to be part of the project team.
- P_{22}: Years of experience in similar work of the cultural environment professional.
- P_{23}: Definition of responsibilities of the cultural environment professional.

Evaluation: Each sub-indicator has to be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-27. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-27: Criteria to assess each sub-indicator of the indicator P_2

Sub-indicators	Level	Definition	Score
$P_{21.}$ Curriculum vitae of the cultural environment professional	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
$P_{22.}$ Years of experience in similar works	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Less than "y" years of experience (y must be defined by the agency)	0.00
	None	None shown	X
$P_{23.}$ Definition of responsibilities	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.3. Industry participation plan

Indicator P_3: Industry participation plan

Description: The aim of this indicator is involving local businesses and industry during the development of the project, including only tier one subcontractors and suppliers. The procurer has to define the term 'local' because this depends on the location and the project characteristics. This can be defined according to a particular area.

The company should prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{31}: Community employment needs.
- P_{32}: How local services and suppliers will be utilized. Defining the opportunities for local participation, gathering:
    - Enhancements to business and industry capability.
    - Opportunities for networks and alliances.
    - Integration of local industry into global supply chains.
- P_{33}: Communication strategy and reporting methodology:
    - Outlining how the proponent will inform local industry about particular opportunities.
    - Including structural tender documents to ensure that local suppliers are provided the same opportunity as existing supply chain partners to participate in the project.
    - Framework for reporting against key elements of the Industry Participation Plan and schedule of report submissions.
- P_{34}: The minimum ratio of participation of local firms in the project that the company undertakes to comply.

Evaluation: Each sub-indicator of the document has to be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-28. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-28: Criteria to assess each sub-indicator of the indicator P_3

Sub-indicators	Level	Definition	Score
$P_{31.}$ Community employment needs	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{32.}$ How local services and suppliers will be utilized	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition proposed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{33.}$ Communication strategy and reporting methodology	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{34.}$ Minimum ratio of participation of local firms	Excellent	The ratio maximum established by law or proposed by the procurer	1.00
	Good	The ratio is greater than the average of the companies' ratio	0.66
	Moderate	The ratio is equal to the average of the companies' ratio	0.33
	Poor	The ratio is lower than the average of the companies' ratio	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.4. Workplace health and safety management plan

Indicator P_4: Workplace health and safety management plan

Description: The aim of this indicator is guaranteeing the safety conditions during the development of the project.

The company has to prepare a workplace health and safety management plan. This must be defined according to the characteristics and complexity of the project, and it should include the following information. Each bullet represents a sub-indicator.

- P_{41}: Details of the management structure and responsibilities.
- P_{42}: Workplace health and safety risk assessment:
    - Identification of project-specific high-risks construction activities.
    - Definition of control measures to mitigate the risks and hazards identified.
    - Procedures for informing other contractors and employees of health and safety hazards.
- P_{43}: Proposal for inspections at work-sites, defining:
    - Regular workplace health and safety inspections.
    - A Proposal for a standard workplace inspection checklist.
- P_{44}: Communication:
    - Procedure by which contractors and employees can report hazards in the workplace.
    - Procedures for communications between the project team, other contractors and site operatives.
    - A system for recording and analyzing health and safety performance statistics.
    - A procedure by which information on company health and safety performance is regularly provided to employees.

Evaluation: Each sub-indicator has to be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-29. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X") the total score of the indicator will be zero.

Table 5-29: Criteria to assess each sub-indicator of the indicator P_4

Sub-indicators	Level	Definition	Score
P_{41}. Details of the management structure and responsibilities	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

$P_{42.}$ Workplace health and safety risk assessment	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{43.}$ Proposal of inspections at worksites	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{44.}$ Communication	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.5. Work health and safety management officer

Indicator P_5: Work health and safety management officer

Description: The aim of this indicator is guaranteeing the safety conditions during the development of the project.

The company should prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{51}: Curriculum vitae of the work health and safety management officer that is going to be part of the project team, defining site-related working experience specific to the activities associated with the project.
- P_{52}: Definition of occupational health and safety regulations in the workplace.
- P_{53}: Definition of responsibilities of the work health and safety management officer, regarding:
    - Being responsible for completing contractor's health and safety training sessions and ensuring that personnel not completing required training are not permitted to enter the construction site to perform work.
    - Implementing, enforcing in detail, and monitoring site-specific contractor's health and prevention program.
    - Being at the construction site at all times during the execution of work, report directly to the site supervisor and acting in accordance with his instructions.

Evaluation: Each sub-indicator should be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-30. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-30: Criteria to assess each sub-indicator of the indicator P_5

Sub-indicators	Level	Definition	Score
P_{51}. Curriculum vitae of the work health and safety management officer	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{52}. Regulations	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{53}. Definition of responsibilities	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.6. Community relations program

Indicator P_6: Community relations program

Description: The aim of this indicator is enhancing the consideration of the opinion of stakeholders in the decision-making of the construction project.

The company should prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{61}: The person from the project team responsible for communicating with the stakeholder groups.
- P_{62}: Inclusion of the opinion of the stakeholders in project decision-making processes:
  - Lists of stakeholder groups identified as key, compared to the total potential.
  - Procedures and periodicity for communicating with the stakeholder groups.
  - Methods to include the opinion of the stakeholders in project decision-making processes.

Evaluation: Each sub-indicator should be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-31. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-31: Criteria to assess each sub-indicator of the indicator P_6

Sub-indicators	Level	Definition	Score
P_{61}. Person responsible for communicating with the stakeholder groups	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{62}.Inclusion of the opinion of the stakeholders	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.1.2.7. Effects on neighbors

Indicator P_7: Effects on neighbors

Description: The aim of this indicator is minimizing the disturbances in human communities.

The company should prepare a document with the following content. Each bullet represents a sub-indicator.

- P_{71}: Traffic management plan for use during construction. This should consider the following:
    - Construction materials delivery.
    - Construction waste removals.
    - Construction lift or crane locations, set-up, and operations.
    - Coordination between pedestrian access and construction traffic.
    - Requirements for construction traffic control measures such as temporary barriers, temporary signage, flagmen, etc.
- P_{72}: Control measures to put in place to minimize noise, dust, and pollution during construction.
- P_{73}: Measures to improve users' safety during construction.

Evaluation: Each sub-indicator has to be assessed according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are gathered in Table 5-32. The total score of the indicator has to be calculated as the average of the scores obtained in each sub-indicator. In case a sub-indicator is assessed at the "none" level ("X"), the total score of the indicator will be zero.

Table 5-32: Criteria to assess each sub-indicator of the indicator P_7

Sub-indicators	Level	Definition	Score
P_{71}. Traffic management plan	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

$P_{72.}$ Minimize noise, dust and pollution	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
$P_{73.}$ Users' safety	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

SOURCE: Own elaboration

5.4.2. Weights

Once the indicators in the social commitment in the project group (G3) were established, the following step was determining the weight associated with each indicator. The weight of each indicator depicts the level of importance of each indicator in the composite indicator. This level of importance must be defined depending on the project characteristics. Based on the recommendations of Kraft and Molenaar (2015) and Yu et al. (2017), project factors, which represent the project characteristics, were established to determine the level of importance of each indicator. Subsequently, the determination of the level of importance of each indicator, depending on the project factors, was carried out through a focus group. Based on this, a weighting methodology was defined, and sensitivity analysis was performed to verify the suitability of the weighting methodology.

5.4.2.1. Definition of project factors

Project factors represent the features of specific projects. According to the literature review and the results obtained through the characterization of the tendering documents, the three project factors that influence the inclusion of social criteria in the procurement procedures are: (1) contract size; (2) project complexity; and, (3) social context. The reasons are:

- Contract size. One of the main results of analyzing the tendering documents was the strong influence of the project contract size on the inclusion of social criteria in public-works procurement.
- Project complexity. Social impacts could evolve into project risks and even lead to social conflicts if they are not dealt with carefully and properly (Xiahou et al. 2018). For that reason, numerous authors highlighted the importance of project management and the definition of plannings before starting tasks to minimize the uncertainties and risks that can appear in accomplishing the tasks. This is highly relevant, taking into account that the need to decrease a project's uncertainties increases with its complexity (Luo et al. 2017; Xiahou et al. 2018).

- Social context. Civil engineering projects cause major disturbances to the existing communities and environment. For that reason, the impact associated with the project depends on features of the territory affected by the project (Ugwu and Haupt 2007; Valdes-Vasquez and Klotz 2013; Abdel-Raheem and Ramsbottom 2016; Yu et al. 2017). Additionally, CEEQUAL (2010) claimed the importance of strengthening social requirements in construction projects when the territory which is affected by the construction is characterized by the presence of historic-environmental assets. On the other hand, European Commission (2010) and CEEQUAL (2010) claimed the importance of involving small and medium enterprises in the projects to have a positive impact on the community from an economic perspective. However, Kraft and Molenaar (2015) emphasized that to involve local industry in project development, an important factor to be considered is the level of trust established between the local industry and the agency, to control and guarantee the final quality of the project. Based on these facts, three subfactors were defined within the social context: (1) cultural environment; (2) territorial conditions; and, (3) industry competence.

To characterize the project according to these project factors, different levels were established for each of them. The aim of these levels was to represent the different possible scenarios for each project factor.

- The contract size is determined by the initial budget of the construction project (Lines and Miao 2016). Following the classification established in chapter 3, three levels of contract size were defined:
    - > 10,000,000€
    - 1,000,000€ - 10,000,000€
    - < 1,000,000€
- Project complexity. There is no single understanding of what complexity means and how it can be measured (Dao et al. 2017). Although project complexity is perceived as a condition associated with project difficulty and project risk, there is a lack of consensus on what constitutes those factors. Consequently, defining and quantifying the level of complexity of a project is a difficult task (Luo et al. 2017). A common and accepted method to determine the level of project complexity is comparing the project to other types of projects or to similar projects. For that reason, and based on the recommendations of NCHRP (2015b), the level of complexity for a specific project can be defined comparing the project to other projects awarded by the same procurer. Some aspects that could be relevant in determining the level of complexity of the project are scope, constraints, construction methods, site conditions, budget, funding constraints, and specialty

materials. Based on this, three levels are established, associated with project complexity:

- Low: This project is not complex compared to the average of projects awarded by the procurer.
- Medium: This project is complex compared to the average of projects awarded by the procurer.
- High: This project is highly complex compared to the average of projects awarded by the procurer.

- Social context is defined according to the social characteristics of the site and surrounding areas of the project (Sierra et al. 2017a). Three sub-factors have been established:
  - Cultural environment. Current research is focused on developing powerful tools based on spatial statistical models to simulate and predict areas where historical, architectural, archeological, or paleontological resources may be found (Domínguez-Rodrigo et al. 2017). Other methodologies analyze hazard assessment, vulnerability assessment, and risk assessment to determine the likelihood of damage to heritage sites on a territorial scale (Esen and Altınöz 2018). However, most commonly and widely used methods involve simple distance approaches to identify risk areas (Domínguez-Rodrigo et al. 2017). An example is CEEQUAL (2010), which recommends actions to protect the cultural heritage in an area when there are, or there have been, historic-environment assets on the site or its vicinity. This is the approach that is proposed to establish three levels depending on the risk on finding historic resources:
    - Low: Previous studies have determined a low risk of damaging historic resources, or there has not been any discovery in the region of the project.
    - Medium: Previous studies have determined a medium level of risk of damaging historic resources or there have not been previous studies to assess the risk of damaging historic resources; however, there has been any discovery in the region of the project.
    - High: Previous studies have determined that the risk of damaging historic resources exists, there have been several discoveries in the region of the project, or there are areas to be protected.

  - Industry competence. NCHRP (2015a) highlighted that the quality of a construction project can be significantly influenced by one industry factor: industry characteristics or abilities associated with the local firms' levels of competence in engineering, contracting and consulting in the type of project to be awarded. The competence of a firm is determined based on its experience, training, education, industry culture, or a combination of any of these (NCHRP 2015b). Thus, based on the trust between the agency and the industry to involve local firms in the project, three levels have been established:

- Low: The level of competence of the local industry is low or the procurer does not know about the technical capabilities of the local industry to perform for tasks required in the project; consequently, the procurer has a low level of confidence in the industry's involvement in the works.
- Medium: the level of competence of the local industry to perform for tasks required the project is medium; consequently, the procurer has a medium level of confidence in the industry's involvement in the works.
- High: the level of competence of the local industry to perform for tasks required in the project is high; consequently, the procurer has a high level of confidence into the industry's involvement in the works.

- Territory. According to NCHRP (2010), identifying and alleviating the negative social consequences derived from construction projects are essential for the success of the project. Wang et al. (2016) highlighted that the social impact of a construction project in a territory depends mainly on aspects related to the project distances to residential areas, the project dependency on traffic pattern and changes in living standards due to the project; being evident that the level of impact of a project in a territory is higher when there is a high population in close proximity to the project, high dependence on established traffic patterns, and changes to their living conditions. Thus, three levels are defined based on the negative effects that the project could have on the territory**:**
  - Low: during the development of the project, construction works hardly produces negative effects in the territory.
  - Medium: during the development of the project, construction works produces negative effects in the territory.
  - High: during the development of the project, construction works produces important negative effects in the territory.

5.4.2.2. Relationship between indicators and project factors

The determination of the level of importance of each indicator was carried out through the focus group defined in chapter 3. The method was based on defining a two-dimensional array to represent the relationship between project factors and the indicators (see Table 5-33). The focus group assessed the relationships according to the following three ratings (NCHRP 2015a):

- An indicator defined as "-" for a particular level of a project factor represents that, under this scenario, the consideration of this indicator in the project does not influence project success.
- An appropriate rating (+) indicates that the consideration of the indicator can be recommended taking into account the particular level of the project factor.
- This rating (++) indicates that, in the scenario defined according to the level of a project factor, the consideration of the specific indicator is strongly recommended.

In order to guide experts to perform this task correctly, they received the following information:

- Goal of the focus group.
- Definition of indicators.
- Definition of project factors and the levels of each project factor.
- Rating method to assess the relationships.
- Brief explanation about how to fill the two-dimensional array (Table 5-33).

Table 5-33: Two-dimensional array to assess the relationship between project factors and indicators

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€							
1,000,000€ - 10,000,000€							
< 1,000,000€							
Project complexity							
High							
Medium							
Low							
Social context							
Cultural environment							
High							
Medium							
Low							
Industry competence							
High							
Medium							
Low							
Territory							
High							
Medium							
Low							

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Finally, to guarantee the understanding of the experts, the final objective of the two-dimensional array was explained. This is important because the ratings defined in the two-dimensional array are crucial for the definition of the weights of each indicator. The reason is that, based on the specific characteristics of a project, the level of each project factor will be determined. The weight of each indicator will depend on the maximum rating that each indicator has obtained depending on the levels established for each project factor. This will be explained in-depth in the following section.

Once the two-dimensional array was defined by each member of the focus group, their assessments were compiled and the goal of the focus group meeting was discussing the different approaches of the experts until reaching consensus. Table 5-34 gathers the result of the focus group.

Table 5-34: Relationships between the indicators and each level of the projects factors

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

As can be seen, the level of importance of the indicators 'Cultural heritage appraisal and management plans' and 'Collaboration with cultural preservationists' is established mainly by the subfactor 'cultural environment'. Per CEEQUAL (2010), the rating increases with the risk of finding historic resources. However, if the risk of finding historic resources is low, a Cultural heritage appraisal and management plans will be required when both the level of complexity is high or medium and the contract size is over 1,000,000€. This is in line with Luo et al. (2017), who highlighted the importance of minimizing the uncertainties and risks that can appear in the project' development depending on project complexity. On the other hand, Collaboration with cultural preservationists will only be taken into account in procurement procedures when the level of the sub-factor cultural heritage is high or medium.

The industry competence sub-factor has a very important influence on the final rating of the indicator 'Industry participation plan'. In general, the rating of this indicator is '+', except when the industry competence is high. In this scenario, the indicator is highly recommended (++) regardless of the level of the contract size and the project complexity. However, although the level of competence is medium and high, when the complexity of the project is low or the contract size is over 10,000,000€, the inclusion of this indicator in the procurement procedure is highly recommended to offer the local industry chances to improve their level of competence. This result is associated with boosting local industry when the project characteristics are the most favorable. This is an important aspect, taking into account the role of local industry in the national economies (CEEQUAL 2010; European Commission 2010) and in developing the social value of construction projects (Burke and King 2015).

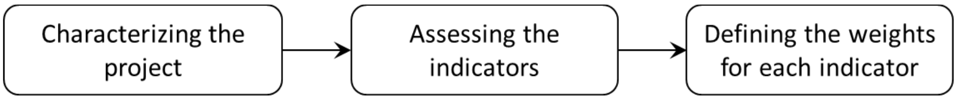
The indicators 'Workplace health and safety management plans' and 'Work health and safety management officer' obtained the same ratings. These indicators are highly recommended (++) when the project complexity is high or medium, and when the contract size is greater than 1,000,000€, being only recommended (+) in the other scenarios. However, when industry competence is low, regardless of the contract size or project complexity, the inclusion of these indicators will be highly recommended. Oswald et al. (2018) emphasized the risk of making the project dangerous when high participation of subcontractors and long supply chains exist in the project; and increasing with the lack of competence of the local companies.

Similarly to the two previous indicators, 'Community relations program' and 'Effects on neighbors' obtained the same ratings for each level. The importance of these indicators only depends on the sub-factor territory, and it is highly recommended when the level of this sub-factor is medium or high. This is motivated by the significant disturbances that civil engineering projects can cause to the existing communities and environment (Ugwu and Haupt 2007; Abdel-Raheem and Ramsbottom 2016).

Finally, an other fact to be highlighted is that, according to the ratings established by the focus group, the indicators 'Industry participation plan', 'Workplace health and safety management plans', 'Work health and safety management officer', 'Community relations program', and 'Effects on neighbors' will always be included in the procurement procedures, defining the level of importance depending on the different levels of the project factors; however, the indicator 'Cultural heritage appraisal and management plans' will be excluded from projects with budget under 1,000,000€, with low project complexity and low level in cultural environment. On the other hand, 'Collaboration with historical or cultural preservationists' will only be considered when the level of cultural heritage is medium or high.

5.4.2.3. Weighting methodology

To determine the weighting methodology, the following process has been defined: 1) characterizing the project; 2) assessing the indicators based on project factors; and, 3) defining the weights for each indicator (see Figure 5-35).



SOURCE: Own elaboration

Figure 5-35: Process to define the weights in social commitment in the project group (G3)

<u>1. Characterizing the project.</u>

Five project factors have been considered in the method (contract size, project complexity, cultural environment, industry competence, and territory), and each project factor has three possible levels (see section 5.4.2.1). Thus, for each specific project, the procurer has to identify the level associated with each project factor depending on the features of the project. Table 5-35 shows the project factors form used to determine the level for each project factor

Table 5-35: Project factors form

Project factors		Levels associated with the project		
Contract size		☐ > 10,000,000€	☐ 1,000,000€ - 10,000,000€	☐ < 1,000,000€
Project complexity		☐ High	☐ Medium	☐ Low
Social context	Cultural environment	☐ High	☐ Medium	☐ Low
	Industry competence	☐ High	☐ Medium	☐ Low
	Territory	☐ High	☐ Medium	☐ Low

SOURCE: Own elaboration

2. Assessing the indicators based on project factors

According to the levels identified by the procurer for each project factor, the ratings of each indicator can be extracted from the two-dimensional array. These ratings depict the importance of the indicators to ensure the correct development of the project. Thus, the maximum rating will be used to assess each indicator. The maximum rating for each indicator must be defined based on the most restrictive score obtained for each indicator.

3. Defining the weights for each indicator

To determine the weight of each indicator in a specific project, the maximum rating obtained for each indicator was converted into numerical scores:

- “-“represents a value of “0”, since this rating indicates that the use of this subcategory does not influence the project success.
- “+” represents a value of “1”. This score informs that the use of this category could be important for the project and, thus, it is recommended.
- “++” represents a value if “2”. Because this rating indicates the importance of the subcategory for the project.

Transforming the ratings extracted from the two-dimensional array to numerical values converts the level of importance of each indicator as to its proportional value with respect to the scoring results. Finally, the linear aggregation was the aggregation method used. This choice was based on the recommendations of Zhou et al. (2012) who highlighted the simplicity, transparency, and easy understanding of this aggregation method. Once the weights were defined, the composite indicator can be calculated for each construction company involved in the procurement procedure.

With the aim of achieving a complete understanding of the process to establish the weights in the social commitment with in the project group methodology, the following example is shown. Imagine that a procurer wants to bid the construction of the following project “Construction of a new road bridge”.

According to the established process, the first step focuses on characterizing the project based on the project factors form. Thus, the procurer has to select the level associated with each project factor. For this specific example, the result of the project factor form is shown in Table 5-36. The project has a budget between 1,000,000€ and 10,000,000€. This project is complex compared to the average of projects awarded by the procurer and, thus, the level of the project complexity is medium. The project is going to be developed in a region where there has been discovery of historic resources; thus, the level of the cultural environment sub-factor is medium. The level of competence of the local industry to perform the tasks required by the project is medium. And, finally, the construction process will produce important negative effects in the territory, assigning, thus, a high level to the territory sub-factor.

Table 5-36: Project factors form for the "CONSTRUCTION OF A NEW ROAD BRIDGE" project

Project factors		Levels associated with the project		
Contract size		☐ > 10,000,000€	☒ 1,000,000€ - 10,000,000€	☐ < 1,000,000€
Project complexity		☐ High	☒ Medium	☐ Low
Social context	Cultural environment	☐ High	☒ Medium	☐ Low
	Industry competence	☐ High	☒ Medium	☐ Low
	Territory	☒ High	☐ Medium	☐ Low

SOURCE: Own elaboration

Once the level of each project factor has been selected, in the second step, the procurer must extract the ratings for each indicator from the two-dimensional array where the relationship between indicators and project factors are established (Table 5-34). This information can be seen in Table 5-37.

Table 5-37: Ratings for each indicator in the "CONSTRUCTION OF A NEW ROAD BRIDGE" project

Project Factor and levels	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
Project complexity							
Medium	+	-	+	++	++	+	+
Social context							
Cultural environment							
Medium	+	+	-	-	-	-	-
Industry competence							
Medium	-	-	+	+	+	-	-
Territory							
High	-	-	-	-	-	++	++

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Finally, in the third step, the procurer must determine the weights. The maximum rating obtained for each indicator must be converted into numerical scores. All the indicators must be considered because the maximum ratings obtained are '+' or '++'. The maximum ratings are transformed to numerical values according to the following rules: '-' represents 0 points, the '+' is 1 point and '++' represents 2 points. This can be seen in the row named "Scoring results" in Table 5-38.

Table 5-38: Scoring results for each indicator in the project.

Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7
		Indicators						
Contract size		+	-	+	++	++	+	+
Project complexity		+	-	+	++	++	+	+
Social context	Cultural environment	+	+	-	-	-	-	-
	Industry competence	-	-	+	+	+	-	-
	Territory	-	-	-	-	-	++	++
Maximum rating		+	+	+	++	++	++	++
Scoring results		1	1	1	2	2	2	2

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Finally, the weight of each indicator is obtained by the proportion of the score of each indicator with respect to the total scoring results. Taking into account that the total score is 11 (1+1+1+2+2+2+2) for this project, the weights of P_1, P_2 and P_3 are 0.091 (1/11=0.091); and the weights of P_4, P_5, P_6 and P_7 are 0.182 (2/11=0.182) (Table 5-39).

Table 5-39: Weight of each indicator in the project.

Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
		Indicators							
Contract size		+	-	+	++	++	+	+	
Project complexity		+	-	+	++	++	+	+	
Social context	Cultural environment	+	-	-	-	-	-	-	
	Industry competence	-	+	+	+	-	-	-	
	Territory	-	-	-	-	++	++	++	
Maximum rating		+	+	+	++	++	++	++	**Total**
Scoring results		1	1	1	2	2	2	2	11
Weights		0.091	0.091	0.091	0.182	0.182	0.182	0.182	1

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

5.4.2.4. Sensitivity analysis

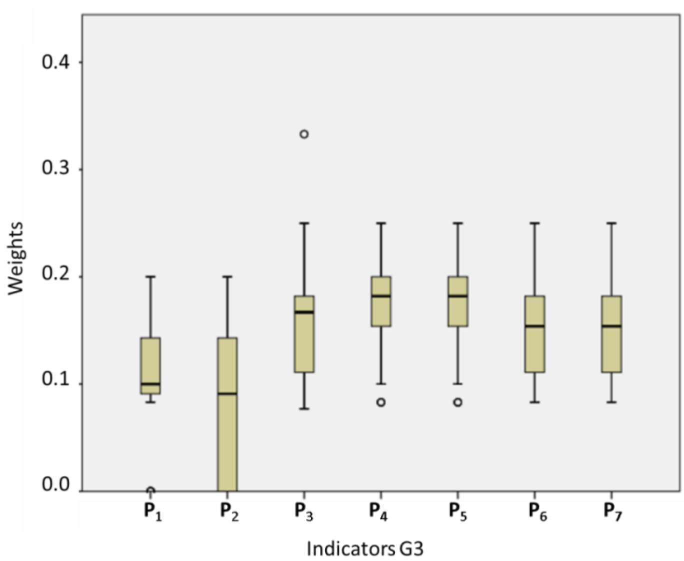
As for social commitment in the project group (G3), the goal of its composite indicator is assessing objectively the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of a specific project. Based on this objective, indicators and weights have been defined in previous sections. However, two requirements were established in the methodological approach (chapter 3):

1. The definition of each indicator must adapt to the characteristics of the project that is going to be procured.

2. The level of importance of each indicator (its weight) must be defined depending on the characteristics of the project that is going to be procured.

The first requirement has been satisfied by the definition of the indicators, and the weighting methodology has been established to satisfy the second requirement. To verify if the weights are able to be adjusted for each specific project, a sensitivity analysis was required.

The aim of the sensitivity analysis was assessing how the weights vary for each indicator depending on the project characteristics. Therefore, to carry out this analysis, the objective was analyzing all the possible projects that can be defined as the combination of the different levels defined for each project factor. As five project factors have been defined to characterize the project, and each project factor has 3 levels, if these are combined, 243 (3^5) projects can be defined. Figure 5-36 shows the variability of the weights for each indicator taking into account the 243 possible projects. These results depend on the level of importance that each indicator receives depending on the project characteristics. Consequently, Figure 5-36 is the result of the combination of the rows of table 5-34 for each one of the 243 defined projects.



Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-36: Variability of the weight of each indicator in the 243 scenarios

As can be seen, the weights associated with the indicators P_1 (cultural heritage appraisal and management plans) and P_2 (collaboration with cultural preservationists) are the only indicators that received values equal to zero for some of the 243 analyzed projects. The reason for these results lies in the fact that the indicators P_1 and P_2 are assessed as not recommendable (-) when there is not a risk to damage historical resources, the contract size is lower than 1,000,000€, and the project complexity is low (see Table 5-34). Thus, depending on the features of each project, the weights of these indicators can vary from zero to 0.2. However, the rest of the indicators: P_3 (industry participation plan), P_4 (workplace health and safety management plans), P_5 (work health and safety management officer), P_6 (community relations program), and P_7 (effects on neighbors), were considered in every project scenario since these did not receive weights equal to zero for any project because these indicators did not obtain a score of '-' for any level of project factors in the two-dimensional array (Table 5-34), always guaranteeing their consideration, with weights between 0.09 and 0.25.

To achieve a comprehensive understanding, four scenarios were analyzed. As the maximum variability corresponds to the indicators P_1 (cultural heritage appraisal and management plans) and P_2 (collaboration with cultural preservationists), the influence of these indicators over the global distribution of weights was studied to analyze the sensitivity of the method. The scenarios were:

- Scenario 1: when both P_1 and P_2 are assessed as not recommended (-).
- Scenario 2: when the risk of damaging historical resources is low and, thus, it is not necessary to require a cultural preservationists in the project (P_2); however, because of the complexity of the project or the contract size, the definition of a cultural heritage appraisal and management plans (P_1) is required.
- Scenario 3: when the risk of damaging cultural resources is medium, and both P_1 and P_2 are assessed as recommended (+).
- Scenario 4: when the risk of damaging cultural resources is high, and both P_1 and P_2 are assessed as highly recommended (++).

Each scenario was analyzed independently. Figures 5-22, 5-23, 5-24 and 5-25 show the variation of the weights, taking into account the characteristics of the projects associated with each of these scenarios. This is discussed in detail below.

- Scenario 1: When both P_1 and P_2 are assessed as not recommended (-)

Table 5-40 shows the relationships between the indicators and each level of the projects factors. As the weight of each indicator depends on their maximum rating, within this scenario, only rows highlighted in yellow are considered. In these rows, P_1 and P_2 are assessed as not recommended. When indicators P_1 and P_2 are not recommended when the risk of damaging cultural resources is low, the project complexity is low and the contract size is less than 1,000,000€.

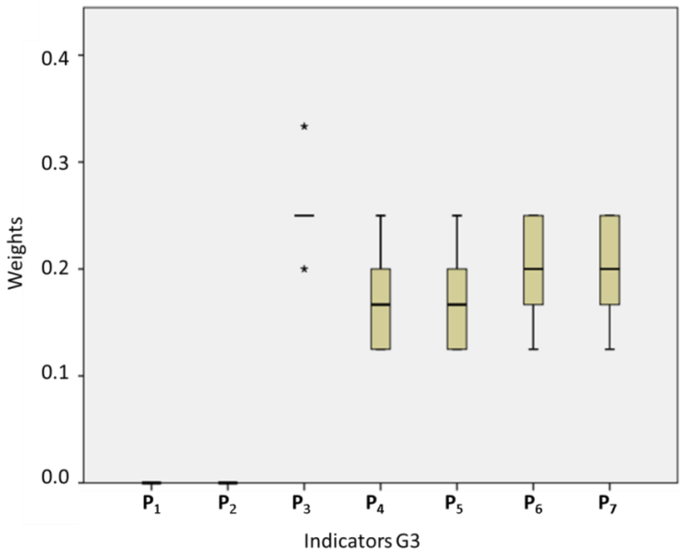
Table 5-40: Relationships between the indicators and the levels of the projects factors in scenario 1

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-37 shows the variability of the weights of each indicator considering the projects in Scenario 1. These projects result from combining the rows highlighted in yellow in Table 5-40. In these projects, the industry participation plan (P_3) is highly recommended (++); therefore, three possible weights can be assigned to P_3 depending on the levels of the project factors 'industry competence' and 'territory'. The indicator P_3 receives the maximum weight (33%) when the affection over the territory is low and the competence of the industry is high or medium and (P_4 and P_5 are only recommended). Consequently, in this scenario, the biggest efforts can focus on encouraging industrial participation in the project. On the other hand, the minimum weight that the indicator 'industry participation plan' (P_3) may obtain in this group of scenarios (20%) is when the level of competence of the industry is low and, thus, the inclusion of indicators related to health and safety issues (P_4 and P_5) are highly recommended and, the affection over the territory is medium or high.



Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-37: Distribution of weights in scenario 1 (both P_1 and P_2 are not recommended)

- Scenario 2: P_1 is recommended (+) and P_2 is not recommended (-)

Table 5-41 gathers the relationships between the indicators and each level of the projects factors. As the weight of each indicator depends on their maximum rating, within this scenario, only rows highlighted in yellow are considered.

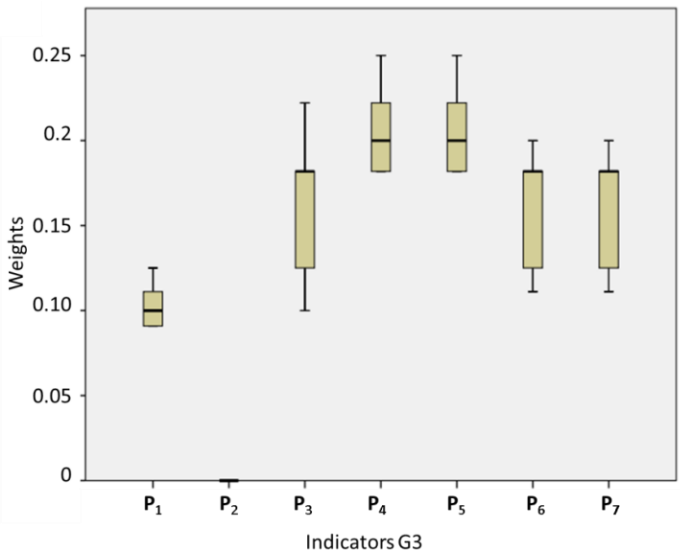
The indicator P_1 is recommended (+) and P_2 is not recommended (-) when the cultural environment is low, the project complexity is medium or high, and the contract size is over 1,000,000€. Figure 5-38 shows the variability of the weights of each indicator, considering the projects in Scenario 2. These projects result from combining the rows highlighted in yellow in Table 5-41. As can be seen, the indicators P_4 and P_5 usually obtain the maximum weights (from 18% to 25%). This is because, in the projects associated with Scenario 2, the indicators P_4 (Workplace health and safety management plans) and P_5 (Work health and safety management officer) are always highly recommended. On the other hand, the weights of the indicators P_3, P_6 and P_7 vary from 10% to 22% depending on the combination of the project factors.

Table 5-41: Relationships between the indicators and the levels of the projects factors in scenario 2

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration



Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-38: Distribution of weights in scenario 2 (P_1 is recommended and P_2 is not recommended)

- Scenario 3: When both P_1 and P_2 are recommended (+)

Table 5-42 gathers the relationships between the indicators and each level of the projects factors. As the weight of each indicator depends on their maximum rating, within this scenario, only rows highlighted in yellow are considered. This scenario gathers all the possible levels for each project factor, except for cultural environment, which includes only the medium level.

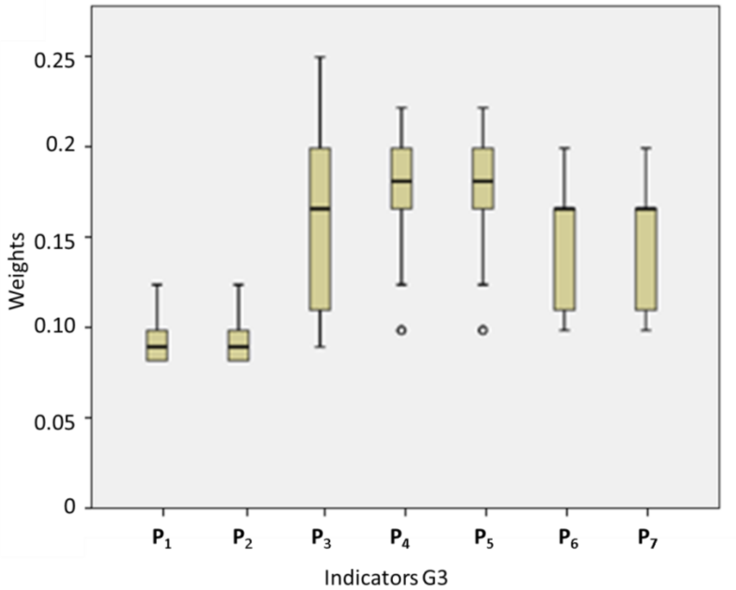
Table 5-42: Relationships between the indicators and the levels of the projects factors in scenario 3

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-39 shows the variability of the weights of each indicator considering the projects in Scenario 3. These projects result from combining the rows highlighted in yellow in Table 5-42. The wide variability that can be seen in Figure 5-39 with respect to the weights of the indicators P_3, P_4, or P_5 is motivated by all possible combinations of the project factors' levels since. In this regard, for example, the maximum values of the indicator P_3, will be achieved when the project complexity is low, with contract size below 1,000,000€, industry competence medium or high and territory factor low. In these combinations, the ratings of P_1, P_2, P_4, P_5, P_6, and P_7 are recommended ('+'), and the rating of P_3 is highly recommended ('++'). Therefore, the weight of P_3 is 0.25, and the weight of the rest of the indicators is 0.125. Contrarily, when the contract size is between 1,000,000€ and 10,000,000€, the project complexity is medium or high, the industry competence is low and the territory is high or medium, P_1, P_2, and P_3 are recommended ('+'), and P_4, P_5, P_6, and P_7 are highly recommended ('++'). In this scenario, P_3 obtains the minimum weight 0.09, together with P_1 and P_2. However, P_4, P_5, P_6, and P_7 obtain weights equal to 0.18.



Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-39: Distribution of weights in scenario 3 (both P_1 and P_2 are recommended)

- Scenario 4: When both P_1 and P_2 are highly recommended (++)

Table 5-43 shows the relationships between the indicators and each level of the projects factors. As the weight of each indicator depends on their maximum rating, within this scenario, only rows highlighted in yellow are considered. This scenario gathers all the possible levels for each project factor, except for cultural environment, which includes only the high level.

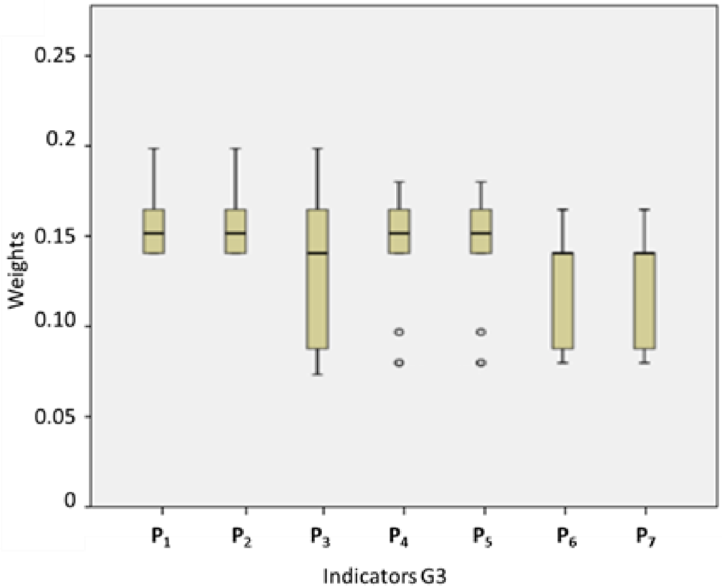
Figure 5-40 shows the variability of the weights of each indicator considering the projects in Scenario 4. These projects result from combining the rows highlighted in yellow in Table 5-43. Similar to the previous scenario, a broad variability exist for each indicator, motivated by all possible combinations of the project factors' levels. The indicator P_3 achieves its maximum value when its rating is '++', and P_4, P_5, P_6, and P_7 are only recommended ('+'). This is satisfied when industry competence is high, the contract size is below 1,000,000€, project complexity is low, and the territory factor is low. However, the weight of P_3 is reduced when its rating is '+' and/or the ratings of P_4, P_5, P_6, and P_7 change to highly recommended ('++') depending on the project characteristics.

Table 5-43: Relationships between the indicators and the levels of the projects factors in scenario 4

Project Factor	P_1	P_2	P_3	P_4	P_5	P_6	P_7
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration



Note: P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors

SOURCE: Own elaboration

Figure 5-40: Distribution of weights in scenario 4 (both P1 and P2 are highly recommended)

Therefore, the sensitivity analysis demonstrates the suitability of the weighting methodology, as it is able to assign the weights of each indicator depending on the project characteristics, while it guarantees a minimum weight for each indicator depending on the relationships, established by the focus group, between the project factors and the indicators in the two-dimensional array.

5.5. Chapter summary

In this chapter, three methodological approaches have been defined to include the groups of social criteria in the procurement procedures of civil engineering construction projects. The method established to implement the human rights group (G1) was based on the inclusion grounds for exclusion in every procurement procedure to ensure that every construction company who is involved in the procedure knows and complies with these criteria. Regarding corporate social responsibility group (G2) and social commitment in the project group (G3), two composite indicators have been defined. The goal of the G2's composite indicator was based on assessing the corporate social features of each construction company that participates in the tendering procedure. On the other hand, the aim of the G3's composite indicator was assessing objectively the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of the project. To establish both composite indicators, the indicators and the method to assign the weight to each indicator have been defined.

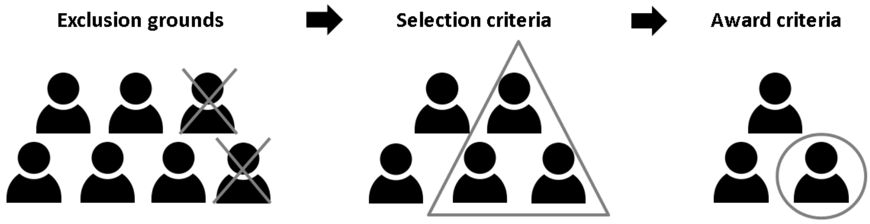
CHAPTER 6

PRACTICAL GUIDE TO INCLUDE SOCIAL SUSTAINABILITY CRITERIA IN PUBLIC-WORKS PROCUREMENT

This chapter presents a practical guide to assist agencies in including, in a comprehensive and effective way, social criteria in public work procurement. This guide establishes the social criteria that should be considered in the procurement procedure of civil engineering projects at the construction phase of the infrastructure life cycle and defines where and how these should be included in bidding specifications to guarantee their objective assessment.

6.1. Summary of key concepts

In public-works procurement, the low bid and the best value are the two main procurement procedures (Molenaar and Johnson 2003; European Commission 2018). The **low bid** is used when aiming to maximize savings, whereas the **best value** is usually proposed for complex projects, in which the expertise of the construction company, among other aspects, is key to guarantee the project success (Ballesteros-Pérez et al. 2016). In both procurement procedures three types of assessment criteria can be used to choose the winning tender: (a) **exclusion grounds**, used to exclude unsuitable bidders from the procurement procedure; (b) **selection criteria**, to determine the suitability of tenderers to carry out the contract; and, (c) **award criteria**, to determine which tenderer has developed the most economically advantageous proposal that delivers the expected results and should, therefore, be awarded the contract. Figure 6-1 has been extracted from the European Commission (2018), and it represents the sequence of steps associated with these assessment criteria.



SOURCE: European Commission (2018)

Figure 6-1: Sequence of steps to award a contract.

- Exclusion grounds are the criteria whose aim is to prevent certain categories of companies from participating in award procedures to begin with (Kiiver and Kodym 2014). An example of exclusion ground could be the exclusion from the procurement procedure the firms that infringe or have infringed the law or who have demonstrated highly reprehensible professional behavior (European Commission 2018). These type of criteria are generally imposed by law (Kiiver and Kodym 2014).
- Selection criteria are defined to identify the companies qualified to carry out the contract (European Commission 2018). Article 58 of the 2014 EU Public Procurement Directive (2014/25/EU) establishes three types of selection criteria regarding companies: (1) to assess if the firms possess the necessary licenses to carry out the works; (2) to evaluate their economic and financial standing; and (3) to analyze their technical and professional ability.
- Award criteria are defined to award the contract to the company that offers the most economically advantageous tender. The application of these criteria depends on the procurement procedure (European Commission 2018):

    - In the low bid procurement procedure, approaches based on price only or cost only use solely cost parameters to choose the best tender. Thus, the tender with the low bid or the lowest cost wins the contract.
    - In the best value procurement procedure, the approach is based on the best price-quality ratio. The purpose of the best price-quality ratio is identifying the tender that offers the best value for money. It must be assessed on the basis of criteria linked to the subject matter of the public contract in question.

Different parameters to assess the bidders can be considered in each one of these assessment criteria. Several studies have analyzed the parameters which are usually included in construction industry procurement procedures (Xia et al. 2014a). In this regard, the report “Best-Value Procurement Methods for Highway Construction Projects” prepared by the Transportation Research Board (NCHRP 2006) defined the most comprehensive classification, establishing the following five groups of parameters:

- Cost parameter generally are based on the definition of the initial capital costs of the construction project, or the requirement of the life-cycle costs incurred, after the construction is complete (Furuta et al. 2011; Xia et al. 2014b). NCHRP (2006) claimed that the great advantage of these types of parameters is their inherent objectivity. However, regarding the life-cycle cost parameter, although it permits a comparison of the long-term advantages of competing proposals

(Whang and Kim 2015), the difficulty in using this type of parameter is that their use could result in relatively weak economic analyses (NCHRP 2006).

- Time parameter are mainly based on the definition of a scheduling system by the contractor (Xia et al. 2014b). The major advantage of this type of parameter is allowing the contractor to establish a schedule that is complementary to the plan for executing the construction (NCHRP 2006). A way to analyze this type of parameters objectively is through an assessment based on cost by converting a time saving to user delay cost (Xia et al. 2014b).
- Qualification parameter focus on assessing the bidders depending on their technical skills and experience to produce a high-quality product (NCHRP 2006). Past performance and experience criteria are generally used to determine whether a contractor is qualified to bid (Xia et al. 2012b). The inclusion of this type of parameter in the procurement procedures must be justifiable and defensible.
- Quality parameter seek to review and rate contractor quality management plans before the contract is awarded (NCHRP 2006). This type of parameters can be based on warranties or performance-based acceptance indicators, creating a situation where delivering quality can be an important factor for the project (Xia et al. 2014b).
- Design alternate parameter are referred to the requirement of design criteria. Although, depending on the project delivery, the requirement of design alternates can have disadvantages related to the design liability considerations. The use of this type of parameters provides the opportunity to request solutions for specific design problems, better materials or more efficient construction processes (NCHRP 2006).

These parameters are responsible for adding value to a project, and their use must be justified (Molenaar et al. 2010). These can be mixed and matched to create procurement procedures depending on the different types of assessment criteria to be considered (European Commission 2018). In this regard, through a specific evaluation and award plan defined for each project, the specifications referred to the rating and/or scoring systems to assess these assessment criteria in the procedure are established. Additionally, the project screening system for selecting the candidates and awarding the project to the best-performing contractors is defined(NCHRP 2006).

6.2. Introduction

6.2.1. What is the purpose of this guide?

This guide aims to establish a method for inclusion and assessment of social criteria in the procurement procedure using a systematic and objective process. It defines a flexible framework that can be tailored to the traditional procurement processes in different countries, and it can be applied to both the low bid and the best value procurement procedures.

6.2.2. Who is this guide for?

This guidance is aimed primarily at procurers within contracting authorities who are responsible for planning and delivering the purchase of public works.

6.2.3. What is the scope of this guide?

This guide has been defined to include social criteria in public procurement of civil engineering construction projects. The methodology defined to include the social criteria in public-works procurement is valid to be implemented in any country. However, the focus of this guide is showing how social criteria should be included by contracting authorities in public-works procurement within the European Union.

It is important to highlight that, to seek a high degree of flexibility that allows adapting the different methodologies to the constraints associated with the different procurement regulations of each country, the evaluation and award plan is not going to be addressed in this practical guide. The reason is based on the fact that the evaluation and award plan must be defined by each public procurement agency, depending on the choice of the procedure (open, restricted, negotiated, etc.) and their particular priorities with respect to the different parameters to be considered in the procurement procedure. These decisions are crucial to avoid reducing the effectiveness of the project delivery system and ensuring the success of each specific project (NCHRP 2006). Thus, the decision-making concerning the different parameters that must be used in the procurement procedure (cost, time, qualification, quality, and design alternate) and how these parameters should be mixed and matched with the social criteria within the procurement procedure, are not within the aim of this practical guide.

6.2.4. How to use this guide

This practical guide has three main sections. First, the groups of social criteria that should be included in public-works procurement are presented, and the methodology to assess each group in the procurement procedure is established. Second, recommendations on how to include them in public-works procurement are explained. This section seeks to help the procurers in terms of where to include the social criteria depending on the procurement procedure, and how to include them in bidding specifications. Finally, guidance on how to assess the social criteria in public-works procurement is defined. The steps to assist the procurers in these tasks have been determined and forms to guide in the process have been included in the Appendices.

6.3. Social criteria to be included in public-works procurement

Currently, the lack of knowledge about the social criteria that must be included in public-works procurement or the lack of objective methods to assess and monitor these social criteria are hindering the effective and efficient implementation of social sustainability criteria in public-works procurement. Thus, the purpose of this section is establishing the social criteria that should be included in public procurement of civil engineering construction projects and defining the method to assess them in the procurement procedure.

6.3.1. Current scenario of social criteria in public procurement

Recently, public procurement has started to cover additional policy goals such as environmental and social sustainability inclusion and the promotion of innovation. The parameters to assess the bidders have been adapted to this trend towards more sustainable solutions. This way, regarding social sustainability:

- Qualification parameters, which focus on assessing the experience of the firms, can include requirements associated with social certification or other equivalent forms of confirmation of social characteristics such as social labels (Kiiver and Kodym 2014; European Commission 2018). Social labels can be used to assess the social performance of companies, individual goods, services or works, ensuring assessment methods based on verifiability, transparency, and independence (IHRB 2015). On the other hand, within qualification parameters, aspects related to increasing the importance of small business participation to influence the contractor's subcontracting plan, or assessing the safety record of the contract can be considered (NCHRP 2006).
- Quality parameters can specify aspects related to social standards or the use of social-labels products (Kiiver and Kodym 2014; IHRB 2015).
- Design alternates parameters can include aspects related to cultural sensitivity or the effect on neighbors (NCHRP 2006).

On the other hand, regarding the inclusion of social sustainability in each type of criteria, Kiiver and Kodym (2014), IHRB (2015), and the European Commission (2018) highlighted the importance of the exclusion grounds to ensure the fulfillment of human rights by the companies interested in participating in the process. Additionally, the European Commission (2018) remarked that mandatory exclusion grounds must be applied by all contracting authorities in the European Union to exclude those firms that are convicted of legal offenses such as participation in a criminal organization, corruption, terrorism, and child labor or human trafficking. In addition, companies which have not properly paid taxes and social security contributions or do not comply with social labor law in their member state must also be excluded from any procurement procedure.

Regarding the definition of selection criteria, the European Union establishes that this type of criteria can be related to the bidder at a company-wide level (Cravero 2017). Qualification parameters are generally used as selection criteria in public procurement procedures. In this regard, parameters related to the safety record of the bidder, or the proposal regarding small business participation in the project are commonly used as selection criteria in the USA public procurement processes (NCHRP 2006). Table 6-1 sets out the most commonly used social criteria for the selection of contractors acceptable to the contracting authority including criteria related to social sustainability as selection criteria.

Table 6-1: Examples of social selection criteria

Selection criteria
Percentage of permanent employees in the company
Percentage of permanent employees during the contract
Percentage of disabled employees in the company
Percentage of women employees in the company
Percentage of women employees in the project
Preference for companies focused on promoting labor insertion of people at risk of social exclusion
Recruitment goals at non-employed people
Employment opportunities that will be created during the contract
The number of apprentice/trainee positions that will be created during the contract
Workplace health and safety management system
Occupational health and safety certification
Results of safety statistics in the company
Construction safety plan
Health and safety management officer at the construction site during the execution of work
Indigenous development plan
Aboriginal participation in the project
Construction community and stakeholder engagement plan
Traffic management plan
Employees training management plan in the company
Industry participation plan
Promoting supply-chain opportunities to new and small businesses
Implementing research and innovation solutions in the project
Research and innovation projects performed by the company

SOURCE: Own elaboration

Regarding award criteria, the 2014 EU Public Procurement directives explicitly state that quality parameters and design alternative parameters can include social aspects in order to promote a broader policy goal. In line with this, Kiiver and Kodym (2014) emphasized that, according to these directives, aspects related to the hiring by the contractor of long-term unemployed persons, female or disabled people can be perfectly legitimate award criteria, and IHRB (2015) claimed the use of social labels within this type of criteria. However, IHRB (2015) and Kiiver and Kodym (2014), both focused on the interpretation of the 2014 EU Public Procurement Directives, defining different perspectives. On the one hand, IHRB (2015) stated that award criteria should be linked to the subject matter of the contract for European members; thus, the social aspects need to be referred to the performance of companies in the contract or individual goods, services or works in the contract. However, Kiiver and Kodym (2014) established that social criteria do not need to be referred to the contract, and what it is imperative is the verifiability of the quality parameters to use as award criteria and the importance of including award criteria associated with actual needs in the country. Table 6-2 lists the social criteria that are usually used as award criteria.

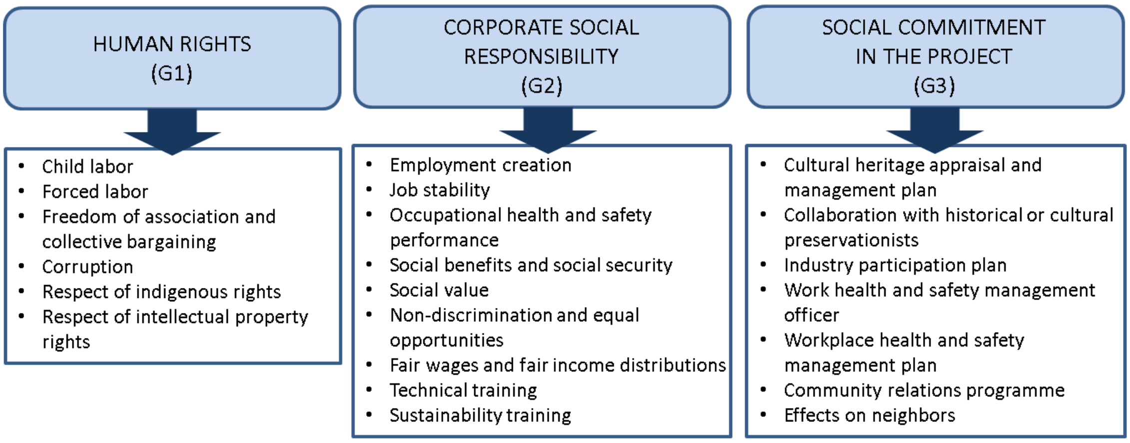
Table 6-2: Examples of social award criteria

Award criteria
Enterprise social responsibility
Social value on similar projects
Local employment in the project
Regional companies preference
Enhancement of industry and business capability in the project
Percentage of local products, services and contractors in the project
Level of usage of apprentices and trainees in carrying out the works
Occupational health and safety management systems
Occupational health and safety certification
Safe and fair workplace record in the company
Health & safety and risk management
Construction safety plan
Indigenous opportunities in the project
Aboriginal participation in construction
Construction community and stakeholder engagement plan
Company’s approach to supporting and being involved in Community
Traffic management and diversions
Traffic and pedestrian management
Resident satisfaction
Community benefit outcomes
Skills and training development details in the company
Training program in the contract
Staff competence, equality and diversity training in the project
Industry participation plan
Industrial relations management plan
Subcontracting proposal
Implementing research and innovation solutions in the project
Research and innovation projects performed by the company
Innovation management system

SOURCE: Own elaboration

6.3.2. Social criteria that should be included in public-works procurement

Three groups of social criteria have been defined for inclusion in public-works procurement of civil engineering projects during the construction phase of the infrastructure life cycle: (1) human rights group (G1); (2) corporate social responsibility group (G2); and, (3) social commitment in the project group (G3) (see Figure 6-2).



SOURCE: Own elaboration

Figure 6-2: Groups of social criteria to include in public-works procurement

- <u>Human rights (G1):</u>
  This group gathers those criteria related to human rights: child labor, forced labor, freedom of association and collective bargaining, corruption, respect of indigenous rights, and respect of intellectual property rights.

- <u>Corporate social responsibility (G2):</u>
  This group gathers the social criteria that, being defined at the company level, are able to assess the corporate social responsibility linked to its social daily performance. These criteria are employment creation, job stability, occupational health and safety performance, social benefits and social security, social value, non-discrimination and equal opportunities, fair wages and fair income distributions, technical training, and sustainability training. Additionally, these criteria are divided into subcategories (see Table 6-3).

Table 6-3: Subcategory of each criterion in corporate social responsibility group

Criteria	Subcategories
Employment creation	Employment opportunities
Job stability	Employee turnover
	Quality employment
Social benefits and social security	Benefits
	Parental leave
Occupational health and safety performance	Health and safety training
	Health and safety management
	Work-related injuries
	Occupational diseases
	Absence rate
Social Value	Corporate citizenship
Non-discrimination and equal opportunities.	Diversity of governance bodies
	Diversity of employees
	Ratio of basic salary and remuneration of women to men
Fair wages and fair income distributions	Fair income distribution
Technical training	Expenditure on education and training
Sustainability training	Employee training on human rights policies or procedures
	Technology and Human Resource Development

SOURCE: Own elaboration

- Social commitment in the project (G3):

  This group includes those social criteria whose definition must be based on the project characteristics and, thus, linked to the project. These criteria are cultural heritage appraisal and management plan, collaboration with cultural preservationists, industry participation plan, work health and safety management officer, workplace health and safety management plan, community relations program, and effects on neighbors.

6.3.3. Methodologies to assess the social criteria in public-works procurement

This section presents the methods to assess the three groups of social criteria in public-works procurement of civil engineering projects during the construction phase of the infrastructure life cycle. The method associated with the human rights group (G1) and the social commitment of construction companies in the project group (G3) can be implemented in any country. The method associated with the corporate social responsibility group (G2) is fitted only for European countries. A brief description to implement it in non-European countries has been presented in Appendix V.

To assess these three groups of social criteria, a specific methodology was defined for each group to achieve their specific goals.

- Human rights (G1)

The goal of the methodology is guaranteeing that every procurement procedure considers the requirements related to the human rights criteria, and ensures that every construction company who is involved in the process knows and complies with each one of these. Therefore, to assess this group of criteria, a signed Human Rights

Declaration should be submitted by each offeror to be declared suitable for assessment.

- Corporate social responsibility (G2)

This methodological approach was based on assessing the corporate social features of each company that participates in the tendering procedure, focusing on the entire company in the country where the project is procured. The reason was based on the fact that analyzing only the company linked to the project could imply a significant bias, because of the social performance of the company in the project does not have necessarily to be the social performance in the whole company. According to this approach, the composite indicator '$\mathrm{CI}_{\mathrm{G2}}$', defined in Equation 6-1, was set to assess the corporate social responsibility of the construction companies in the procurement procedure.

$$CI_{G2\ jc} = \sum_{i=1}^{n} I'_{ij} \cdot w_{ic} \qquad \text{(6-1)}$$

Where:

- I'_{ij}: Normalized values of each company indicator (i) associated with each construction company (j) involved in the procurement procedure.
- w_{ic}: Weight assigned to each company indicator (i) in a specific country (c).

Depending on the corporate social responsibility of each company, the result of this composite indicator ($\mathrm{CI}_{\mathrm{G2}}$) varies from zero to one. This is formed by the summation of sixteen weighted company indicators:

- I'_1: New staff hiring
- I'_2: Temporary contracts
- I'_3: Employee turnover
- I'_4: Benefits
- I'_5: Chronic disease
- I'_6: Fatal accidents at work
- I'_7: Non-fatal injuries at work
- I'_8: Social value
- I'_9: Female labor force participation
- I'_{10}: Wage gap
- I'_{11}: Women in executive management positions
- I'_{12}: Disabled
- I'_{13}: Salary distribution
- I'_{14}: Technical training
- I'_{15}: Social ethics, social awareness, and human rights
- I'_{16}: Research and development

The weight of each company indicator (w_{ic}) is defined for each European country (c) with the aim of minimizing the social weaknesses that exist in each country. With this purpose, the maximum weights in the composite indicator are given to the company indicators that represent the worst social performance in the country. Under this approach, on the one hand, decision-makers will be able to measure the real social progress of the construction companies, avoiding the bias that may exist if only the company in the project is analyzed; and, on the other hand, the direction of change on social sustainability in the construction industry at the national level could be assessed, identifying whether the construction industry is meeting the goal of social responsibility.

- Social commitment in the project (G3)

The aim of this group is assessing objectively the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of the project. According to this approach, the composite indicator 'CI_{G3}', defined in Equation 6-2, was established to undertake this assessment.

$$CI_{G3\,j} = \sum_{i=1}^{m} P_{ij} \cdot W_i \qquad (6\text{-}2)$$

Where:

- P_{ij}: Value of each indicator (i) associated with each construction company (j) involved in the procurement procedure.
- W_i: Weight assigned to each indicator (i) in each specific project.

Depending on the social commitment of each company in the project, the result of this composite indicator varies from 0 to 1. This is formed by the addition of seven weighted indicators:

- P_1: Cultural heritage appraisal and management plan
- P_2: Collaboration with cultural preservationists
- P_3: Industry participation plan
- P_4: Work health and safety management officer
- P_5: Workplace health and safety management plan
- P_6: Community relations program
- P_7: Effects on neighbors

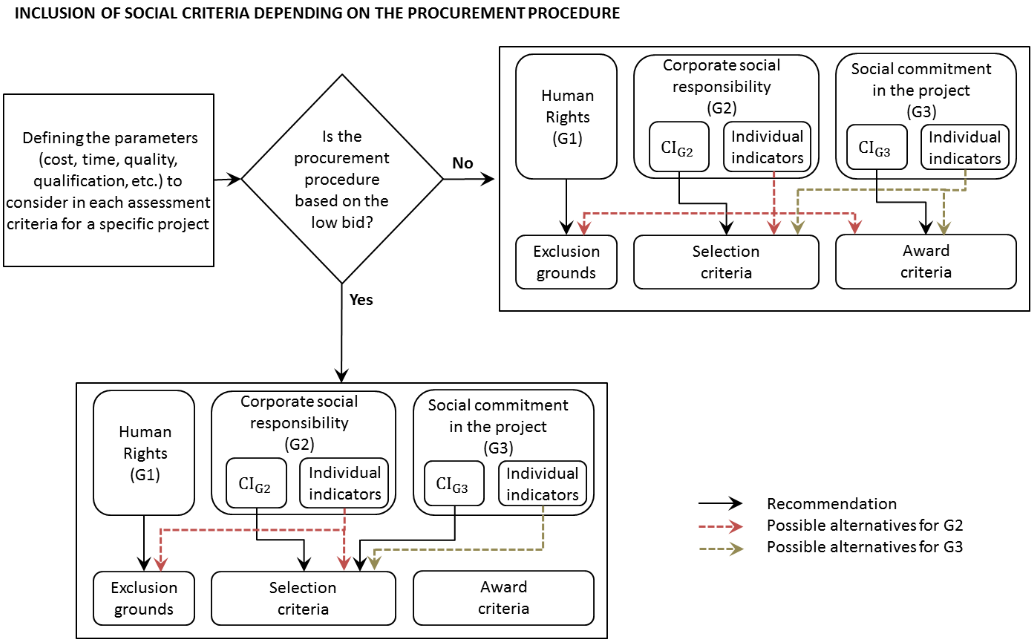
The indicators have been defined to be directly linked to the subject matter of the project. Additionally, the allocation of weights to each indicator in the composite indicator depends on the characteristics of each specific project. Under this approach, the indicators and the level of importance of these indicators (weights) are defined, seeking to satisfy the social needs and priorities associated with each specific project; and the procurer can establish the requirements in the procurement procedure allowing the companies interested in the project to appropriately account for cost, risks or staffing requirements, depending on the level of social commitment that these want to take on.

6.4. Guidance on how to include the social criteria in bidding specifications

This section seeks to guide procurers regarding where to include each group of social criteria in public-works procurement, depending on the procurement procedure; and assist in the process that the agency has to perform to define the social criteria in bidding specifications. At the end of this section, an application example is shown.

6.4.1. Where to include the social criteria in public-works procurement

Social criteria in public-works procurement can be considered as grounds for exclusion, selection criteria and award criteria, depending on two main constraints: (1) the procurement procedure (best-value or low bid); and, (2) national, regional or local policies, and requirements established by law. Figure 6-3 displays the decision making flow chart to determine how to include the social criteria, depending on the procurement procedure. Additionally, in Figure 6-3, red and brown arrows highlight different ways to incorporate the groups of social criteria depending on existing policies or requirements established by law.



SOURCE: Own elaboration

Figure 6-3: Flow-chart to include the groups of social criteria within the assessment criteria depending on the procurement procedure

Recommendations to include the three groups of social criteria in public-works procurement are defined as follows.

- Human rights (G1)

Contracting authorities must exclude all the companies that infringe or have infringed on the law or that have demonstrated highly reprehensible professional behavior from the procurement procedure. The legislation of each country defines exclusion grounds that are either mandatory or left to the discretion of contracting authorities. Therefore, the human rights criteria should be included in the procurement procedure, being added to the exclusion grounds established in each country, state, or region.

- Corporate social responsibility (G2)

The company indicators defined to evaluate these groups of criteria have been established to assess each company, taking into account the social performance of the entire company in the country where the project is procured. To include this group of social criteria in the procurement procedure under this approach, the composite indicator 'CI_{G2}' should be included as selection criteria regardless of the procurement procedure (best value or low bid). In both best value and low bid procurement procedures, the composite indicator must be used within a screening system in the selection criteria, selecting those candidates with the maximum corporate social responsibility, in two-step processes, or with a minimum corporate social responsibility depending on the minimum threshold established by the procurer for this composite indicator, in one-step processes.

However, it is common knowledge that the inclusion of social criteria in public procurement can strongly depend on national, regional or local policies, or on the requirements established by law. Therefore, to satisfy these requirements, the agency could need to include some of the sixteen company indicators separately as:

- Grounds for exclusion, if some of the company indicators are required by law. In this case, these indicators should also be included as exclusion ground. The minimum threshold that the construction company would have to satisfy for each indicator should be defined according to the requirements established by law.
- Selection criteria, if the procurer wants to enforce the consideration of some of the company indicators. In this case, in addition to the G2's composite indicator, some of them could also be considered as selection criteria separately, and the minimum threshold of each indicator should be defined by the agency depending on national, regional or local policies, or specific social needs associated with the project.

- Social commitment in the project (G3)

The indicators have been defined to be directly linked to the subject matter of the project. Based on this, the composite indicator 'CI_{G3}' should be included as one of the award criteria in best-value procurement procedures. On the other hand, in low bid procurement procedures, the price is the only award criteria; thus, when the project is awarded under this type of procurement procedure, the recommendation is to include the composite indicator within the selection criteria. In the selection criteria phase, the composite indicator should be included conjoint to the other parameters considered by the public agency as necessary, such as qualification and/or quality parameters, among others.

However, the inclusion of these social criteria in public procurement can also strongly depend on national, regional, or local policies or the requirements established by law. Therefore, to satisfy these requirements, the agency could include some of the seven indicators of social commitment in project group (G3) separately. These may be included as selection criteria or award criteria, depending on the preferences of the agency and the selected procurement procedure.

6.4.2. How to include the social criteria in bidding specifications

Recommendations about how to include the social criteria in bidding specifications are exposed for each group of social criteria as follows.

- Human rights (G1)

To include the human rights group as ground for exclusion, the procurer shall require construction companies interested in participating in the procedure to submit a signed Human Rights Declaration. The goal is to guarantee that offerors are suitable for assessment only if they declare to know and fulfill human rights. The following wording has been defined as part of the human rights declaration. This wording should be adapted, modified, and supplemented with local, regional, and national procurement regulations as may be applicable.

"The company declares its awareness that companies who have been convicted of one of the following legal offenses must be excluded from any procurement procedure: participation in a criminal organization; corruption; fraud; terrorism; money laundering; child labor or human trafficking. In addition, companies have not properly paid taxes and social security contributions in their Member State must also be excluded from any procurement procedure. Where the period of exclusion was not set in a final judgment, the period of exclusion cannot exceed 'x' years from the date of the conviction."

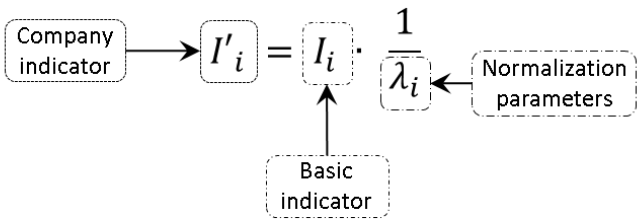
"The company declares its awareness with all present and future provisions which are established in labor legislation, social security, workplace health and safety, intellectual, industrial and commercial property, protection of the national industry, corruption, etc."

"The company declares its awareness that the contracted company acquires, during the contract, the obligation to guarantee the respect of basic labor rights throughout the production chain. Being mandatory to comply with the fundamental conventions of the International Labor Organization, especially those focused on freedom of association and collective bargaining, the elimination of forced or compulsory labor, the elimination of discrimination with respect to employment and occupation based on race, color, sex, religion, political opinion, national ascendancy or social origin and the abolition of child labor."

In cases of joint tendering where several economic operators form a consortium to submit a common tender, the grounds for exclusion apply to all tenderers. The definition of the period of exclusion 'x' depends on country regulations. For example, for the European countries, European Commission (2018, p. 13) stated that "the period of exclusion cannot exceed 5 years from the date of the conviction in cases of mandatory exclusion grounds or 3 years from the date of the relevant event in cases of optional grounds for exclusion".

- Corporate social responsibility (G2)

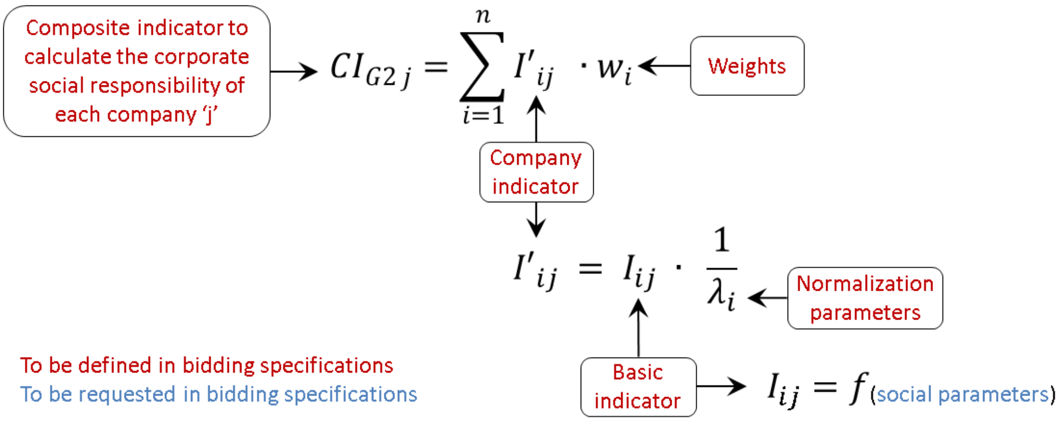
The assessment of the corporate social responsibility group of criteria has to be done through the composite indicator 'CI_{G2}', defined in Equation 6-1. This composite indicator is formed by the summation of sixteen weighted company indicators. Thus, to calculate the corporate social responsibility criteria, both the company indicators and the weight of each of them should be defined in bidding specifications. The company indicators are quantitative indicators. Figure 6-4 represents the general form of the equations to calculate them.



SOURCE: Own elaboration

Figure 6-4: General form of company indicator equations

The company indicators have been defined as the normalization of basic indicators. The normalization is performed by normalization parameters (λ_i). These need to be fixed for each country since these represent the benchmark of each basic indicator. On the other hand, I_i are the basic indicators that gather the social parameters to assess each company. To calculate the basic indicators, social parameters of each company must be requested in bidding specifications. Figure 6-5 defines the general layout of equations to assess corporate social responsibility. In red is the information to be defined in bidding specifications and in blue the information to be requested in bidding specifications.



SOURCE: Own elaboration

Figure 6-5: General layout of equations to assess the corporate social responsibility

Therefore, the information that the agency has to include in bidding specifications to define the evaluation factor 'Corporate social responsibility' includes:

A. To define the method to assess the corporate social responsibility:

A1. Definition of the equation to calculate the composite indicator '$\mathrm{CI}_{\mathrm{G2}}$'. This definition can be found in Appendix G.

A2. Definition of the equations to calculate the company indicators 'I'_i'. This definition can be found in Appendix H.

A3. Definition of the value associated with each normalization parameter 'λ_i'.

- The process to define the normalization parameters is explained below.
- A form to assist in defining the normalization parameters of each country can be found in Appendix I.
- How to define the normalization parameters in bidding specifications can be found in Appendix G.

A4. Definition of the value of the weight of each company indicator '$\mathrm{w_i}$'.

- The process to define the weights is explained below.
- The table with the weights of each company indicator for each European country can be found in Appendix J.
- How to define the weights in bidding specifications can be found in Appendix G.

B. To request the information of each company to assess corporate social responsibility.

B1. Use a form to collect the social parameters of each company involved in the procurement procedure. This form can be found in Appendix K.

Normalization parameters (λ_i)

Normalization parameters are established for a specific country. These can be defined through the opinion of a group of experts or based on the values of measurements and standards in the construction industry of the country, local legal regulations, Global Reporting Initiative (GRI) reports for the construction industry, and other relevant documents. This guide recommends the use of GRI reports to define the normalization parameters. The normalization parameters must be updated every three years. The process to define the normalization parameters is:

1. Collect GRI reports of construction companies in the country where the project is procured. The reports have to be collected from the years ‘y-3’, to ‘y-1’, being ‘y’ the year that the project is tendered; however, this range of years can be modified depending on the availability of information. These reports can be found in the following link: https://database.globalreporting.org/.
2. The social parameters should be collected from each GRI report. Form I-1 has been defined to assist agencies in this task (see Appendix I).
3. The calculation of basic indicators for each report must be undertaken using the collected social parameters. Form I-2 has been defined to assist agencies in this task (see Appendix I). The normalization parameters are obtained as the maximum value for each basic indicator. It is important to note that the agency may fix other values, with respect to the one extracted by this process, for some of the normalization parameters (λ_i) according to the social preferences established by the agency, government, etc.

By way of example, the normalization parameters were defined for Spain. A total of eight GRI reports of Spanish construction companies from 2016 to 2017 were collected. Table 6-4 shows the main characteristics of these construction companies.

Table 6-4: Characteristics of the eight Spanish construction companies with GRI reports from 2016 to 2017

	Firm 1	Firm 2	Firm 3	Firm 4	Firm 5	Firm 6	Firm 7	Firm 8
Company size	MNE	large	large	large	large	large	large	SME
Total employees	32,147	196,967	6,851	95,978	24,251	26,383	8,890	5
Revenue (€M)	7,445	24,925	1,992	10,759	3,862	2,860	4,793	0.37

SOURCE: Own elaboration

Based on these reports, Table 6-5 shows Form I-2 with the normalization parameters for Spain. The pages of each report were read, and indicators presented in the text or performance scorecards were recorded to identify social parameters. Additionally, the information that was explained in charts, tables, framed or in bold characters was reviewed, and the data associated with the social parameters were collected. Subsequently, basic indicators for each construction company were calculated using the social parameters extracted from these reports (see Appendix I).

As can be seen, some basic indicators were not calculated in each report (for example, I_{41}, I_{42}, I_8 and I_{13} in Report 1; I_{42}, I_{52}, I_{53}, $I_{61, \dots}$ in Report 2, etc.). The reason was that social parameters associated with these basic indicators were not found in the reports. This happened because GRI guidelines are recommendations to assess the sustainability of a company through the use of a set of indicators. But, the use of these indicators is not mandatory; thus, indicators can be excluded or not considered, if the company decides not to measure them (Tokos et al. 2012). Notwithstanding this fact, the normalization parameters were defined as the maximum value for each basic indicator. For Spain, the values obtained for the normalization parameters $\lambda_{42,}$ λ_9, λ_{10} and, λ_{11} were not considered. These normalization parameters were defined as follows:

- λ_{42} was defined as 1.0, representing that every man and woman entitled to parental leave take leave and return to work to the same or a comparable position, increasing, thus, their employment security, securing their remuneration, and enhancing their career path.
- λ_9 was fixed as 0.5 to achieve equality between women and men in the company workforce.
- λ_{10} was set as 1.0 to eliminate the wage gap between women and men.
- I_{11} was defined as 0.5 to promote workforce equality between women and men in executive management positions.

The motivation to establish the values for these normalization parameters was based on European goals.

Table 6-5: Form I-2 with the normalization parameters for Spain

Basic Indicators (I_i)	Report 1	Report 2	Report 3	Report 4	Report 5	Report 6	Report 7	Report 8	$\lambda_i = Max(I_i)$**
I_1	0.35	0.01	0.10	0.25	0.01	0.05	0.04	0.00	0.35
I_2	0.18	0.71	0.56	0.23	0.34	0.23	0.26	0.00	0.71
I_3	0.05	0.06	-	0.13	0.05	0.04	0.03	0.00	0.13
I_{41}	-	0.06	-	0.04	-	-	-	-	0.06
I_{42}	-	-	-	-	-	-	-	-	1.00
I_{51}	7.15	2.30	4.03	5.16	-	-	-	0.00	7.15
I_{52}	0.04	-	-	-	-	-	-	0.00	0.04
I_{53}	1.54E-03	-	-	4.15E-03	1.7E-03	-	5.30E-04	1.90E-03	0.004
I_{61}	0.00E+00	-	-	1.10E-08	-	1.89E-08	3.65E-08	0.00E+00	3.65E-08
I_{71}	3.90	18.56	8.34	20.00	13.50	5.15	2.00	0.00	20.00
I_{72}	0.57	0.50	0.34	0.43	0.40	0.54	-	0.00	0.57
I_8	-	2.32E-06	-	-	2.8E-04	-	-	-	2.81E-04
I_9	0.68	0.80	0.26	0.58	0.65	0.95	0.69	0.40	0.5
I_{10}	0.95	-	-	-	-	-	-	0.91	1.00
I_{11}	0.31	0.11	0.36	0.29	0.17	-	0.20	0.33	0.50
I_{12}	0.04	0.03	-	-	0.03	0.03		0.00	0.04
I_{13}	-	-	-	28.83	-	-	-	1.24	28.83
I_{14}	840.32	513.10	233.54	-	-	-	-	-	840.32
I_{15}	3.19E-04	4.75E-04	-	-	3.9E-04	-	-	-	4.75E-04
I_{16}	2.76E-02	1.58E-03	3.61E-03	4.09E-03	2.0E-03	2.97E-03	3.13E-03	0.00E+00	2.76E-02

Note: Definition of the social parameters of each basic indicator in Appendix I

SOURCE: Own elaboration

Weights (w_i)

The weights are defined for each country taking into account the existing social weaknesses. These weights must be updated every three years following the process established in Appendix V. To define the weights to be used in bidding specifications, Appendix J should be read. This Appendix gathers a table with the weights of each company indicator for each European country. Thus, the procurer only has to select the row in the table associated with the country were the project is procured. By way of example, the row of Spain contains the weights of each company indicator for this country. Table 6-6 shows the weights extracted from Appendix J for Spain.

Table 6-6: Weights of corporate social responsibility group for Spain extracted from Appendix J

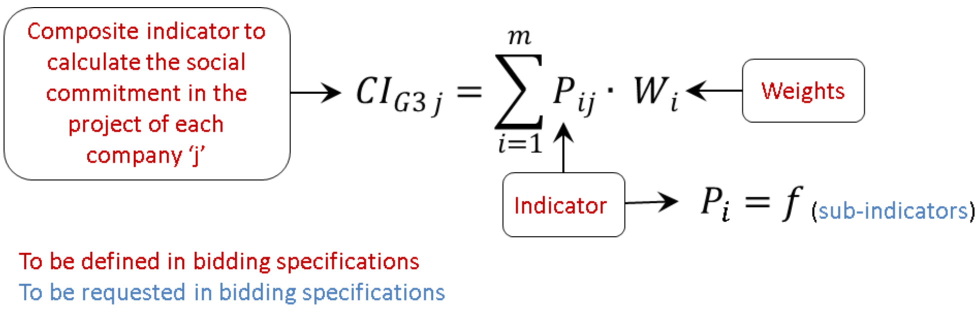
	Weights															
Country	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	W_{14}	W_{15}	W_{16}
Spain	0.05	0.12	0.11	0.04	0.04	0.04	0.11	0.04	0.04	0.04	0.04	0.13	0.05	0.04	0.05	0.05

Note: $W_{1:}$ New staff hiring; W_2: Temporary contracts; W_3: Employee turnover; W_4: Benefits; W_5: Chronic disease; W_6: Fatal accidents at work; W_7: Non-fatal injuries at work; W_8: Social value; W_9: Female labor force participation; W_{10}: Wage gap; W_{11}: Women in executive management positions; W_{12}: Disabled; W_{13}: Salary distribution; W_{14}: Technical training; W_{15}: Social ethics, social awareness and human rights; and, W_{16}: Research and Development

SOURCE: Own elaboration

- Social commitment in the project (G3)

The assessment of the social commitment in the project group of criteria has to be performed through the composite indicator 'CI_{G3}', defined in Equation 6-2. This composite indicator is formed by the summation of seven weighted indicators. Thus, to assess the social commitment in the project of each offeror, both the indicators and the weight of each of them should be defined in bidding specifications. Figure 6-6 represents the general layout of the equations to calculate the social commitment in the project of each offeror.



SOURCE: Own elaboration

Figure 6-6: General layout of equations to assess the social commitment in the project of each offeror

The indicators (P_{ij}) are qualitative indicators defined to be linked to the subject matter of the project. The description of these indicators gathers:

- The sub-indicators contained in each indicator. These sub-indicators represent the submittal requirement in bidding specifications to assess the indicators.
- The evaluation method to assess the indicators.

The weight of each indicator (W_i) must be calculated for each specific project depending on the project characteristics.

Therefore, the information that the procurer should include in bidding specifications to define the evaluation factor 'Social commitment in the project' includes:

A. To define the method to assess the social commitment in the project:
   A1. Definition of the equation to calculate the composite indicator 'CI_{G3}'. This definition can be found in Appendix L.
   A2. Definition of the indicators 'P_i'. The definitions can be found in Appendix M and gather:
   - Submittal requirement of each indicator.
   - Assessment method for each indicator.

A3. Definition of the value of the weight of each indicator 'W_i'.

- The process to define the weights is explained below.
- The form to characterize the project is in Appendix N.
- The table with the level of importance of each indicator depending on the project characteristics can be found in Appendix O.
- The form to calculate the weight of each indicator is in Appendix P.

B. To request the information of each company to assess the social commitment in the project.

B1. The information that should be requested to assess the social commitment of each offeror in the project is defined in Appendix M. This information is related to each of the sub-indicators for each indicator.

Weights (W_i)

The weights in social commitment in the project group must be defined for each specific project. The reason is that the weight of each indicator depicts its level of importance in the composite indicator, and this level of importance has to be defined according to the project characteristics. Therefore, to determine the weight of each indicator, the procurer has to undertake the following steps: (1) characterizing the project; (2) defining the level of importance of each indicator in the project; and, (3) obtaining the weight of each indicator in the project.

1. Characterizing the project.

For each specific project, the procurer has to characterize the project according to a group of project factors. Project factors represent the features of the project. The established project factors are:

- Contract size, which is determined by the initial budget of the construction project.
- Project complexity, which represents the project difficulty and project risk.
- Social context, which represents the social characteristics of the site and surrounding areas of the project. This project factor depends on three sub-factors:
  - Cultural environment, which represents the risk of damaging heritage sites.
  - Industry competence, which represents the industry characteristics or abilities associated with the levels of competence of local firms in engineering, contracting, and consulting referred to the project to be awarded.

- Territory, which assesses the negative social consequences derived from the construction project in the territory surrounding the project.

The definition of these project factors, as well as the levels established for each of them, can be seen in Appendix N. Based on these, the procurer has to select the level associated with each project factor depending on the project characteristics. A form to help the procurer in this process has been defined in Appendix N.

The result of this step is the selection of the level of each project factor according to the characteristics of the project.

2. Defining the level of importance of each indicator in the project.

The relationship between the indicators of social commitment in the project group with each level of the project factors has been defined in Table O-1 (see Appendix O). These relationships depict the importance of the indicators to ensure the correct development of the project; they are characterized by taking into account the following ratings:

- "-" represents an indicator that is the least recommended for the project, because it does not influence the project success.
- "+" informs that the indicator is recommended for the project.
- "++" notes that the indicator is highly recommended for the project.

In this step, the procurer has to select, from Table O-1, the rows associated with the levels of project factors established in the previous step (Appendix N).

3. Obtaining the weight of each indicator in the project.

The weight of each indicator depends on its maximum rating obtained in the previous step. A form has been developed and is shown in Appendix P to assist the procurer in this step. In this appendix, the following process to calculate the weights is established:

- Obtaining the maximum ratings of each indicator taking into account the levels selected for each project factor and the relationships established in Table O-1.
- Converting the maximum ratings of each indicator into numerical scores according to the following rules:
  - "-"represents a value of "0", since this rating determines that the use of this subcategory does not influence project success.

  - "+" represents a value of "1". This score highlights that the use of this category could be important for the project and, thus, it is recommended.
  - "++" represents a value of "2", because this rating highlights the importance of the subcategory for the project.
- Obtaining the weight of each indicator as the proportion of the score of each indicator with respect to the total of scoring results.

6.4.3. Application example

To achieve a comprehensive understanding of how to include the groups of social criteria in the procurement procedure of civil engineering projects at the construction phase of the infrastructure life cycle, a hypothetical example is shown to understand how to apply this practical guide.

Imagine that a Spanish agency wants to bid the construction of the project "New road in XYZ". The estimated price for the project is 11,000,000€, and the process is based on two-steps using the best value procurement procedure, where:

- In the selection stage (step 1) the composite indicator to assess the corporate social responsibility criteria (CI_{G2}) is combined with individual indicators of G2 to enforce aspects of the corporate social responsibility and technical qualifications.
- In the award stage (step 2) the price and the composite indicator to assess the social commitment of the company in the project (CI_{G3}) are considered.

The previous work that the Agency has to undertake, for each group of criteria, to define them in bidding specifications is described next.

- Human rights (G1)

The Agency has to determine the period of exclusion 'x' to be taken into account in the human rights declaration. For the European countries, the European Commission (2018, p.13) stated that "the period of exclusion cannot exceed five years from the date of the conviction in cases of mandatory exclusion grounds or three years from the date of the relevant event in cases of optional exclusion grounds".

- Corporate social responsibility (G2)

The Agency has to include in bidding specifications the following information:

- Equation to calculate the composite indicator 'CI_{G2}'. This information has been defined in Appendix G. To provide this information, the Agency has to calculate:
    - Normalization parameters. A form to assist in this task has been defined in Appendix I. Additionally, the normalization parameters for Spain have been presented in Table 6-5 (see section 6.4.2).
    - Weight of each company indicator. These have to be selected from Table J-1 (Appendix J) where the weights of each company indicator for each European country are established. Additionally, the weights for Spain have been presented in Table 6-6 (see section 6.4.2).
- Equation to calculate the company indicators. This information has been defined in Appendix H.
- Submittal Requirement to assess the corporate social responsibility of each construction company involved in the procurement procedure. This information has been defined in Appendix K.

• <u>Social commitment in the project (G3)</u>

The Agency has to include in bidding specifications the following information:

- Equation to calculate the composite indicator 'CI_{G3}'. This information has been defined in Appendix L. To provide this information, the Agency has to calculate the weight of each indicator. The process to calculate the weights for this example is shown below.
- Definition of the indicators of social commitment in the project group. This information has been gathered in Appendix M and compiles the submittal requirement and the assessment method for each indicator.

<u>Weights of social commitment in the project group for this example</u>

The following steps have been established: (1) characterizing the project; (2) defining the level of importance of each indicator in the project; and, (3) obtaining the weight of each indicator in the project. These steps are developed as follows.

1. Characterizing the project.

The Agency has to select the level of each project factor according to the characteristics of the project. In Appendix N, a form has been defined to assist in this process. Additionally, in this appendix the definition of each level of the project factor is established.

For this example, assume that after reading the definition of the levels of each project factor, the Agency considers that:

- The level of contract size is '> 10,000,000€', as in this example the estimated price for the project is 11,000,000€.
- The level of project complexity is 'medium' since this project is complex compared to the average of projects awarded by the Agency, but it is not highly complex.
- The level of cultural environment is 'medium' because there has been any discovery in the region of the project.
- The level of industry competence is 'medium' because the level of competence of the local industry is low to perform works gathered in the project
- The level of territory is 'medium' because during the development of the project, construction works will produce negative effects in the surrounding area.

Based on this information, the Agency fills the Form N (see Table 6-7).

Table 6-7: Form N for the example

Project factors		Levels associated with the project		
Contract size		[X] > 10,000,000€	[ ] 1,000,000€ - 10,000,000€	[ ] < 1,000,000€
Project complexity		[ ] High	[X] Medium	[ ] Low
Social context	**Cultural environment**	[ ] High	[X] Medium	[ ] Low
	Industry competence	[ ] High	[X] Medium	[ ] Low
	Territory	[ ] High	[X] Medium	[ ] Low

SOURCE: Own elaboration

2. Defining the level of importance of each indicator in the project.

According to the levels defined in Table 6-7 for each project factor, the Agency has to select the rows associated with these levels from Table O-1 in Appendix O. Table 6-8 represents Table O-1 with the rows associated with this example highlighted in yellow.

Table 6-8: Table O-1 with rows associated with this example highlighted in yellow.

	Indicators of social commitment in the project group						
Levels in each project factor	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note:
P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.

3. Obtaining the weight of each indicator in the project

To calculate the weights, the Agency has to fill out the form represented in Table P-1 and defined in Appendix P. The process to carry out this task has been included in this Appendix, and it is developed as follows.

- Filling out the white rows in Table P-1 with the rows selected from Table O-1 (in Appendix O). Table 6-9 represents this task, where white rows have been filled with yellow rows from Table 6-8.

Table 6-9: Table P-1 filled after performing the first task to obtain the weights

		Level of importance for each indicator							
Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
Contract size		+	-	++	++	++	+	+	
Project complexity		+	-	+	++	++	+	+	
Social context	Cultural environment	+	+	-	-	-	-	-	
	Industry competence	-	-	+	+	+	-	-	
	Territory	-	-	-	-	-	++	++	
Maximum rating									**Total**
Scoring results									
Weights									

Note: P1: Cultural heritage appraisal and management plans; P2: Collaboration with cultural preservationists; P3: Industry participation plan; P4: Workplace health and safety management plans; P5: Work health and safety management officer; P6: Community relations program; and, P7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.
SOURCE: Own elaboration

- Filling out the row 'maximum rating' with the maximum rating obtained for each indicator. To select the maximum rating is important to note that "++" is better than "+", and "+" is better than "-".Table 6-10 shows Table P-1 filled after performing this task.

Table 6-10: Table P-1 filled after performing the second task to obtain the weights

		Level of importance for each indicator							
Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
Contract size		+	-	++	++	++	+	+	
Project complexity		+	-	+	++	++	+	+	
Social context	Cultural environment	+	+	-	-	-	-	-	
	Industry competence	-	-	+	+	+	-	-	
	Territory	-	-	-	-	-	++	++	
Maximum rating		+	+	++	++	++	++	++	**Total**
Scoring results									
Weights									

Note: P1: Cultural heritage appraisal and management plans; P2: Collaboration with cultural preservationists; P3: Industry participation plan; P4: Workplace health and safety management plans; P5: Work health and safety management officer; P6: Community relations program; and, P7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.
SOURCE: Own elaboration

- Converting the maximum ratings of each indicator into numerical scores according to the following rules: (a) "-"represents a value of "0"; (b) "+" represents a value of "1"; and, (c) "++" represents a value of "2". Table 6-11 shows Table P-1 filled after performing this task.

Table 6-11: Table P-1 filled after performing the third task to obtain the weights

		Level of importance for each indicator							
Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
Contract size		+	-	++	++	++	+	+	
Project complexity		+	-	+	++	++	+	+	
Social context	Cultural environment	+	+	-	-	-	-	-	
	Industry competence	-	-	+	+	+	-	-	
	Territory	-	-	-	-	-	++	++	
Maximum rating		+	+	++	++	++	++	++	**Total**
Scoring results		1	1	2	2	2	2	2	**12**
Weights									

Note: P1: Cultural heritage appraisal and management plans; P2: Collaboration with cultural preservationists; P3: Industry participation plan; P4: Workplace health and safety management plans; P5: Work health and safety management officer; P6: Community relations program; and, P7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.
SOURCE: Own elaboration

- Obtaining the weight of each indicator. Based on the score results, the weight of each indicator is obtained by the proportion of the score of each indicator with respect to the total. The sum of the weights has to be one. Table 6-12 shows Table O-1 filled after performing this task. For this example, the weights for the indicators Cultural heritage appraisal and management plan (P1) and Collaboration with historical or cultural preservationists (P2) are 0.0835 (1/12=0.0835). On the other hand, the rest of the indicators have weights equal to 0.1666 (2/12=0.1666).

Table 6-12: Table P-1 filled after performing the fourth task to obtain the weights

		Level of importance for each indicator							
Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
Contract size		+	-	++	++	++	+	+	
Project complexity		+	-	+	++	++	+	+	
Social context	Cultural environment	+	+	-	-	-	-	-	
	Industry competence	-	-	+	+	+	-	-	
	Territory	-	-	-	-	-	++	++	
Maximum rating		+	+	++	++	++	++	++	**Total**
Scoring results		1	1	2	2	2	2	2	**12**
Weights		0.0835	0.0835	0.1666	0.1666	0.1666	0.1666	0.1666	**1.0000**

Note: P1: Cultural heritage appraisal and management plans; P2: Collaboration with cultural preservationists; P3: Industry participation plan; P4: Workplace health and safety management plans; P5: Work health and safety management officer; P6: Community relations program; and, P7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.
SOURCE: Own elaboration

Once this information has been defined, the bidding specifications can be established by the Agency (see following example).

<u>Example:</u>

Construction Contract for the project "New road in XYZ".

The Solicitation, Phase 1 – Request for Qualifications

Full and Open Competition

Table of Contents

Only contents highlighted in red are going to be developed in this example.

I. General Information

B. The Solicitation and Contract

This procurement is being conducted using the two-phase selection process. Qualification proposals will be evaluated in Phase 1 to determine which offerors will submit proposals for Phase 2. In Phase 1, the Agency will select a short list of the most highly qualified offerors and request that those offerors submit Phase 2 proposals. All responsible sources may submit a Phase 1 proposal. A maximum of 3 firms will be selected to submit Phase 2 proposals. Only those selected offerors are authorized to submit Phase 2 proposals. All offerors for participation in Phase 2 will be notified. In Phase 2, offerors will be assessed according to their price proposal and their social commitment in the project.

II. Phase 1 Proposals

A. Proposal Contents

Proposals shall consist of the following documents, completed and executed in accordance with this Phase 1 Solicitation:

(1) Technical Proposal
(2) Other Documents as Required

C. Technical Proposal

Evaluation factors for Phase 1are listed below in order of importance:

Factor 1: Technical qualifications	Maximum 100 points
Factor 2: Corporate social responsibility	Maximum 100 points
Factor 3: Ratio of disabled people in the company	Maximum 100 points
Total	Maximum 300 points

EVALUATION FACTOR 1: TECHNICAL QUALIFICATIONS

SUBFACTOR 1.A: EXPERIENCE OF THE GENERAL CONTRACTOR AND ENGINEERING FIRM

Description:

This evaluation factor considers the extent of the past experience of the General Contractor and Architectural or Engineering Firm (A/E from now on) members of the Offeror's team. For the purposes of this evaluation factor, the term A/E is defined as an individual, firm, partnership, corporation, association, or other legal entity permitted by law to practice the profession of architecture and engineering that will have responsibility for developing detailed construction works.

Submittal Requirement:

Each Offeror shall provide sufficient documentation in order to demonstrate the extent of the Offeror's past experience for at least three (3) projects of similar size, scope, and complexity.

SUBFACTOR 1.B: PAST PERFORMANCE OF THE GENERAL CONTRACTOR AND A/E

Description:

This factor considers the Offeror's past performance in providing construction services on the projects submitted by the Offeror under factor 1.A. Past performance will be evaluated to determine the probability that the Offeror will successfully perform the project identified in the RFQ based on demonstrated past performance. Contractor and A/E shall provide additional project information on projects submitted as similar that identifies the performance of the project.

Submittal Requirement:

The following information shall be provided for projects submitted under factor 1A:

- Awarded contract amount, final contract amount and reason for change orders (owner required scope increases, unknowns, etc)
- Awarded construction schedule versus actual schedules. An actual project schedule shall be provided with enough detail to identify where time was gained and/or lost.
- Provide an owners contact information for each project provided

EVALUATION FACTOR 2: CORPORATE SOCIAL RESPONSIBILITY

Description:

The evaluation factor 'Corporate social responsibility' has to be assessed through the composite indicator 'CI_{G2}' defined in Equation 1. This composite indicator is formed by the summation of weighted company indicators. The result of the composite indicator varies from 0 to 1 depending on the social parameters data submitted by each offeror.

$$CI_{G2} = \sum_{i=1}^{n} I'_{ij} \cdot w_i \qquad (1)$$

Where:

- I'_{ij} represent the normalized values of each company indicator (i) associated with each construction company (j) involved in the procurement procedure.
- w_i are the weights assigned to each company indicator (i) for Spain.

The composite indicator to assess the corporate social responsibility criteria collects sixteen (16) company indicators. These indicators are:

- I'_1: New staff hiring
- I'_2: Temporary contracts
- I'_3: Employee turnover
- I'_4: Benefits
- I'_5: Chronic disease
- I'_6: Fatal accidents at work
- I'_7: Non-fatal injuries at work
- I'_8: Social value
- I'_9: Female labor force participation
- I'_{10}: Wage gap
- I'_{11}: Women in executive management positions
- I'_{12}: Disabled
- I'_{13}: Salary distribution
- I'_{14}: Technical training
- I'_{15}: Social ethics, social awareness and human rights
- I'_{16}: Research and development

The equations to calculate these company indicators are defined in Appendix H.

The normalization parameters to be considered in these equations to calculate the company indicators are as follows.

Normalization parameters	Value
λ_1	0.35
λ_2	0.71
λ_3	0.13
λ_4	0.06
λ_5	1.00
λ_6	7.15
λ_7	0.04
λ_8	0.004
λ_9	3.65E-08
λ_{10}	20.00
λ_{11}	0.57
λ_{12}	2.81E-04
λ_{13}	0.5
λ_{14}	1.00
λ_{15}	0.50
λ_{16}	0.04

The weightings applicable to assess the corporate social responsibility are as follows.

Company indicators (I'_i)	**Weights (w_i)**
New hires	0.05
Temporary contracts	0.12
Employee turnover	0.11
Social Benefits	0.04
Chronic disease	0.04
Fatal accidents at work	0.04
Non-fatal injuries at work	0.11
Social value	0.04
Female labor force participation	0.04
Wage gap	0.04
Women in executive management positions	0.04
Disabled	0.13
Salary distribution	0.05
Technical training	0.04
Social ethics, social awareness and human rights	0.05
Research and development	0.05
TOTAL	**1.00**

Submittal Requirement:
Contractor shall provide the information gathered in Appendix K. Only the information of the company in Spain has to be considered.

EVALUATION FACTOR 3: RATIO OF DISABLED PEOPLE IN THE COMPANY

Description:

This evaluation factor considers the ratio of disabled people the company staff. This factor represents the ratio of workers in the company over the last year registered as disabled considering part-time and full-time staff, with respect to the maximum number of workers in the company considering total staff (temporal, part-time and full-time staff).

Submittal Requirement:

Contractor shall provide the information gathered in Appendix K. Only the information of the company in Spain should be considered.

D. Other Information to Submit with Proposal

Mandatory Requirements: A tender response that does not comply with these requirements will be an unresponsive bid, declared inadmissible for assessment. The Contracting Officer will make the initial determination as to offer responsibility/responsiveness, and submit only those offers for a full evaluation.

Proposal conforms to the requirements of the Request for Qualifications (RFQ), including, but not limited to:

- Proof of Bonding Capacity to 20,000,000€ in the form of a letter from Surety that demonstrates necessary bonding capacity.
- Signed Human rights declaration. This declaration has to include the following wording:

> "The company declares its awareness that companies who have been convicted of one of the following legal offenses must be excluded from any procurement procedure: participation in a criminal organization; corruption; fraud; terrorism; money laundering; child labor or human trafficking. In addition, economic operators who have not properly paid taxes and social security contributions in their Member State must also be excluded from any procurement procedure. Where the period of exclusion was not set in a final judgment, the period of exclusion cannot exceed 5 years from the date of the conviction."
>
> "The company declares its awareness with all present and future provisions which are established in labor legislation, social security, workplace health and safety, intellectual, industrial and commercial property, protection of the national industry, corruption, etc."
>
> "The company declares its awareness that the contracted company acquires, during the contract, the obligation to guarantee the respect of basic labor rights throughout the production chain. Being mandatory to comply with the fundamental conventions of the International Labor Organization, especially those focused on freedom of association and collective bargaining, the elimination of forced or compulsory labor, the elimination of discrimination with respect to employment and occupation based on race, color, sex, religion, political opinion, national ascendancy or social origin and the abolition of child labor."

III. Phase 2 Proposals

A. Proposal Contents

Proposals shall consist of the following documents, completed and executed in accordance with Phase 2 Solicitation:

(1) Social Commitment in the Project
(2) Total Evaluated Price

C. Social Commitment in the Project Proposal

Description:

The evaluation factor 'Social commitment in the project' must be assessed through the composite indicator 'CI_{G3}' defined in Equation 2. This composite indicator is formed by the summation of weighted company indicators. The result of the composite indicator varies from 0 to 1 depending on the information associated with each indicator submitted by each offeror.

$$CI_{G3\,j} = \sum_{i=1}^{m} P_{ij} \cdot W_i \tag{2}$$

Where:

- P_{ij} represent the values of each indicator (i) associated with each construction company (j) involved in the procurement procedure.
- W_i are the weights assigned to each indicator (i).

The composite indicator to assess the evaluation factor 'Social commitment in the project' collects seven (7) indicators. These indicators are:

- P_1: Cultural heritage appraisal and management plan
- P_2: Collaboration with cultural preservationists
- P_3: Industry participation plan
- P_4: Work health and safety management officer
- P_5: Workplace health and safety management plan
- P_6: Community relations program
- P_7: Effects on neighbors

The definition of these indicators and the method established for their assessment can be found in Appendix M.

The weightings applicable to assess the corporate social responsibility are as follows.

Company indicators (P_i)	**Weights ($\mathrm{W_i}$)**
Cultural heritage appraisal and management plan	0.0835
Collaboration with cultural preservationists	0.0835
Industry participation plan	0.1666
Work health and safety management officer	0.1666
Workplace health and safety management plan	0.1666
Community relations program	0.1666
Effects on neighbors	0.1666
TOTAL	**1.0000**

<u>Submittal Requirement</u>:
Contractor shall provide the information gathered in Appendix M.

D. Total Evaluated Price Proposal

The Agency will evaluate offers for award purposes by adding the total price for all options to the total price for the basic requirement. Evaluation of options will not obligate the Agency to exercise the option(s). Total Evaluated Price shall be calculated using the prices indicated in the Phase 2 Price Proposal. The Agency will normalize the total evaluated price of each offeror using the following equation. The normalized prize is calculated as 1 less the ratio between the total evaluated price of the offeror "i" and the maximum total evaluated price submitted by the offerors in Phase 2.

$$\text{Normalized Price}_{offeror\ i} = 1 - \frac{(Total\ evaluated\ price)_{offeror\ i}}{\max\ (Total\ evaluated\ price)}$$

VI. Method of Award

A. Evaluation of Phase 1 Proposals

The Agency will evaluate Phase 1 proposals based on the following evaluation factors and a shortlist with a maximum of 3 offerors will be selected to submit Phase 2 proposals:

- Technical Qualifications
- Corporate social responsibility
- Ratio of disabled people in the company

B. Evaluation of Phase 2 Proposals

The Agency will award a contract resulting from this solicitation to the responsible offeror whose offer conforming to the solicitation will be most advantageous, total evaluated price and other factors are considered. In addition to total evaluated price, the following Phase 2 non-price factors shall be used to evaluate offers:

- Social commitment in the project

These criteria and percentage weightings applicable to the Phase 2 proposals are:

Social commitment in the project	50%
Total evaluated price	50%
Total	100%

6.5. Guidance on how to assess the social criteria in public-works procurement.

This section defines the process of assessing each group of criteria in accordance with what was set out in bidding specifications. Additionally, forms to assist to the procurer in the assessment have been included in the Appendices.

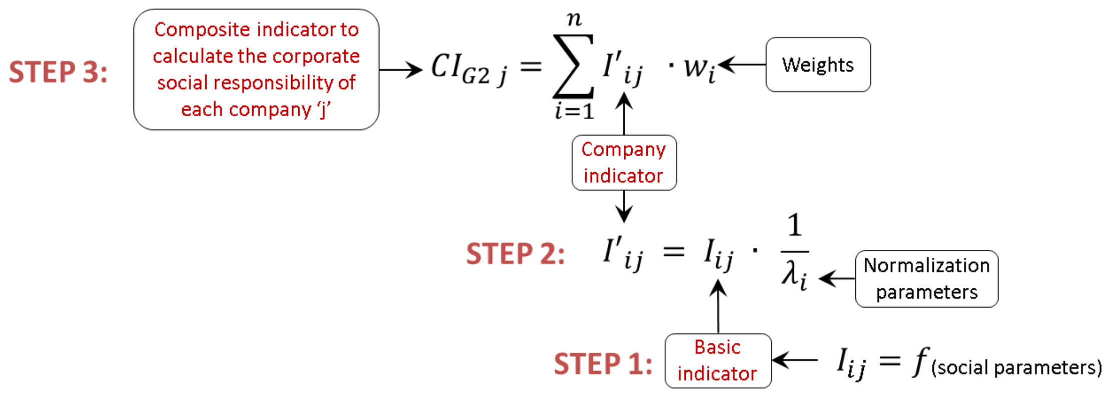
6.5.1. Human rights (G1)

To assess the human rights group in public-works procurement, the agency only require, in bidding specifications, the submission of a signed human rights declaration by each offeror, claiming that a tender response that does not comply with this requirement will be declared inadmissible for assessment. Thus, the assessment of the human rights group is based on the fact that a tender response that does not comply with these requirements will be excluded from the procedure.

6.5.2. Corporate social responsibility (G2)

To assess the corporate social responsibility group in public-works procurement, the agency requires, in bidding specifications, the submission of a form to collect the social parameters of each offeror. This form has been defined in Appendix K.

Figure 6-5 showed the general layout of equations to assess corporate social responsibility. Based on this, Figure 6-7 shows the process that the agency must carry out to determine the corporate social responsibility of each offeror. This process is explained below.



SOURCE: Own elaboration

Figure 6-7: Steps to perform the assessment of corporate social responsibility of the offerors

Step 1: Obtaining the basic indicators for each offeror.

Based upon the social parameters collected for each offeror through the form in Appendix K, the first step in assessing the corporate social responsibility focuses on calculating the basic indicators for each offeror. In Appendix Q, a form has been defined to calculate the basic indicators. In this form, the equation of each basic indicator is defined.

Step 2: Obtaining the company indicators for each offeror.

To calculate the company indicators for each offeror, two groups of information are needed:

- The normalization parameters defined in bidding specifications for the country where the project is procured.
- The results of the basic indicators for each offeror (step 1).

A form has been defined in Appendix R to calculate the company indicators for each offeror. The equations associated with each company indicator are gathered in this Appendix.

Step 3: Corporate social responsibility assessment.

The assessment of corporate social responsibility must be performed through the composite indicator defined in Equation 6-1. To calculate the composite indicator, two groups of information are needed:

- The results of the company indicators for each offeror (step 2).

- The weight associated with each company indicator. These have been defined in bidding specifications for the country where the project is procured.

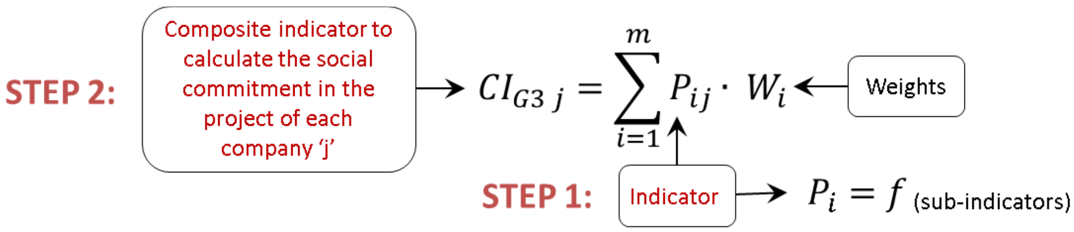
A form has been defined in Appendix S to assess the corporate social responsibility of each offeror. The result of each offeror will vary from zero to one depending on their corporate social responsibility. The higher the result is, the better the corporate social performance of the offeror. Thus, depending on what has been defined in bidding specifications associated with this evaluation factor, two main options can be used to select the offerors:

- In two-step processes, the offerors with the highest values of corporate social responsibility may be selected.
- In one-step processes, only the candidates that guarantee a minimum corporate social responsibility may be selected. The minimum threshold shall be fixed in bidding specifications. As the composite indicator varies from zero to one, an acceptable minimum threshold could be 0.5.

6.5.3. Social commitment in the project (G3)

To assess the social commitment in the project group in public-works procurement, the procurer requires, in bidding specifications, the submission of the information defined in Appendix M for each indicator.

Figure 6-6 showed the general layout of equations to assess the social commitment in the project. Based on this, Figure 6-8 shows the process that the agency has to carry out to determine the social commitment in the project of each offeror, according to their submitted information. This process is explained below.



SOURCE: Own elaboration

Figure 6-8: Steps to perform the assessment of the social commitment in the project of each offeror

Step 1: Assessing each offeror through the indicators in G3 group.

To assess each offeror, seven indicators have been defined. Both the information that each offeror has to submit associated with each indicator and the method to assess them were established in bidding specifications according to Appendix M.

A form has been defined in Appendix T to assist the agency in this step. First, the agency has to assess each sub-indicator according to five levels: (1) excellent; (2) good; (3) moderate; (4) poor; and, (5) none. The definition of these levels varies for each sub-indicator (see Appendix T). Each level has an associated score:

- Excellent: 1.00 point
- Good: 0.66 points
- Moderate: 0.33 points
- Poor: 0.00 points
- None: X

The total score of each indicator must be calculated as the average of the scores obtained in its sub-indicators. In case a sub-indicator is assessed at the "none" level ("X") the total score of the indicator will be zero.

The result of this step is the final score associated with each indicator for each offeror.

Step 2: Assessing the social commitment of each offeror in the project.

The assessment must be performed through the composite indicator defined in Equation 6-2. To calculate the composite indicator, two groups of information are needed:

- The results of the assessment of each indicator for each offeror (step 1).
- The weight associated with each indicator. These have been defined in the bidding specifications.

A form has been defined in Appendix V to assess the social commitment of each offeror. The result of each offeror will vary from zero to one, depending on their social commitment. The higher the result , the stronger the company's commitment. Thus, depending on what has been defined in the bidding specifications associated with this evaluation factor, two main options can be used to select the offerors:

- If the composite indicator is considered as award criteria or selection criteria in a two-steps processes, the offerors with the highest values of corporate social responsibility should obtain the highest probabilities of being awarded the contract.

- If the composite indicator is considered as selection criteria in one-step processes, only the candidates which guarantee a minimum social commitment may be considered. The minimum threshold shall be fixed in the bidding specifications. As the composite indicator varies from 0.0 to 1.0, an acceptable minimum threshold could be 0.5.

6.5.4. Application example

With the aim of achieving a comprehensive understanding of how to assess the three groups of social criteria in the procurement procedure of civil engineering projects in the construction phase of the infrastructure life cycle, an example is shown as follows. In this example, five offerors are assessed according to the bidding specifications defined in section 6.4.3. This example is based on:

- Two-phase selection process.
- Qualification proposals will be evaluated in Phase 1 to determine the offerors that will submit proposals for Phase 2.
- A maximum of three firms will be selected to submit Phase 2 proposals.
- In Phase 2, offerors will be assessed according to their price proposal and their social commitment in the project.

The process to perform the assessment is the following:

- <u>Evaluation of Phase 1 Proposals (Selection Stage)</u>

In this section, the offerors are assessed according to the Phase 1 factors defined in the bidding specifications.

Each contractor had to submit in Phase 1 the following information:

(1) Proof of bonding capacity to 20,000,000€ in the form of a letter from surety that demonstrates necessary bonding capacity.
(2) Signed human rights declaration.
(3) Technical qualifications.
(4) Social parameters to assess social corporate responsibility. The form to request this information has been defined in Appendix K.

Assume that in Phase 1 the information of five offerors was submitted. Table 6-13 shows if the offerors submitted each bit of information (✓) or not (X).

Table 6-13: Information submitted by each offeror in Phase 1

	Offeror 1	Offeror 2	Offeror 3	Offeror 4	Offeror 5
Proof of Bonding Capacity	X	✓	✓	✓	✓
Human Rights Declaration	✓	✓	✓	✓	✓
Technical Qualifications	✓	✓	✓	✓	✓
Social Parameters	✓	✓	✓	✓	✓

SOURCE: Own elaboration

As can be seen, offeror 1 did not submit the proof of bonding capacity; thus, that proposal was declared inadmissible for assessment and excluded from the tender procedure.

The evaluation factors in Phase 1 are: (1) technical qualifications; (2) corporate social responsibility; and, (3) ratio of disabled people in the company.

Regarding technical qualifications, assume that, based on the information provided by each offeror, the four offerors have obtained the maximum score for this evaluation factor: 100 points.

With respect to corporate social responsibility, Table 6-14 shows the data associated with the social parameters of the offerors 2, 3, 4 and 5. The submission of these social parameters was required in the bidding specifications. The definition of each social parameter can be found in Appendix K.

Table 6-14: Summary of data associated with the social parameters of each Offeror.

Parameter	Offeror 2	Offeror 3	Offeror 4	Offeror 5
A	1.00	10.00	6.00	3.00
B	10.00	500.00	250.00	50.00
C	1.00	105.00	50.00	15.00
D	5.00	30.00	22.00	6.00
$\mathbf{E_0}$	0.01	0.50	0.23	0.05
$\mathbf{E_1}$	1.30	101.60	62.50	9.20
$\mathbf{E_2}$	0.00	9.00	4.00	6.00
$\mathbf{E_3}$	0.00	15.00	5.00	6.00
$\mathbf{F_0}$	0.00	3002.00	2505.00	15.00
$\mathbf{F_1}$	51.00	1205.00	600.00	105.00
$\mathbf{F_2}$	2.00	60.00	45.00	15.00
$\mathbf{F_3}$	20900.00	1089000.00	600000.00	104000.00
$\mathbf{F_4}$	75.00	7550.00	5500.00	400.00
$\mathbf{I_{54}}$	0	1	1	1.00
G	0.00	3.00	1.00	0.00
$\mathbf{H_0}$	14.00	51.00	23.00	16.00
$\mathbf{H_1}$	42.00	201.00	54.00	66.00
$\mathbf{K_0}$	0.00	32.00	10.00	5.00
$\mathbf{K_1}$	11.00	605.00	300.00	65.00
L	3.00	105.00	150.00	21.00
$\mathbf{S_{W\,1}}$	0.00	160000.00	70000.00	0.00
$\mathbf{S_{W\,2}}$	0.00	70000.00	180000.00	0.00
$\mathbf{S_{W\,3}}$	60000.00	5580000.00	5200000.00	385000.00
$\mathbf{S_{W\,4}}$	25000.00	560000.00	405000.00	250000.00
$\mathbf{S_{W\,5}}$	0.00	0.00	34000.00	0.00

Parameter	Offeror 2	Offeror 3	Offeror 4	Offeror 5
H_{W1}	0.00	3600.00	2000.00	0.00
H_{W2}	0.00	1800.00	6000.00	0.00
H_{W3}	3200.00	223200.00	260000.00	17600.00
H_{W4}	1600.00	36000.00	30000.00	16000.00
H_{W5}	0.00	0.00	2000.00	0.00
S_{M1}	50000.00	800000.00	510000.00	65000.00
S_{M2}	45000.00	1400000.00	840000.00	330000.00
S_{M3}	90000.00	15165000.00	3870000.00	805000.00
S_{M4}	0.00	0.00	54000.00	0.00
S_{M5}	0.00	0.00	1344000.00	0.00
H_{M1}	1600.00	18000.00	12000.00	1600.00
H_{M2}	1600.00	36000.00	28000.00	9600.00
H_{M3}	4800.00	606600.00	172000.00	36800.00
H_{M4}	0.00	0.00	4000.00	0.00
H_{M5}	4800.00	163800.00	84000.00	22400.00
N_0	0.00	3.00	4.00	0.00
N_1	2.00	33.00	24.00	7.00
P	0.00	19.00	10.00	1.00
Q_1	50000.00	100000.00	70000.00	60000.00
Q_2	22000.00	39130.79	41595.32	27734.38
T	1650.00	484000.00	180000.00	19500.00
S	4.40	605.00	48.00	6.50
R	0.01	4.06	3.75	0.74

SOURCE: Own elaboration

To assess the corporate social responsibility of each offeror, three steps have been established:

Step 1: Obtaining the basic indicators for each offeror. Appendix Q has been defined to assist to the agency in this task. Table 6-15 shows the results of the basic indicators for each offeror. By way of example, the basic indicator "I_1" is equal to A/B. According to the Appendix K, 'A' represents the total number of new hires in the company over the last year considering part-time and full-time staff, and 'B' is the maximum number of workers in the company over the last year, considering part-time and full-time staff. For Offeror 2, the social parameter A is equal to 1.00, and B is 10.00 (see Table 6-14). Thus, the indicator I_1 for the offeror 2 is equal to 0.1000 (1/10), and for the Offeror 4 is 0.0240 (6/250). Both have been highlighted in yellow in table 6-15.

Table 6-15: Result of the basic indicators of each offeror

Basic Indicators (I_i)	Offeror 2	Offeror 3	Offeror 4	Offeror 5
I_1=A/B	0.1000	0.0200	0.0240	0.0600
I_2=C/B	0.1000	0.2100	0.2000	0.3000
I_3=D/B	0.5000	0.0600	0.0880	0.1200
$I_{41}= E_0/ E_1$	0.0060	0.0049	0.0036	0.0052
$I_{42}= E_2/ E_3$	0.0000	0.6000	0.8000	1.0000
$I_{51}= F_0/ F_1$	0.0000	2.4913	4.1750	0.1429
$I_{52}= F_2/ F_3$	0.0191	0.0110	0.0150	0.0288
$I_{53}= F_4/ F_3$	0.0036	0.0069	0.0092	0.0038
$I_{61}=G/ F_3$	0.00E+00	2.75E-06	1.67E-06	0.00E+00
$I_{71}= H_0/F_3 \cdot 100,000,000$	66.9856	4.6832	3.8333	15.3846

Basic Indicators (I_i)	Offeror 2	Offeror 3	Offeror 4	Offeror 5
$I_{72}= H_1/F_3 \cdot 1{,}000$	2.0096	0.1846	0.0900	0.6346
$I_8= K_0/ K_1$	0.00E+00	5.29E-02	3.33E-02	7.69E-02
$I_9= L/B$	0.3000	0.2100	0.6000	0.4200
I_{10}*	0.0000	0.0000	0.1173	0.0000
$I_{11}= N_0/ N_1$	0.0000	0.0909	0.1667	0.0000
$I_{12}= P/ K_1$	0.0000	0.0314	0.0333	0.0154
$I_{13}= Q_1/ Q_2$	2.2727	2.5555	1.6829	2.1634
$I_{14}= T/ K_1$	150	800	600	300
$I_{15}= S/ K_1$	0.4000	1.0000	0.1600	0.1000
$I_{16}= R/ E_1$	0.0100	0.0400	0.0600	0.0800

*: $\mathbf{I_{10}} = \frac{1}{n} \cdot \sum_{i=1}^{n} \left(\frac{\max(a,b)_i - \min(a,b)_i}{\max(a,b)_i} \right)$

SOURCE: Own elaboration

Step 2: Obtaining the company indicators for each offeror. Appendix R has been defined to assist the agency in this task. To calculate the company indicators, the procurer needs the following information:

- The equations defined in Appendix R.
- The results of the basic indicators (I_i) for each offeror (Table 6-15).
- The normalization parameters defined in the bidding specifications.

Based on this information, the basic indicators are normalized to obtain the company indicator of each offeror. Table 6-16 gathers the results of the company indicators for each offeror. By way of example, the company indicator "I_1'" represents the new staff hiring in the company. According to Appendix R, the equation to calculate this company indicator is: " If $I_1 \le \lambda_1$, $I_1' = I_1 \cdot \frac{1}{\lambda_1}$; else $I_1' = 1$". Thus, as the basic indicator I_1 for Offeror 2 is 0.1000 (highlighted in yellow in Table6-15), and the normalization parameter λ_1 is equal to 0.35 for Spain, I_1' is 0.29 ($I_1' = I_1 \cdot \frac{1}{\lambda_1} = 0.1000 \cdot \frac{1}{0.35} = 0.29$).

Table 6-16: Result of the company indicators of each offeror

Company Indicators (I_i')	Offeror 2	Offeror 3	Offeror 4	Offeror 5
I_1'	0.29	0.06	0.07	0.17
I_2'	0.86	0.70	0.72	0.58
I_3'	0.00	0.54	0.32	0.08
I_4'	0.55	0.34	0.43	0.54
I_5'	0.00	1.00	1.00	1.00
I_6'	0.60	0.84	0.76	0.81
I_7'	0.00	0.77	0.81	0.23
I_8'	0.00	0.68	0.84	0.00
I_9'	0.22	0.86	0.91	0.55
I_{10}'	0.00	1.00	1.00	1.00
I_{11}'	0.60	0.42	1.00	0.84
I_{12}'	1.00	1.00	0.88	1.00
I_{13}'	0.00	0.18	0.33	0.00

Company Indicators (I_i')	Offeror 2	Offeror 3	Offeror 4	Offeror 5
I_{14}'	0.00	0.79	0.83	0.38
I_{15}'	0.92	0.91	0.94	0.92
I_{16}'	0.18	0.95	0.71	0.36

SOURCE: Own elaboration

Step 3: Corporate social responsibility assessment. Appendix S has been defined to assist the agency in this task. Table 6-17 gathers the results of the corporate social responsibility for each offeror. To calculate the composite indicator, the agency needs the following information:

- The equations defined in Appendix S.
- The results of the company indicators (**I_i'**) for each offeror (Table 6-16).
- The weight of each company indicator defined in the bidding specifications.

Table 6-17 gathers the results of the corporate social responsibility for each offeror. For example, to calculate the corporate social responsibility of Offeror 2:

$$CI_{G2\ \mathbf{Off2}} = \sum_1^{16} I'_{i\ \mathbf{Off2}} \cdot W_i = I'_1 \cdot W_1 + I'_2 \cdot W_2 + I'_3 \cdot W_3 + I'_4 \cdot W_4 + \cdots + I'_{15} \cdot W_{15} + I'_{16} \cdot W_{16} = 0.29 \cdot 0.05 + 0.86 \cdot 0.12 + 0.00 \cdot 0.11 + 0.55 \cdot 0.04 + \cdots + 1.00 \cdot 0.05 + 0.36 \cdot 0.05 = 0.398$$

Table 6-17: Corporate social responsibility of each offeror

	Company Indicators				Weights	
I_i'	**Offeror 2**	**Offeror 3**	**Offeror 4**	**Offeror 5**	**W_i**	**Value**
I_1'	0.29	0.06	0.07	0.17	W_1	0.05
I_2'	0.86	0.70	0.72	0.58	W_2	0.12
I_3'	0.00	0.54	0.32	0.08	W_3	0.11
I_4'	0.55	0.34	0.43	0.54	W_4	0.04
I_5'	0.60	0.84	0.76	0.81	W_5	0.04
I_6'	0.63	0.67	0.67	0.99	W_6	0.04
I_7'	0.22	0.86	0.91	0.55	W_7	0.11
I_8'	0.00	1.00	1.00	1.00	W_8	0.04
I_9'	0.60	0.42	1.00	0.84	W_9	0.04
I_{10}'	1.00	1.00	0.88	1.00	W_{10}	0.04
I_{11}'	0.00	0.18	0.33	0.00	W_{11}	0.04
I_{12}'	0.00	0.79	0.83	0.38	W_{12}	0.13
I_{13}'	0.92	0.91	0.94	0.92	W_{13}	0.05
I_{14}'	0.18	0.95	0.71	0.36	W_{14}	0.04
I_{15}'	1.00	1.00	1.00	1.00	W_{15}	0.05
I_{16}'	0.36	1.00	1.00	1.00	W_{16}	0.05
Corporate Social Responsibility	**Offeror 2**	**Offeror 3**	**Offeror 4**	**Offeror 5**		
$CI_{G2\ \mathbf{Off\ j}} = \sum_{i=1}^{16} I'_{i\ \mathbf{Off\ j}} \cdot w_i$	0.398	0.705	0.711	0.564		

SOURCE: Own elaboration

Finally, regarding the ratio of disabled people in the company, this evaluation factor represents the ratio of workers in the company over the last year registered as disabled considering part-time and full-time staff, with respect to the maximum number of workers in the company, considering total staff (temporal, part-time and full-time staff). This criterion depends on the social parameters "P" and "K1" gathered in Appendix K of each offeror. The values of the social parameters submitted by each offeror are shown in Table 6-14. Therefore, Table 6-18 shows the ratio of disabled people for each offeror. For example, the ratio of offeror 3 is $\frac{\mathrm{P}}{\mathrm{k}_1} = \frac{19}{605} = 0.031$.

Table 6-18: Ratio of disabled people for each offeror

Parameter	Offeror 2	Offeror 3	Offeror 4	Offeror 5
P	0	19	10	1
K_1	11	605	300	65
Ratio of disabled people	0.000	0.031	0.033	0.015

SOURCE: Own elaboration

Thus, the results in Factor 2 and Factor 3 for each offeror are in Table 6-19.

Table 6-19: Results Factor 2 and Factor 3

	Offeror 2	Offeror 3	Offeror 4	Offeror 5
Corporate Social Responsibility (CI_{G2})	0.398	0.705	0.711	0.564
Ratio of disabled people	0.000	0.031	0.033	0.015

SOURCE: Own elaboration

Taking into account that the points assigned to Factor 2 and Factor 3 are 100 points, respectively. Table 6-20 shows the results for each offeror, also taking into account the three Phase 1 Factors. These values are obtained by multiplying the values of Table 6-18 by 100 (points assigned to each Factor). The sum of the three results gives the phase 1 results.

Table 6-20: Phase 1 results

	Offeror 2	Offeror 3	Offeror 4	Offeror 5
Technical qualifications,	100	100	100	100
Corporate Social Responsibility	39.8	70.5	71.1	56.4
Ratio of disabled people	0	3.10	3.30	1.50
Total	139.8	**173.6**	**174.4**	**157.9**

SOURCE: Own elaboration

According to the bidding specifications, a maximum of three firms will be selected to submit phase 2 proposals. Analyzing the results, the offerors 3, 4 and 5 have to be the selected firms since these have the highest results (offeror 4: 174.4; offeror 3: 173.6; and, offeror 5: 157.9).

- Evaluation of Phase 2 Proposals (Award Stage)

In this section, the three selected offerors are assessed according to the Phase 2 factors defined in the bidding specifications.

To award the contract, two factors have been defined in the bidding specifications: (1) social commitment in the project; and, (2) total evaluated price. To assess the social commitment in the project criteria, each offeror submits the information defined in Appendix M associated with each one of these indicators:

- Cultural heritage appraisal and management plan
- Cultural environment professional
- Industry participation plan
- Workplace health and safety management plan
- Work health and safety management officer
- Community relations program
- Effects on neighbors

Table 6-21 shows whether or not the offerors 3, 4, and 5 submitted the information associated with the award criteria phase (✓) or not (X).

Table 6-21: Information submitted by each offeror in step 2

	Offeror 3	Offeror 4	Offeror 5
Social Commitment in the project			
Cultural heritage appraisal and management plan	✓	✓	✓
Cultural environment professional	✓	✓	✓
Industry participation plan	✓	✓	✓
Workplace health and safety management plan	✓	✓	✓
Work health and safety management officer	✓	✓	✓
Community relations program	✓	✓	✓
Effects on neighbors	✓	✓	✓
Total evaluated price			
Total evaluated price	✓	✓	✓

SOURCE: Own elaboration

The weights for these criteria have been defined in the bidding specifications (Social commitment in the project: 50%; and, Total evaluated price: 50%).

The method to assess the social commitment in the project has been defined in the bidding specifications. Additionally, in section 6.5.3, two steps have been established to carry out this assessment, as follows.

Step 1: Assessing each offeror through the indicators in the G3 group. Appendix T has been defined to assist to the agency in this task. This Appendix contains a form to be completed with the results of the assessment, and the method to assess each indicator and the sub-indicators associated with these. Table 6-22 gathers the assessment of each indicator for each offeror. An example of this assessment is shown as follows.

The indicator Cultural environment professional (P_2) is assessed through the following sub-indicators:

- P_{21}: Curriculum vitae of the cultural environment professional member of the project team.
- P_{22}: Years of experience on similar projects for the cultural environment professional.
- P_{23}: Definition of responsibilities of the cultural environment professional.

Each sub-indicator has to be assessed comparing the information submitted by each offeror according to five levels: excellent, good, moderate, poor, and none. The definition and score of each level are defined for each indicator and each sub-indicator in Appendix T. For example, the levels to assess the sub-indicator P_{22} are defined as:

- Excellent: Outstanding compared to the other companies
- Good: Better than the professional proposed by the other companies
- Moderate: Equal to the professional proposed by the other companies
- Poor: Less than "x" years of experience. "x" must be defined by the agency
- None: None shown

The scores associated with each level are:

- Excellent: 1.00 point
- Good: 0.66 points
- Moderate: 0.33 points
- Poor: 0.00 points
- None: X

The total score of the indicator has to be calculated as the average of the scores obtained in its sub-indicators. In case where a sub-indicator is assessed at the “none” level (“X”) the total score of the indicator will be zero.

For example, imagine that the information of each offeror referred to the sub-indicator ‘years of experience in similar works’ (P_{22}) is:

- Offeror 3: 10 years of experience in similar works
- Offeror 4: 6 years of experience in similar works
- Offeror 5: 8 years of experience in similar works

Additionally, for this example the agency establishes that the level “poor” in this sub-indicator is achieved when the years of experience of the Cultural environment professional is less than 5 years. Thus, based on the definition of each level for this sub-indicator, Offeror 3 obtains a level of excellent, Offeror 4 is assessed as moderate, and Offeror 5 is good for this sub-indicator (cells highlighted in yellow in Table 6-22). This process was performed for each sub-indicator and each offeror (see Table 6-22). On the other hand, to obtain the result of each indicator, this is calculated as the average of the scores obtained for its sub-indicators. In this regard, the result of the indicator P_2 for Offeror 4 is 0.33 ((0.33+0.33+0.33)/3). However, the result of the indicator P_1 for the Offeror 4 is 0.00, because the level of the sub-indicators P_{17} and P_{18} are "none" (X); it was established that in case a sub-indicator is assessed as "none" level ("X") the total score of the indicator will be zero. These have been highlighted in yellow in Table 6-22.

Table 6-22: Form T with the assessment of each G3 indicator for each offeror

	Offeror 3		Offeror 4		Offeror 5	
	Level	**Score**	**Level**	**Score**	**Level**	**Score**
P_{11}	Excellent	1.00	Moderate	0.33	Moderate	0.33
P_{12}	Excellent	1.00	Moderate	0.33	Moderate	0.33
P_{13}	Moderate	0.33	Excellent	1.00	Moderate	0.33
P_{14}	Moderate	0.33	Excellent	1.00	Moderate	0.33
P_{15}	Moderate	0.33	Excellent	1.00	Moderate	0.33
P_{16}	Moderate	0.33	Excellent	1.00	Moderate	0.33
P_{17}	Moderate	0.33	None	X	Excellent	1.00
P_{18}	Moderate	0.33	None	X	Excellent	1.00
P_1	**Average**	**0.49**	**Average**	**0.00**	**Average**	**0.49**
P_{21}	Excellent	1.00	Moderate	0.33	Good	0.66
P_{22}	Excellent	1.00	Moderate	0.33	Good	0.66
P_{23}	Excellent	1.00	Moderate	0.33	Good	0.66
P_2	**Average**	**1.00**	**Average**	**0.33**	**Average**	**0.66**
P_{31}	Moderate	0.33	Good	0.66	Excellent	1.00
P_{32}	Moderate	0.33	Good	0.66	Excellent	1.00
P_{33}	Moderate	0.33	Good	0.66	Excellent	1.00
P_{34}	Moderate	0.33	Good	0.66	Excellent	1.00
P_3	**Average**	**0.33**	**Average**	**0.66**	**Average**	**1.00**
P_{41}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_{42}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_{43}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_{44}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_4	**Average**	**0.33**	**Average**	**1.00**	**Average**	**0.00**
P_{51}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_{52}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_{53}	Moderate	0.33	Excellent	1.00	Poor	0.00
P_5	**Average**	**0.33**	**Average**	**1.00**	**Average**	**0.00**
P_{61}	Excellent	1.00	Moderate	0.33	Good	0.66
P_{62}	Excellent	1.00	Moderate	0.33	Good	0.66
P_6	**Average**	**1.00**	**Average**	**0.33**	**Average**	**0.66**
P_{71}	Excellent	1.00	Good	0.66	Moderate	0.33
P_{72}	Excellent	1.00	Good	0.66	Moderate	0.33
P_{73}	Excellent	1.00	Good	0.66	Moderate	0.33
P_7	**Average**	**1.00**	**Average**	**0.66**	**Average**	**0.33**

SOURCE: Own elaboration

Step 2: Assessing the social commitment of each offeror in the project. Appendix V has been defined to assist the agency in this task. Table 6-23 gathers the results of the social commitment of each offeror in the project. To calculate the composite indicator, the agency needs the following information:

- The results of the assessment of each indicator for each offeror (Table 6-22).
- The weight associated with each indicator. These have been defined in the bidding specifications.

Table 6-23 gathers the social commitment of each offeror. By way of example, the social commitment of the Offeror 3 is calculated as:

$$\mathrm{CI}_{\mathrm{G3\ Off3}} = \sum_1^7 \mathrm{P}_{\mathrm{i\ off3}} \cdot \mathrm{W_i} = \mathrm{P_1} \cdot \mathrm{W_1} + \mathrm{P_2} \cdot \mathrm{W_2} + \mathrm{P_3} \cdot \mathrm{W_3} + P_4 \cdot W_4 + P_5 \cdot W_5 + P_6 \cdot W_6 + P_7 \cdot W_7 = 0.49 \cdot 0.083 + 1 \cdot 0.083 + 0.33 \cdot 0.166 + 0.33 \cdot 0.166 + 0.33 \cdot 0.166 + 1 \cdot 0.166 + 1 \cdot 0.166 = 0.620$$

Table 6-23: Social commitment in the project for each offeror

	Indicators			Weights	
P_i	Offeror 3	Offeror 4	Offeror 5	W_i	Value
P_1	0.49	0.00	0.49	W_1	0.083
P_2	1.00	0.33	0.66	W_2	0.083
P_3	0.33	0.66	1.00	W_3	0.166
P_4	0.33	1.00	0.00	W_4	0.166
P_5	0.33	1.00	0.00	W_5	0.166
P_6	1.00	0.33	0.66	W_6	0.166
P_7	1.00	0.66	0.33	W_7	0.166
Social commitment assessment	**Offeror 3**	**Offeror 4**	**Offeror 5**		
$CI_{G3\ \mathrm{Firm\ j}} = \sum_{i=1}^{i} P_{i\ \mathbf{Firm\ j}} \cdot W_i$	0.620	0.633	0.426		

SOURCE: Own elaboration

On the other hand, the **total evaluated price** of each offeror can be seen in Table 6-24. These values were normalized by the equation defined for this factor in the bidding specifications. For example, the normalized price factor of Offeror 4 is $1 - \frac{(\text{Total evaluated price })_{Offeror\ 4}}{\max(\text{Total evaluated price })} = 1 - \frac{10{,}000{,}000}{11{,}000{,}000} = 0.091.$

Table 6-24: Normalized prices for each offeror.

	Offeror 3	Offeror 4	Offeror 5
Total evaluated price	11,000,000€	10,000,000€	8,500,000€
Normalized price	0.000	0.091	0.227

SOURCE: Own elaboration

Finally, Table 6-25 gathers: (1) the results for each offeror in each Phase 2 factor; (2) the weights defined in the bidding specifications for each of them; and, (3) the result of the Phase 2 assessment for each Offeror. By way of example, the result of the Phase 2 assessment for offeror 4 is 0.362 (0.633*0.5+0.091*0.5= 0.362). Therefore, analyzing the results of each offeror, the contract should be awarded to offeror 4 since this offeror has obtained the maximum value in Phase 2 (0.362).

Table 6-25: Results in Phase 2

	Offeror 3	**Offeror 4**	**Offeror 5**
Social Commitment in the Project (weight: 50%)	0.620	0.633	0.426
Normalized price (weight: 50%)	0.000	0.091	0.227
Total	0.310	**0.362**	0.327

SOURCE: Own elaboration

6.6. Chapter summary

In this chapter, a practical guide is presented to explainwhere to include social criteria in the procurement procedure of civil engineering construction projects, and how to guarantee their objective assessment. Three groups of social criteria have been defined for inclusion in these procurement procedures: human rights group, corporate social responsibility group, and social commitment in the project group. For each of these groups, a procedure has been defined to assess these social criteria. Additionally, forms have been defined to assist agencies in gathering the information of each offeror in the procurement procedure. Finally, examples are provided to explain how to include social criteria in bidding specifications, and how to assess the offerors based on the developed methods. These examples have been provided to enable a comprehensive understanding of the implementation of the three groups of social criteria in public-works procurement.

CHAPTER 7

CONCLUSIONS

This chapter summarizes the key findings, contributions, and limitations of this research. First, the achievement of the research goals is reviewed. Subsequently, the main contributions arising from this research are listed; practical recommendations for researchers and procurement practitioners are also established. Finally, the limitations are recognized and areas of future work branching from this research are suggested.

7.1. Achievement of the specific objectives

The research methodology established early in this work, as well as the analyses and developments carried out, have allowed the researcher to reach the research objectives. The following figures show the specific objectives, how these have been acomplished, the chapter where the account of their pursuit, and the main contributions of this research (see Figures 7-1,7-2,7-3,7-4,7-5,7-6).

Objective 1 (O1): Analyzing how public-works procurement procedures and project delivery methods are considered at the international level

How it is satisfied	Where it is developed	Main contributions
Tendering documents Descriptive analysis Logistic regressions	Chapter 3 gathers the definition of the research method Chapter 4 contains the results and their discussion	• The best-value procurement procedure is achieving strength, especially in integrated delivery methods where it is prevailing. • The use of the traditional delivery method is still dominant, and, practically, this type of delivery method uses the low bid as the main procurement procedure. • The variable contract size highly influences the choice of the project delivery method and procurement procedure. • Significant differences exist between types of infrastructure and countries regarding the use of project delivery methods. • Building projects are more focused on integrated delivery methods than civil engineering projects, which tend to use the traditional method. • The Spanish-speaking countries are still closely focused on traditional methods.

Figure 7-1: Fulfillment of Objective 1

Objective 2 (O2): Identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined depending on the stage of the tendering procedure where these are considered.		
How it is satisfied	**Where it is developed**	**Main contributions**
Tendering documents Descriptive analysis Mann-Whitney U test	Chapter 3 gathers the definition of the research method Chapter 4 contains the results and their discussion	• The main groups of social criteria that should be considered in public procurement of the construction industry are: cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact. • Currently, there is a lack of objective methods to assess social sustainability in public-works procurement. • Only 50% of tenders with best-value procurement procedures considered social criteria in award criteria phase. • The lack of social criteria in award criteria phase of low bid procurement procedures is only compensated by increasing social criteria in selection criteria phase.

Figure 7-2: Fulfillment of Objective 2

Objective 3 (O3): Assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures.		
How it is satisfied	**Where it is developed**	**Main contributions**
Tendering documents Descriptive analysis Logistic regressions Correspondence analysis Chi-square contingency table	Chapter 3 gathers the definition of the research method Chapter 4 contains the results and their discussion	• The variables country and contract size were the most influential variables including social criteria in public-works procurement. • The comparison between countries revealed important differences between Anglo-Saxon countries and Spanish-speaking countries. • The inclusion of social criteria in tendering documents increases significantly as the contract size increases. • There were no significant differences between project delivery methods and between procurement procedures with respect to the inclusion of social criteria.

Figure 7-3: Fulfillment of Objective 3

Objective 4 (O4): Defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures.		
How it is satisfied	**Where it is developed**	**Main contributions**
Literature review Focus group	Chapter 3 gathers the definition of the research method Chapter 4 contains the results and their discussion	• Eight categories and 22 subcategories of social criteria were established to be considered in the construction stage of civil engineering projects. • The 22 subcategories were classified into three groups of social criteria: human rights (G1), corporate social responsibility (G2), and social commitment in the project (G3).

Figure 7-4: Fulfillment of Objective 4

Objective 5 (O5): Determining a methodology to include the social sustainability criteria in public-works procurement procedures.		
How it is satisfied	**Where it is developed**	**Main contributions**
Literature review Focus group Composite indicators DEA-BOD Sensitivity analysis	Chapter 3 gathers the definition of the research method Chapter 5 contains the results and their discussion	• A methodology was defined for each group of social criteria. • To include human rights group in public procurement, the procurer must require construction companies interested in participating in the procedure to deliver a declaration in order to confirm their respect for human rights. • A composite indicator was defined to assess the corporate social responsibility group based on these two principles: 1) company indicators need to be quantitative, reliable and verifiable to guarantee the robustness of the methodology; and 2) the weighting system has to be addressed to minimize the social weaknesses of each country over time. • A sensitivity analysis demonstrated that the G2 methodological approach is valid to compare the corporate social responsibility performance of construction companies, regardless of their size. • To include the social commitment in the project group, a composite indicator was defined based on the premise that both the definition of each indicator and their level of importance in the composite indicator had to be able to adapt to the project characteristics. • A sensitivity analysis demonstrated that in the G3 method the weights are able to adapt for each indicator depending on the project characteristics.

Figure 7-5: Fulfillment of Objective 5

Objective 6 (O6): Identifying the stage of the public-works procurement procedures to include the social sustainability criteria		
How it is satisfied	**Where it is developed**	**Main contributions**
Practical guide	Chapter 6 contains the proposal	• Human rights group (G1) must be included in public-works procurement as exclusion ground. • Corporate social responsibility group (G2) must be included as selection criteria regardless of the procurement procedure. • The inclusion of the Social commitment in the project group (G3) in public-works procurement depends on the type of procurement procedure. In best-value procurement procedures, it must be included as one of the award criteria. In low bid procurement procedures, it must be included

Figure 7-6: Fulfillment of Objective 6

7.2. Contributions

The contributions of this research are exposed for each one of the established specific objectives:

- **Objective 1 (O1): Analyzing how public-works procurement procedures and project delivery methods are considered at the international level:**

    - The sample encompassed 451 tendering documents from 10 countries. Approximately 40.1% of the tendering documents were from English-speaking countries (Australia, Canada, the UK, and the USA), and 59.9% from Spanish-speaking countries (Argentina, Chile, Colombia, Panama, Peru, and Spain). Of the analyzed tenders 26.2% were building projects and 73.8% were civil engineering projects. The best-value procurement method used was in 61.7% of the analyzed sample, so the use of low bid procurement was evident in the remaining 38.3% of the tendering documents. Regarding project delivery methods, the traditional method was considered in 80.3% of the tendering documents; the use of this delivery method in both English-speaking and Spanish-speaking countries. Less than20% of the sample comprised integrated delivery contracts (DB, CMR, CM/GC, Concessions, PPP, etc.).

    - To consider the robustness of the sample, the use of project delivery methods and procurement procedures was assessed. Results confirmed what is widely highlighted by numerous researchers. The best-value procurement procedure is achieving strength, especially in integrated delivery methods where it is prevailing. However, the use of the traditional delivery method is still dominant, and, practically, this type of delivery method uses the low bid as the main procurement procedure. 56% of traditional delivery methods and 85% of integrated delivery methods included best-value procurement procedures. However, these percentages were highly influenced by the results associated with the English-speaking countries. These countries showed a clear predisposition towards the use of best-value in both traditional and integrated delivery methods, being remarkable the use of best-value procurement procedures in their integrated delivery methods.

- The project contract size was the most influential variable with respect to the decision to use integrated project delivery methods, followed by the type of infrastructure. Building projects tended to be procured through integrated project delivery methods; however, civil engineering projects were more oriented towards traditional methods. ESCs showed greater use of integrated methods in comparison with Spanish-speaking countries; these are still closely focused on traditional methods, forgetting that the need for bolstering sustainability in public construction procurement departs from enhancing the use of best-value procurement procedures and integrated delivery methods. The use of integrated delivery methods increased considerably in projects with contract size over 10 M€.

- The project contract size was the most influential variable with respect to the decision to use a specific procurement procedure, followed on a similar level by the project delivery method and country. The greater the contract size, the higher the odds of using the best value. Best value prevails in integrated delivery methods, where the odds ratio was 3.5 times higher with respect to traditional methods. The use of best value was notably higher in ESCs compared to SSCs, where the odds ratio was 2.3 times higher.

- **Objective 2 (O2): Identifying the main social sustainability criteria that, currently, are included in public-works procurement, and how these criteria are defined, depending on the stage of the tendering procedure where these are considered.**

- The literature review established that the main social categories, or groups of social criteria, that should be considered in public procurement were cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact. A quantitative content analysis, which combined both inductive and deductive approaches, was performed to the 451 tendering documents in order to characterize the inclusion of social criteria in public procurement.

- The results showed that within the 451 analyzed tendering documents, 2,724 social indicators were included. These indicators were clustered in 22 "sub_2" subcategories. The most considered "sub_2" subcategories were workplace health and safety management plan, employment of vulnerable groups, avoiding or minimizing mobility disruption, and technical and sustainability training of workers. Contrarily, "sub_2" subcategories related to professional expertise in cultural heritage and occupation health and safety certifications were the least included despite their easy quantification.

- Three groups of social categories were differentiated depending on their frequency of inclusion in the analyzed tendering documents: the first and most important level was formed by health and safety criteria; the second level was composed of employment, users' impact, professional ethics, and training criteria; and the third level comprised local development and cultural heritage criteria.

- Regarding the first level, the number of times that the category health and safety showed up was notably higher in comparison with the rest of the categories. Instances associated with this group of criteria appeared in almost the whole analyzed sample. Within this group, indicators related to the development of workplace health and safety management plans and ensuring public safety were the most frequently considered.

- Regarding the second level, the results showed that the employment of vulnerable groups was one of the most frequently cited instances within the group of employment criteria. However, sub_2 subcategories such as job stability and industry participation plan were included in very low percentages. With respect to the use of professional ethics criteria, none of the sub_2 subcategories in this group overcame one third in the frequency of occurrence. The consideration of non-discriminatory hiring practices and fair wages was scarce; and, although gender equality was the most considered within this group, it was included in less than one-third of the analyzed sample. Criteria referred to training of workers and minimizing mobility disruption was widely considered.

- Regarding the third level, results showed a lack of cultural heritage criteria in most of the tendering documents. Local development criteria presented wide variability in the obtained results. Some countries are aware of the importance of including local criteria in the procurement procedures; however, a low percentage of tendering documents consider this type of criteria.

- To characterize how the social criteria are included in the tendering documents, two terms were used: indicator with metric and indicators without metric. Only 19% of the 2,724 social indicators collected had associated metrics. This result highlights the lack of objective methods to assess social sustainability in public-works procurement.

- The main sub_2 subcategories of indicators considered with metrics were associated with the inclusion of professionals in terms of health and safety, the requirement of occupational health and safety certifications, job stability, employment of vulnerable groups and, finally, gender equality. Nevertheless, subcategories of indicators such as workplace health and safety management plans, technical and sustainability training of workers, minimizing the harm done to the neighborhood or the existing services, industry participation plan, and employment created or retained were characterized by a lack of metrics.

- Regarding the inclusion of social criteria in the analyzed tendering documents, the descriptive statistics showed that there are hardly any differences between both procurement procedures. The lack of social criteria found in the award criteria phase of the low bid tenders is only compensated by increasing social criteria in the selection criteria phase. However, only 50% of tenders with best-value procurement procedures considered social criteria in the award criteria phase, and there was an absence of metrics to assess social criteria encouraging subjective assessments.

- The results showed that the lack of objective methods to assess social sustainability in public-works procurement is common in every analyzed country. The assessment of the variability associated with the percentage of inclusion of each group of social criteria in each of the countries has shown that, except for health and safety, a wide variability exists with respect to the inclusion of social criteria. Cultural heritage and local development criteria are the least considered social criteria at the international level.

- **Objective 3 (O3): Assessing the variables associated with project characteristics which are the most influential in introducing social sustainability criteria in public-works procurement procedures.**
  - The variables country and contract size were the most influential variables including social criteria in public-works procurement. ESCs were clearly ahead of SSCs regarding the consideration of social criteria, and procurers generally seem to be more aware of social sustainability as the contract size increases. Finally, it is worth emphasizing that there were no significant differences between project delivery methods and between procurement procedures with respect to the inclusion of social criteria. However, there was a visible trend towards the use of employment and cultural heritage in traditional delivery methods and the use of professional ethics and cultural heritage in low bid procurement procedures.

  - The comparison between countries revealed important differences between ESCs and SSCs. Although both groups had similarities, such as the notable use of health and safety criteria, the main differences between these groups were associated with the consideration of the users' impact and training criteria and the percentage of inclusion of the rest of the social criteria. In general, the ESCs showed a better performance than SSCs because they include every social criterion more frequently than the SSCs.

  - Within each group of countries, important differences were found based on the use of professional ethics and employment criteria. In this regard, Colombia, Spain, and Chile, within the SSCs, and the USA and the UK, within the ESCs, were the countries that considered these criteria the most.

  - Regarding the highest inclusion of each social category per country, employment is mainly considered in tendering documents from the USA and Spain. Training criteria are frequently included in countries such as Canada, Australia, and the USA. Local criteria are highlighted at the first level in Colombia and, at the second level, in Australia, the USA, and the UK. Professional ethics criteria appear mainly in tendering documents from the USA, the UK, and Colombia. Meanwhile, users' impact is frequently considered in Australia. Regarding cultural heritage criteria, these criteria are less considered than the rest of the social categories; however, Canada is the country that considers cultural heritage criteria the most (50% of their analyzed tenders).

  - Results showed that depending on the contract size of the project, the inclusion of social criteria in tendering documents can notably vary. The inclusion of social categories in tendering documents increases significantly as the contract size is raised, except for the health and safety category that is considered in most of the projects regardless of the contract size.

- **Objective 4 (O4): Defining the indicators that should be used to assess the social sustainability criteria in public-works procurement procedures.**

  - Eight categories and 22 subcategories of social criteria were established to be considered in the construction stage of civil engineering projects. These 22 subcategories were classified into three groups of criteria: human rights (G1), corporate social responsibility (G2), and social commitment in the project (G3).

  - Human rights group (G1) comprised those criteria related to human rights (child labor, forced labor, freedom of association and collective bargaining, corruption, respect of indigenous rights, and respect of intellectual property rights).

  - Corporate social responsibility group (G2) was composed of the social criteria that, being defined at the company level, and linked to its social daily performance, can be used to assess the corporate social responsibility, of the construction companies involved in the procurement procedure. These criteria were: employment creation, job stability, occupational health and safety performance, social benefits and social security, social value, non-discrimination and equal opportunities, fair wages and fair income distributions, technical training, and sustainability training. After a literature review through the scientific literature, guides and reports, 18 sub-subcategories were needed to define the nine subcategories gathered in G2; and 83 indicators, which satisfied a group of quality criteria, were collected from these documents.

- Social commitment in the project group (G3) encompasses those social criteria whose definition must be based on the project characteristics and, thus, linked to the project. The subcategories in this group were: cultural heritage appraisal and management plan, collaboration with cultural preservationists, industry participation plan, work health and safety management officer, workplace health and safety management plan, community relations program, and effects on neighbors. Sustainability certification systems and the 451 analyzed tendering documents were used to establish a comprehensive definition of each subcategory. Seven indicators were defined to assess the seven G3's subcategories.

- **Objective 5 (O5): Determining a methodology to include the social sustainability criteria in public-works procurement procedures.**
  - To include social criteria in the procurement procedure, the unit of analysis must be the companies involved in public contracting, and the method needs to be developed ensuring the transparency, objectivity, and equitability in the bid-selection processes. The scope of the methodology was defined to assess the social sustainability of construction companies in the procurement procedures of civil engineering construction projects at the international level.
  - A methodological approach was defined for each group of social criteria: human rights (G1), corporate social responsibility (G2), and social commitment in the project (G3). The goal of the human rights group's approach was guaranteeing that every procurement procedure considers the requirements related to the human rights criteria, and ensuring that every construction company who is involved in the process knows and complies with each one of these. The goal of the methodological approach of the corporate social responsibility group was based on defining a composite indicator to assess the corporate social features of each company that participates in the tendering procedure. The objective of the social commitment in the project was defining a composite

indicator focused on assessing objectively the social commitment that the construction companies involved in the procurement procedure intend to achieve during the development of the project.

- To include human rights in public procurement, the procurer must require construction companies interested in participating in the procedure to deliver a declaration confirming their respect for human rights.

- Regarding the corporate social responsibility group, a composite indicator was defined. Two principles were established to define the composite indicator: 1) company indicators need to be quantitative, reliable and verifiable to guarantee the robustness of the methodology; and 2) the weighting system must be addressed to minimize the social weaknesses of each country over time. Sixteen company indicators were established to assess the corporate social responsibility of the construction companies. The weights were defined through the Data Envelopment Analysis based on the Benefit of Doubt Approach (DEA-BOD). The pessimistic version of this model was selected to guarantee the maximum weights in the composite indicator are assigned to the worst performance indicator in each country. National indices were selected as proxy indicators of the company indicators to perform the DEA-BOD method.

- A sensitivity analysis demonstrated that the method defined for corporate social responsibility group is valid to compare the corporate social responsibility performance of construction companies, regardless of their size. The social behavior of the construction companies significantly influences their corporate social responsibility performance results.

- To include social commitment in the project group, a composite indicator was defined. The principles established to develop this composite indicator were that both the indicators and weights had to be directly linked to the subject matter of the project; and the definition of each indicator and their level of importance had to be adaptable to the project characteristics. Seven indicators were defined and a methodology was established based on the relationship of these indicators with the characteristics of the project.

- A sensitivity analysis demonstrated that in the method defined for social commitment in the project group, the weights are adapted for each indicator depending on the features of the project. Additionally, the method is able to adapt to the project characteristics guaranteeing a minimum weight for each indicator depending on the relationships between the indicators and the project characteristics.

- **Objective 6 (O6): Identifying the stage of the public-works procurement procedures to include the social sustainability criteria.**

    - Social criteria in public-works procurement can be considered for exclusion, selection criteria and award criteria depending on two main constraints: (1) the procurement procedure (best-value or low bid); and, (2) national, regional or local policies, and requirements established by law.

    - Recommendations about how to include the social criteria in bidding specifications of civil engineering construction projects have been defined for each group of social criteria: human rights group, corporate social responsibility, and social commitment in the project.

    - Regarding human rights group, as contracting authorities have to exclude all the companies that infringe or have infringed the law or who have demonstrated highly reprehensible professional behavior from the procurement procedure, the recommendation to include the human rights criteria in public-works procurement establishes that these should be included with the grounds for exclusion of each country, state or region.

    - A composite indicator (CI_{G2}) has been defined to assess the companies involved in the procurement procedure concerning their corporate social responsibility. The indicators defined to evaluate these groups of criteria have been established to assess each company taking into account the social performance of the entire company in the country where the project is procured. To include this group of social criteria in the procurement procedure under this approach, the composite indicator 'CI_{G2}' should be included as selection criteria regardless of the procurement procedure (best value or low bid). However, the inclusion of social criteria in public procurement can strongly depend on national, regional or local policies, or on the requirements established by law.

Therefore, to satisfy these requirements, the agency could need also including some of the indicators separately as grounds for exclusion and/or selection criteria.

- A composite indicator (CI_{G3}) has been defined to assess the social commitment with in the project of each company involved in the procurement procedure. The indicators of this composite indicator have been defined as directly linked to the subject matter of the project. Based on this, the composite indicator 'CI_{G3}' should be included as one of the award criteria in best-value procurement procedures. However, when the project is awarded under the low bid procurement procedure, the composite indicator (CI_{G3}) should be included in the selection criteria phase. On the other hand, as the inclusion of these social criteria in public procurement can also strongly depend on national, regional or local policies or on the requirements established by law, the agency could need to also include some of the indicators separately as selection criteria or award criteria depending on the preferences of the agency and the selected procurement procedure.

- A practical guide to assist agencies to include, in a comprehensive and effective way, social criteria in public-works procurement has been established. This practical guide establishes the social criteria that should be considered in the procurement procedure of civil engineering construction projects and defines where and how these should be included in bidding specifications to guarantee their objective assessment.

7.3. Practical recommendations

This research has allowed the author to characterize the current situation regarding the inclusion of social criteria in public-works procurement at the international level, while establishing a methodology to include and assess the social criteria in the procurement procedures of civil engineering construction projects. Consequently, and taking into account the contributions of this research, two groups of recommendations have been developed regarding the analysis of social sustainability in public-works procurement, and the effective inclusion of social sustainability criteria in procurement procedures. These recommendations are:

- Regarding the analysis of social sustainability in public-works procurement:

  - The study of social sustainability in public-works procurement is required to know how to overcome the current barriers that are affecting successful implementation.

  - Eight categories of social criteria (cultural heritage, employment, health and safety, local development, professional ethics, public participation, training, and users' impact) are the minimum group of social criteria that should be considered when one desires to perform a study of social sustainability in the construction industry.

  - The variable "country" exhibits a significant influence over the inclusion of social criteria in public procurement at the international level. The consideration of this variable is essential when the social sustainability of construction projects is going to be compared at the international level.

  - Differentiation between ESCs and SSCs countries must be considered when developing an international assessment of social sustainability. Since the cultural history and current performance of each group of countries with respect to sustainability, make them sufficiently dissimilar as to be distinguished.

- Regarding the inclusion of social sustainability in public-works procurement:

  - All efforts should be made to integrate social sustainability appropriately within contractual procedures. In fact, although the use of social criteria in tendering procedures is a reality, in general, less than three groups of social criteria are included per tender.

  - Results show that social criteria are generally considered in public procurement procedures in the construction industry; however, the efforts of public agencies at the international level seem to have focused only on boosting the inclusion of health and safety criteria since this is the only group of criteria that appears in practically 100% of the analyzed sample. Major efforts are needed to encourage the consideration of each group of social criteria in public-works procurement to try to achieve the integration of all of them into each construction contract.

  - To achieve sustainable production in the construction industry, setting social criteria to cover each social category is needed. Additionally, metrics must be defined to assess these criteria quantitatively, control the proper performance of construction companies and monitor the achievement of social outcomes in construction projects.

- To overcome the existing shortcomings, strong social policies should be implemented to promote the use of social criteria in the award of projects. For both developing and developed countries, performance indicators should be defined, and strong implications of public agencies are required for the evaluation and monitoring of social performance in the construction industry.

- The use of subjective methods to assess social criteria in tendering procedures is the predominant option. Thus, working on these weaknesses and increasing social awareness in the construction industry is needed. For that purpose, providing a mutual understanding of social policies and explaining how these can be adjusted for each specific project and how these can be implemented, depending on procurement procedures and project delivery methods would be useful for procurers to reduce their uncertainty of how to incorporate social sustainable issues in tendering procedures.

- The inclusion of performance indicators into construction procurement, regardless of the project delivery method or procurement procedure, is required to ensure that procurer's objectives are achieved. Increasing the number of social criteria in the tendering documents and including metrics to allow an objective assessment of social sustainability in tendering procedures are key measures to boost social sustainability effectively. These recommendations are especially important in integrated projects, where aspects such as the early collaboration of the project's participants or the timing of communication are most likely to achieve sustainable outcomes. They are also key in projects with best-value procurement procedures in which the social criteria can be a fundamental part of the award criteria in the tendering procedures. Hence, tools, guides, and training programs are needed to drive procurers effectively towards the inclusion of social criteria.

7.4. Limitations

This research recognizes that the following limitations exist:

1. Regarding the analysis of social sustainability in public-works procurement,

    a) The data collection was based only on those documents that were available free online in the public procurement Internet websites of each country and were published in English or Spanish.

    b) Tendering documents were mainly from national or regional agencies, which notably reduced the number of documents from local authorities.

    c) Although the searches of the government procurement sites were largely consistent, it is possible that some tendering documents were mischaracterized, excluding them from the search results. Thus, this study cannot claim a truly random sample. However, these limitations are also shared by other studies based on the content analyses of tendering documents.

    d) This research focused only on the assessment of social sustainability criteria in public-works procurement, ignoring other dimensions of sustainability (environmental and economic).

2. Regarding the inclusion of social sustainability in public-works procurement:

    a) To assess the corporate social responsibility group in public procurement, a wide number of indicators were found in the literature review; however, only 16 indicators were established for two reasons: (1) the scope of this research focused only on assessing the social sustainability in public procurement of civil engineering construction projects; and, (2) the difficulty of ensuring the reliability and verifiability of the data associated with each indicator.

    b) While the methodologies captured most key social criteria for the construction industry, it should be emphasized that specific research should be performed to apply these methodologies, established for civil engineering construction projects, to the other stages of the infrastructure life cycle.

c) The corporate social responsibility group does not process any indicator to assess the social responsibility of subcontractors and suppliers; and, although extending the social requirements beyond the main subcontractor to their subcontractors is a recommendation of EU Public Procurement Directives, the focus group decided to refuse this option because nowadays the quality of this type of information can not be guaranteed.

d) The methodology of corporate social responsibility group (G2) has been developed for the European Union countries. Additionally, the definition of the composite indicators depends on public datasets at the macro level; thus, the availability and quality of national indices to assess the social performance of the countries influence the results.

e) Although the weighting of the G2's composite indicator avoid the subjectivity that can result from involving decision-makers in the procedure, the use of national indices to establish the weights depending on the social weaknesses that exist in each country emphasizes that the method has to rely on the availability of these national indices and the quality of their data.

f) The weighting defined for the social commitment in the project group (G3) depends on the relationships between the indicators and the project factors. These relationships could vary for each country.

g) Data from GRI reports of Spanish construction companies have been collected to perform the sensitivity analysis of the corporate social responsibility group. In the social commitment in the project group, all the project scenarios have been assessed in its sensitivity analysis. What has not been completed in this research is an extension of the proposed methodology to a specific real case study. This extension could provide insights for validating and improving the methodology.

7.5. Future research

Lines of future research have been established according to each one of the defined limitations:

- Regarding the analysis of social sustainability in public-works procurement:

  - The analysis should be extended to more countries at the international level. Additionally, this study should be performed analyzing the differences between national or regional agencies and local authorities (associated with limitation 1a, and 1b).

  - A joint analysis of the inclusion of social and environmental criteria in procurement procedures and assessing the weights that are given for these criteria in the award phase of the tendering procedure should be conducted. These studies would offer understanding of the role that each dimension plays in achieveing sustainability in public procurement of the construction industry (associated with limitation 1d).

- Regarding the inclusion of social sustainability in public-works procurement:

  - Executing real casestudies in which the social criteria are included in the procurement procedures to assess the influence that these have in the social performance of the project and involved companies (associated with limitation 2a).

  - Defining performance indicators to assess, using objective methods, social performance during the development of the construction project. Furthermore, in-depth studies are needed to analyze the real effects that the inclusion of social aspects in the tendering procedure has on the social environment (associated with limitation 2a).

  - A profound observation of the corporate social responsibility of the construction companies is recommended to adjust the indicators to the industry needs in each country (associated with limitation 2b).

  - Developing indicators and weighting methodologies to assess the social sustainability in public procurement of the other stages of the infrastructure life cycle other than construction (associated with limitation 2a and 2b).

  - Validating the selected indicators through workshops, conferences, and questionnaires (associated with limitation 2a, 2c, 2f, and 2g).

  - Developing industry-based national indices focused on assessing social performance in the construction industry. Additionally, the implementation of social sustainability criteria in public-works procurement may confuse practitioners in performing the methods in specific applications. It would, therefore, be very meaningful to study the strengths and weaknesses of each method in different scenarios (associated with limitation 2d, 2e, 2f and 2g).

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APPENDICES

APPENDIX A: PROTOCOL

The present document presents the basis of the protocol followed to gather information from tendering documents. This protocol has been defined according to Bryman (2012), Neuendorf (2017) and Stanford et al. (2016), and it contains the two main elements to a content analysis coding layout: (1) conceptualization, and (2) coding manual. Conceptualization is performed to identify and define the variables, which want to be analyzed in the study. The coding manual is a statement with the instructions to coders that also includes all the possible categories for each dimension being coded.

CONCEPTUALIZATION

This section presents the concepts of the social categories, which have to be located in tendering documents. The definitions of each social category and some examples of the literature review have been included in the following tables in order to give understanding to coders.

CATEGORY 1. CULTURAL HERITAGE

Description:

The Cultural Heritage category focuses on all those actions that favor the protection of Cultural Heritage in the area where the project will be developed. According to UNESCO, "Cultural Heritage" considered:

- Monuments: architectural works, monumental sculptures or paintings, archaeological elements or structures, inscriptions, caverns and groups of elements, which have an exceptional universal value from the point of view of history, art or science.

- Groups: groups of constructions, isolated or assembled, whose architecture, unity and integration in the landscape give them an exceptional universal value from the point of view of history, art or science.

- The places: man's works and a mixture of man and nature, including archaeological sites that have an exceptional universal value from the historical, aesthetic, ethnological or anthropological point of view.

Some examples of the literature review:

Footprint of project in archaeological site.	Ugwu et al. (2006); Ugwu and Haupt (2007)
Respect for local customs: cultural and historic heritage.	Fernández-Sánchez and Rodríguez-López (2010)
Protection to culture heritage.	Shen et al. (2011); Amiril et al. (2014)
Respect customs and beauty of the place.	Fernández-Sánchez and Rodríguez-López (2010)
Material cultural property (e.g. heritage).	Sierra et al. (2016)
Preserve historic and cultural resources.	ISI (2015)
Collaboration with historic or cultural preservationists.	CEEQUAL (2010); ISI (2015)
Preserving historical, archaeological, and cultural resources.	FHWA (2012)
Reduce negative impacts of project development on any cultural heritage (cropland, natural resources, heritages, cultures and historical sites).	Abdel-Raheem and Ramsbottom (2016)

CATEGORY 2. EMPLOYMENT

Description:	
The employment category considers aspects related to the creation of new jobs, the recruitment of vulnerable personnel (*) or under conditions of social exclusion (**), the promotion of stable jobs in enterprises, the collaboration with other companies in the sector, etc. (*) Vulnerable personnel: young people newly incorporated into employment, disabled people, unemployment people, etc. (**) Social exclusion conditions: young people over eighteen years and under thirty from Child Protection Institutions, people with drug problems or other addictive disorders that are in the process of rehabilitation or social reintegration, penitentiaries, etc.	
Some examples of the literature review:	
Employment contribution: number of employees per functional unit; number of monthly contracts.	Azapagic and Perdan (2000); GRI (2018)
Staff turnover: ratio of new employees to workforce made redundant by company in the life cycle stage.	Azapagic and Perdan (2000)
Provision of employment opportunities.	Shen et al. (2011)
Employment contribution: number of job creation.	Balubaid et al. (2015); ISI (2015); Sierra et al. (2017a)
Job opportunities and / or stability.	Sierra et al. (2016)
Job benefits (e.g. remunerations, salary stability, social security, bonuses).	Sierra et al. (2016)
Total number and rate of new employee hires and employee turnover by age group, gender, and region.	GRI (2018)
Benefits provided to full-time employees that are not provided to temporary or part-time employees, by significant locations of operation.	GRI (2018)
Employment opportunities during the works and resulting from the final project.	CEEQUAL (2010)
Employee turnover: employee departures / annual average workforce.	Rahdari and Rostamy (2015)

CATEGORY 3. HEALTH AND SAFETY

Description:	Health and safety category is aimed at implementing measures and developing the activities necessary for the prevention of work-related risks to guarantee the safety of both the workers and the population that can be involved in the development of the project.
Some examples of the literature review:	
Safety and health of workers.	Ugwu et al. (2006); Ugwu and Haupt (2007); Fernández-Sánchez and Rodríguez-López (2010)
User security.	Ugwu et al. (2006); Ugwu and Haupt (2007); Fernández-Sánchez and Rodríguez-López (2010); Sierra et al. (2016)
Emergency plan.	Fernández-Sánchez and Rodríguez-López (2010)
Occupational health and safety management systems.	Rahdari and Rostamy (2015)
Expenditure on health and safety (EHS): EHS can be expressed as total expenditure on health and safety, HS, over the total number of employees, E, to give an investment in health and safety per employee (and per functional unit).	Azapagic and Perdan (2000)
Deaths and injuries (Safety risks: injuries or fatalities per functional unit).	Jeon and Amekudzi (2005)
Health and safety practices to protect workers.	Sierra et al. (2016)
Occurrence of accidents and incidents.	Sierra et al. (2016)
Average number of accidents per worker during the reporting period.	Traverso et al. (2018)
Percentage of total workforce represented in formal joint management–worker health and safety committees that help monitor and advice on occupational health and safety programs.	GRI (2018)
Rates of injury, occupational diseases, lost days, and absenteeism, and total number of work-related fatalities, by region and by gender.	GRI (2018)
Safety design.	FHWA (2012)
Number of hours of health & safety training given during the reporting period.	Traverso et al. (2018)
Public safety.	ISI (2015)

CATEGORY 4. LOCAL

Description:	The local category seeks to give preference to local entities for the development of the project and/or promote entrepreneurial initiatives that favor local development through collaborations with local entities or local personnel during the development of the project.
Some examples of the literature review:	
Use of local /regional materials.	Ugwu et al. (2006); Ugwu and Haupt (2007)
% Budget in local materials.	Fernández-Sánchez and Rodríguez-López (2010)
Number of local workers / total number of employees.	Fernández-Sánchez and Rodríguez-López (2010); Dobrovolskiien and Tamošiluniene (2016)
Effects on local development.	Shen et al. (2011)
Promotion of community development.	Shen et al. (2011)
Local economic benefits.	Sierra et al. (2016)
Improve local employment levels, skills mix, and capabilities.	ISI (2015)
Policy, practices, and proportion of spending on locally-based suppliers.	GRI (2018)
Procedures for local hiring and proportion of senior local community at locations of significant operation.	GRI (2018)
Local companies to work on the project.	CEEQUAL (2010)
Social impacts during construction on the workforce and on the local community.	CEEQUAL (2010)
The project team commits to working with the community to assess local employment and educational needs.	ISI (2015)
Documentation of plans and commitments for hiring local workers for the project.	ISI (2015)
Engagement with local schools to raise awareness of civil engineering or enhancement to community facilities as part of the contract.	CEEQUAL (2010)
Support and stimulate sustainable growth and development of local communities, including improvements in job growth, capacity building, productivity, business attractiveness, and livability.	ISI (2015)
Improve the net quality of life of all communities	ISI (2015)

affected by the project and mitigate negative impacts to communities.	
Public educational outreach that promotes and educates the public about sustainability including social, environmental, and economic principles.	FHWA (2012)

CATEGORY 5. PROFESSIONAL ETHICS

Description: The professional ethics category criterion refers to the set of policies or actions aimed at improving the development of professional activities through the implementation of anti-corruption policies, gender equality, practices of non-discrimination in hiring processes, fair working conditions, etc.	
Some examples of the literature review:	
Corruption.	Ugwu et al. (2006); Ugwu and Haupt (2007)
Corporate social responsibility.	Fernández-Sánchez and Rodríguez-López (2010); Valdes-Vasquez and Klotz (2013)
Transparency and integrity.	Sierra et al. (2016)
Equity (e.g. gender, social condition, race)	Sierra et al. (2016)
Consideration of employees' sociocultural-religious aspects.	Sierra et al. (2016)
Return to work and retention rates after parental leave, by gender.	GRI (2018)
Percentage of employees covered by collective bargaining agreements.	GRI (2018)
Minimum notice period(s) regarding operational changes, including whether it is specified in collective agreements.	GRI (2018)
"Ratio of basic salary and remuneration of women to men by employee category, by significant locations of operation."	GRI (2018)
Percentage of workers whose wages and social benefits meet at least the legal or industry minimum wage, and are rendered in full compliance with all applicable laws.	Traverso et al. (2018)
Percentage of workers who are paid a living wage.	Traverso et al. (2018)
Average number of hours worked per worker per week during the reporting period.	Traverso et al. (2018)
Number of hours of child labor identified during the reporting period.	Traverso et al. (2018)
Average number of actions targeting business partners to raise awareness about the issue of child labor during the reporting period.	Traverso et al. (2018)
Number of hours of forced labor identified during the	Traverso et al. (2018)

reporting period.	
Number of actions targeting business partners to raise awareness about the issue of forced labor during the reporting period.	Traverso et al. (2018)
Number of complaints related with discrimination identified during the reporting period.	Traverso et al. (2018)
Number of actions taken to increase staff diversity and/or promote equal opportunities during the reporting period.	Traverso et al. (2018)
Number of associations in which the workers are members to organize themselves and/or collectively bargain.	Traverso et al. (2018)
Percentage of workers who have a recognized employment contract.	Traverso et al. (2018)

CATEGORY 6. PUBLIC PARTICIPATION

Description: The public participation category includes those actions aimed at integrating the opinion of the population in the decision making of the project.	
Some examples of the literature review:	
Public participation and control on the project.	Fernández-Sánchez and Rodríguez-López (2010)
Provision of information through collective audiences.	Sierra et al. (2016)
Consideration of actors' opinions regarding project development.	Sierra et al. (2016)
Citizen participation.	Valdes-Vasquez and Klotz (2013); Amiril et al. (2014); Sierra et al. (2017a)
Community involvement.	Valdes-Vasquez and Klotz (2013)
Stakeholder engagement.	Valdes-Vasquez and Klotz (2013)
Community relations programme.	CEEQUAL (2010)
Establishing and maintaining a positive dialogue with community stakeholders throughout the whole project process.	CEEQUAL (2010)
Cooperation with the relevant authorities, agencies and local community.	CEEQUAL (2010)

CATEGORY 7. TRAINING

Description: The training criterion includes those actions aimed at increasing the level of knowledge in technical and/or sustainability-related issues (environmental, social and economic impact of the actions).	
Some examples of the literature review:	
Investment in staff development	Azapagic and Perdan (2000)
yearly training hours / total number of employees.	Fernández-Sánchez and Rodríguez-López (2010); Rahdari and Rostamy (2015); Dobrovolskiien and Tamošiluniene (2016); Sierra et al. (2016); GRI (2018)
Workforce's awareness of sustainability.	Sierra et al. (2016)
Programs for skills management and lifelong learning that support the continued employability of employees and assist them in managing career endings.	GRI (2018)
Number of hours of training during the reporting period.	Traverso et al. (2018)
The project team identifies training and worker education needs.	Abdel-Raheem and Ramsbottom (2016)
Program of training on social issues relevant to the project delivered.	CEEQUAL (2010)
Training and education programs are established in the project delivery phases to strengthen the skills base.	ISI (2015)
Hours of training per year per employee.	Popovic et al. (2018)

CATEGORY 8. USERS' IMPACT

Description:	The users' impact criterion aims to minimize the possible inconvenience that the population may experience due to the development of the project (mobility, services, etc.)
Some examples of the literature review:	
Congestion.	Ugwu et al. (2006); Ugwu and Haupt (2007)
Diversion of roads during construction stage.	Ugwu et al. (2006); Ugwu and Haupt (2007)
Impact on mobility.	Sierra et al. (2016)
Improve community mobility and access.	FHWA (2012); ISI (2015)
Users travel times.	Fernández-Sánchez and Rodríguez-López (2010)
Transport issues that may be of concern during the construction stage should be considered in the detailed design of the project.	CEEQUAL (2010)
Traffic management plans.	CEEQUAL (2010)
To reduce traffic noise.	ISI (2015)
Easing traffic congestion, improving mobility and access, and otherwise improving community livability.	ISI (2015)
Existing site assessment to minimize nuisance.	CEEQUAL (2010)

CODING MANUAL

The coding manual provides a list of all variables and categories to be employed in the coding process. It establishes the dimensions subsumed under each variable or category, the codes that correspond to each dimension and guidance on what each dimension is concerned with and any factor that should be taken into account in deciding how to allocate any particular code to each dimension.

CODING MANUAL:

Unit of Data Collection: tender of a project associated with any of the phases of an infrastructure life cycle. Only those tender documents that include tender characteristics, technical specifications of the project, and contract performance clauses must be analyzed.

Coded ID: Indicate the number of the individual who coded the tender project, according to the cored ID list.

Project ID: Give each project a unique 3-digit number, beginning with 001 and proceeding upward without duplication across all projects.

Name of the project: Fill the project name and the reference established by the country.

Description of the main objective of the project: Give a brief description of the main objective of the project.

VARIABLES: PRINCIPAL CHARACTERISTICS OF THE PROJECT

Country: Indicate the country which is tendering the project

- Spain.
- Australia.
- Panama.
- Colombia.
- Chile.
- The United States.
- Canada.
- The United Kingdom.
- Argentina.
- Peru.

Type of infrastructure: Indicate whether the infrastructure corresponds with a civil engineering infrastructure or a building.

- Building.
- Civil engineering: this group gathers works related to roads and highways, hydraulic works, airports, maritime works and railway.

Contract size: Indicate the project size/budget, which is defined in the tender characteristics to develop the project. Maintain the currency indicated in the tendering documents.

Contract duration: Indicate the duration of the contract (year) which is defined in the tender characteristics to develop the project. Include base periods and any option periods.

<u>SOCIAL CATEGORIES IN THE PROJECT</u>

Category 1. Cultural Heritage: indicate, for each indicator, which is related to cultural heritage aspects, the following information:

- ID number: Give each indicator associated with cultural heritage a unique 4-digit number, beginning with 1001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
    - Indicator with metric.
    - Indicator without metric.

Category 2. Employment: indicate, for each indicator which is related to employment aspects, the following information:

- ID number: Give each indicator associated with employment a unique 4-digit number, beginning with 2001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.

- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
    - Indicator with metric.
    - Indicator without metric.

Category 3. Health and Safety: indicate, for each indicator, which is related to health and safety aspects, the following information:

- ID number: Give each indicator associated with health and safety a unique 4-digit number, beginning with 3001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
    - Indicator with metric.
    - Indicator without metric.

Category 4. Local: indicate, for each indicator, which is related to local aspects, the following information:

- ID number: Give each indicator associated with local a unique 4-digit number, beginning with 4001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
    - Indicator with metric.
    - Indicator without metric.

Category 5. Professional ethics: indicate, for each indicator, which is related to professional ethics aspects, the following information:

- ID number: Give each indicator associated with professional ethics a unique 4-digit number, beginning with 5001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.

- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
  - Indicator with metric.
  - Indicator without metric.

Category 6. Public participation: indicate, for each indicator, which is related to public participation aspects, the following information:

- ID number: Give each indicator associated with public participation a unique 4-digit number, beginning with 6001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
  - Indicator with metric.
  - Indicator without metric.

Category 7. Training: indicate, for each indicator, which is related to training aspects, the following information:

- ID number: Give each indicator associated with training a unique 4-digit number, beginning with 7001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
  - Indicator with metric.
  - Indicator without metric.

Category 8. Users' impact: indicate, for each indicator, which is related to users' impact aspects, the following information:

- ID number: Give each indicator associated with users' impact a unique 4-digit number, beginning with 8001 and proceeding upward without duplications across all episodes. If an indicator appears more than once in the tendering documents of the project, code it each time, but use the same ID number. It is important that these numbers are accurate and non-duplicative.
- Description of the indicator: Include the definition of the indicator, which appears in the document.
- Type of indicator: Indicate whether the indicator contain metrics to be assessed or the definition is qualitative:
  - Indicator with metric.
  - Indicator without metric.

APPENDIX B: PROPOSAL OF PROXY INDICATORS

This appendix provides a brief description of each proxy indicator.

Table B-1: National inicators selected by the practical assessment

National Indicators	Description	Source
Ratio of female to male labor force participation rate	Ratio of female to male labor force participation rate is calculated by dividing female labor force participation rate by male labor force participation rate and multiplying by 100.	ILOSTAT database (World bank)
Ratio of female to male salary	The ratio of female to male salary is calculated by dividing the average gross hourly earnings of female paid employees by the average gross hourly earnings of male paid employees.	Eurostat database
Employed women being in managerial positions	Percentage of women in the occupational group of managerial positions as a share of all employed persons in that group. The occupational group of managerial positions is defined as the ISCO major group 1.	Eurostat database
Death rate due to chronic diseases	Number per 100 000 persons aged less than 65 The indicator measures the standardized death rate of chronic diseases. Death due to chronic diseases is considered premature if it occurs before the age of 65. The rate is calculated by dividing the number of people under 65 dying due to chronic disease by the total population under 65. This value is then weighted with the European Standard Population. Chronic diseases included in the indicator are malignant neoplasms, diabetes mellitus, ischemic heart diseases, cerebrovascular diseases, chronic lower respiratory diseases, and chronic liver diseases.	Eurostat database
Fatal accidents at work	Number of fatal accidents per 100,000 workers. A fatal accident at work is defined as an accident which leads to the death of a victim within one year of the accident.	Eurostat database
Non-fatal accidents at work	Number of non-fatal accidents per 100,000 workers. An accident at work is defined as 'a discrete occurrence in the course of work which leads to physical or mental harm'. Fatal and non-fatal accidents involving more than 3 calendar days of absence from work. If the accident does not lead to the death of the victim it is called a 'non-fatal' (or 'serious') accident.	Eurostat database
Unemployment with advanced education	The percentage of the labor force with an advanced level of education that is unemployed. Advanced education comprises short-cycle tertiary education, a bachelor’s degree or equivalent education level, a master’s degree or equivalent education level, or doctoral degree or equivalent education level according to the International Standard Classification of Education 2011 (ISCED 2011).	ILOSTAT database (World bank)
Unemployment with basic education	The percentage of the labor force with a basic level of education that is unemployed. Basic education comprises primary education or lower secondary education according to the International Standard Classification of Education 2011 (ISCED 2011).	ILOSTAT database (World bank)
Unemployment with intermediate education	The percentage of the labor force with an intermediate level of education that is unemployed. Intermediate education comprises upper secondary or post-secondary non tertiary education according to the International Standard Classification of Education 2011 (ISCED 2011).	ILOSTAT database (World bank)
Unemployment, female	The percentage of unemployed female labor force. Unemployment refers to the share of the labor force that is without work but available for and seeking employment.	ILOSTAT database (World bank)
Unemployment rate	Unemployment refers to the share of the labor force that is without work but available for and seeking employment.	ILOSTAT database (World bank)

APPENDIX B: PROPOSAL OF PROXY INDICATORS

National Indicators	Description	Source
Youth unemployment rate	Percentage of total labor force ages 15-24. Youth unemployment refers to the share of the labor force ages 15-24 without work but available for and seeking employment.	ILOSTAT database (World bank)
Long-term unemployment rate	Percentage of active population. The indicator measures the share of the economically active population aged 15 to 74 who has been unemployed for 12 months or more.	Eurostat database
Unemployment rate of disabled people	Disabled people are people having a work limitation caused by a longstanding health condition and/or a basic activity difficulty. Unemployment rate represents unemployment persons as a percentage of the active population.	Eurostat database
Unemployment rate by Foreign-born	The foreign-born unemployment rate is calculated as the share of unemployed foreign-born persons aged 15-64 in the foreign-born labor force (the sum of employed and unemployed foreign-born) of that same age.	Eurostat database
Temporary employment	A job may be considered temporary if employer and employee agree that its end is determined by objective conditions such as a specific date, the completion of a task or the return of another employee who has been temporarily replaced (usually stated in a work contract of limited duration). Typical cases are: (a) persons with seasonal employment; (b) persons engaged by an agency or employment exchange and hired to a third party to perform a specific task (unless there is a written work contract of unlimited duration); (c) persons with specific training contracts. The indicator is based on the EU Labor Force Survey.	Eurostat database
Job tenure	Percentage of employed persons with job tenure less than 1 year	ILOSTAT database (World bank)
Employed persons At-risk-of poverty rate	Individuals (18-64) who are classified as employed and are at risk of poverty.	Eurostat database
Public health expenditure	Health care expenditure quantifies the economic resources dedicated to health functions, excluding capital investment.	Eurostat database
Employed persons participating in job-related non-formal education and training in the past 12 months	Percentage of employed persons participating in job-related non-formal education and training in the past 12 months	Eurostat database
Human Development Index (2016)	The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.	Eurostat database
Corruption perception Index	The CPI captures the assessment of experts and business executives on a number of corrupt behaviors in the public sector, including: Bribery, Diversion of public funds, Use of public office for private gain, Nepotism in the civil service, State capture. The index uses a scale of 0 to 100, where 0 is highly corrupt and 100 is very clean.	Eurostat database
Patent applications	The indicator measures the requests for protection of an invention directed either directly to the European Patent Office (EPO) or filed under the Patent Cooperation Treaty and designating the EPO (Euro-PCT), regardless of whether they are granted or not. If one application to the EPO has more than one inventor, the application is divided equally among all of them and subsequently among their countries of residence, thus avoiding double counting. Euro-PCT applications are allocated according to the nationality of the first listed applicant. The data shows the total number of applications per country and per million inhabitants.	Eurostat database

National Indicators	Description	Source
Research and development expenditure	Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. R&D expenditures include all expenditures for R&D performed within the business enterprise sector (BERD) on the national territory during a given period, regardless of the source of funds. R&D expenditure in BERD is shown as a percentage of GDP (R&D intensity).	Eurostat database

Table B-2: Values associated with each national indicator for each European country

	Indicators selected by the practical assessment							
European Countries	**NI_1**	**NI_2**	**NI_3**	**NI_4**	**NI_5**	**NI_6**	**NI_7**	**NI_8**
Germany	2.53	3.77	9.37	4.17	1.77	6.89	10.6	13.01
Austria	3.77	5.03	10.10	5.80	1.80	10.73	11.9	9.08
Belgium	4.47	8.67	15.03	7.90	3.97	20.41	8.8	9.54
Bulgaria	4.00	8.33	24.93	7.57	4.50	17.73	8.8	4.37
Cyprus	13.10	16.93	13.33	13.27	5.70	27.40	16.3	16.70
Croatia	9.37	18.80	21.70	13.63	7.13	33.21	11.0	21.15
Denmark	5.13	6.13	10.13	6.23	1.47	11.37	17.2	11.71
Slovak Republic	6.97	12.30	34.80	10.07	6.17	22.30	10.4	10.10
Slovenia	6.90	11.10	14.07	8.17	4.03	14.97	10.0	17.63
Spain	14.83	24.40	33.10	19.70	9.53	44.14	15.0	25.96
Estonia	4.23	7.67	12.73	6.77	2.13	13.51	12.9	3.35
Finland	5.33	9.37	19.87	8.93	2.23	20.76	13.9	15.79
France	6.07	11.03	16.37	10.13	4.47	24.20	10.0	16.62
Greece	22.77	34.10	29.27	23.83	16.93	46.67	8.6	11.53
Hungary	2.60	6.60	16.40	5.37	2.40	13.79	11.8	9.97
Ireland	5.13	10.07	13.53	7.83	4.23	17.14	11.6	8.69
Italy	8.57	12.93	17.57	11.73	6.70	38.43	8.8	14.48
Latvia	5.13	10.63	24.33	9.63	3.93	16.84	12.0	3.50
Lithuania	3.67	11.07	26.93	8.37	3.20	14.74	14.5	1.88
Luxembourg	4.23	7.00	10.40	6.33	2.07	17.64	10.3	9.42
Malta	2.37	3.23	10.17	4.97	2.00	10.95	9.4	6.93
Netherlands	4.07	7.43	11.63	5.93	2.47	10.29	10.9	20.96
Poland	4.40	9.57	16.73	6.27	2.23	17.64	9.3	27.22
Portugal	9.80	15.23	13.43	11.13	5.97	27.68	11.8	22.08
United Kingdom	3.07	6.03	9.03	4.93	1.33	13.10	12.3	5.99
Czech Republic	2.83	5.90	21.30	4.13	1.70	10.47	8.8	10.25
Romania	4.50	6.30	5.30	6.20	2.67	20.17	4.8	1.32
Sweden	3.77	6.30	20.97	7.20	1.33	19.02	15.6	16.92

Note: NI_1: Unemployment with advanced education; NI_2: Unemployment with intermediate education; NI_3: Unemployment with basic education; NI_4: Unemployment rate; NI_5: Long-term unemployment rate; NI_6: Youth unemployment rate; NI_7: Job tenure; NI_8: Temporary employment.

Table B-3: Values associated with each national indicator for each European country

	Indicators selected by the practical assessment							
European Countries	**NI_{9}**	**NI_{10}**	**NI_{11}**	**NI_{12}**	**NI_{13}**	**NI_{14}**	**NI_{15}**	**NI_{16}**
Germany	19.45	113.95	3.89	4820.85	92.30	29.4	82.9	78.1
Austria	16.30	110.15	4.70	3284.99	89.15	31.2	83.0	78.7
Belgium	15.10	104.75	6.28	3477.36	89.30	33.0	81.2	93.6
Bulgaria	10.95	204.05	12.77	136.90	78.70	38.2	80.4	85.3
Cyprus	7.58	87	9.73	877.06	85.30	24.1	85.9	86.0
Croatia	13.99	181.15	7.57	1073.64	82.35	28.7	78.8	91.3
Denmark	16.77	111.95	2.65	3965.89	92.25	27.8	87.7	84.6
Slovak Republic	12.03	194.85	5.07	262.12	84.25	33.4	84.2	80.6
Slovenia	14.95	129.7	11.32	2513.56	88.50	40.1	77.2	92.4
Spain	14.50	96.9	9.09	5835.91	88.20	31.1	81.4	85.6
Estonia	13.54	158.65	8.26	1507.28	86.25	35.0	80.3	73.2
Finland	12.34	103.15	3.21	4158.57	88.75	33.2	88.7	82.2
France	15.66	104.75	9.16	5973.43	89.35	32.8	83.8	84.7
Greece	9.98	120.5	7.03	511.27	86.80	27.2	74.8	87.5
Hungary	10.14	256.85	9.11	347.10	83.30	39.9	74.5	85.6
Ireland	13.44	101.85	7.77	1163.49	92.15	35.6	78.2	86.1
Italy	13.65	88.2	7.50	2231.72	87.85	27.8	67.3	94.4
Latvia	9.81	224.6	5.27	238.12	82.50	45.8	81.5	82.9
Lithuania	12.94	229.1	15.47	396.75	84.40	39.2	84.3	86.0
Luxembourg	13.64	90.8	4.17	5812.40	89.40	18.1	82.2	94.5
Malta	15.64	103.1	11.91	3618.63	84.80	28.8	63.0	89.3
Netherlands	20.86	98.65	1.61	2280.72	92.20	26.5	83.4	84.1
Poland	10.70	161.4	5.70	518.45	84.75	41.4	75.0	92.6
Portugal	12.20	114.9	15.82	6883.50	83.65	34.7	83.6	83.3
United Kingdom	16.52	112.9	2.29	1126.50	91.00	36.1	83.2	79.0
Czech Republic	14.91	143.8	8.40	858.34	87.40	26.8	75.8	77.7
Romania	12.84	232.35	15.87	113.96	79.60	32.1	70.1	94.8
Sweden	19.03	81.3	2.16	1216.42	91.15	39.6	90.1	86.3

Note: NI_{9}: Public health expenditure; NI_{10}: Death rate due to chronic diseases; NI_{11}: Fatal accidents at work; NI_{12}: Non-fatal accidents at work; NI_{13}: Human Development Index; NI_{14}: Employed women being in managerial positions; NI_{15}: Ratio of female to male labor force participation rate; NI_{16}: Ratio of female to male salary.

Table B-4: Values associated with each national indicator for each European country

	Indicators selected by the practical assessment							
European Countries	NI $_{17}$	NI $_{18}$	NI $_{19}$	NI $_{20}$	NI $_{21}$	NI $_{22}$	NI $_{23}$	NI $_{24}$
Germany	3.80	12.20	6.97	9.70	41.7	81.00	256.97	2.89
Austria	5.40	6.00	10.93	7.80	43.8	75.33	230.54	2.91
Belgium	7.53	10.10	15.37	4.70	47.7	76.33	137.73	2.35
Bulgaria	7.00	14.30	7.57	9.43	15.9	41.67	6.55	0.72
Cyprus	13.47	10.20	13.27	8.37	22.9	57.67	9.36	0.47
Croatia	14.33	16.30	13.63	5.73	26.1	49.67	3.43	0.77
Denmark	6.57	10.80	11.40	5.23	38.0	89.67	245.12	3.03
Slovak Republic	11.27	19.00	8.33	6.07	47.2	50.67	9.39	0.85
Slovenia	8.90	9.90	10.47	6.40	43.2	60.67	65.54	2.59
Spain	21.43	23.30	26.43	12.90	32.0	57.67	32.54	1.27
Estonia	6.30	18.40	7.73	10.47	49.2	70.33	18.42	1.81
Finland	8.57	9.10	16.97	3.43	55.2	88.00	341.72	3.36
France	9.83	12.30	16.47	7.80	40.8	69.67	138.74	2.26
Greece	28.57	14.60	30.87	13.63	8.8	46.00	10.77	0.76
Hungary	5.43	19.40	5.33	8.53	25.5	48.00	22.51	1.33
Ireland	6.43	17.90	9.63	5.00	50.9	74.00	71.83	1.62
Italy	12.83	8.10	14.93	11.40	30.4	50.34	69.67	1.28
Latvia	8.50	17.50	9.63	8.53	34.1	56.63	42.12	0.67
Lithuania	7.23	23.60	8.37	8.90	33.8	58.93	16.61	0.96
Luxembourg	6.73	4.90	7.77	11.57	49.2	73.23	111.16	1.35
Malta	5.23	4.97	9.30	5.63	38.4	56.19	12.53	0.85
Netherlands	6.37	8.60	10.53	5.30	50.5	75.07	206.23	2.06
Poland	6.37	11.50	9.70	10.87	35.5	65.88	16.02	0.92
Portugal	11.37	14.40	12.70	10.83	26.0	62.67	12.16	1.39
United Kingdom	4.77	10.60	5.67	8.47	50.6	80.45	83.58	1.71
Czech Republic	5.00	15.70	5.30	3.80	52.9	63.91	25.68	1.94
Romania	5.30	8.10	6.20	19.17	19.2	59.03	5.11	0.44
Sweden	6.90	9.60	15.83	7.47	45.4	84.82	350.41	3.28

Note: NI $_{17}$: Unemployment female; NI $_{18}$: Unemployment rate of disabled people; NI $_{19}$: Unemployment rate by Foreign-born; NI $_{20}$: Employed persons At-risk-of poverty rate; NI $_{21}$: Employed persons participating in job-related non-formal education and training in the past 12 months; NI $_{22}$: Corruption Perception Index; NI $_{23}$: Patent applications; NI $_{24}$: Research and development expenditure.

APPENDIX C: SCENARIOS OF WEIGHTS IN CORPORATE SOCIAL RESPONSIBILITY

This appendix collects the results for each analyzed country in each scenario of α_j, and in each scenario of β_j.

Table C-1: Minimum and maximum weights in each country for each scenario of α_j

	α_j = 0.00		α_j = 0.01		α_j = 0.02		α_j = 0.03		α_j = 0.04		α_j = 0.05		α_j = 0.06	
Countries	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i
Germany	0.00	1.00	0.01	0.89	0.01	0.76	0.02	0.63	0.03	0.48	0.04	0.31	0.05	0.13
Austria	0.00	1.00	0.01	0.89	0.01	0.76	0.02	0.62	0.03	0.48	0.04	0.31	0.05	0.13
Belgium	0.00	1.00	0.01	0.87	0.02	0.73	0.02	0.58	0.03	0.43	0.04	0.28	0.05	0.11
Bulgaria	0.00	0.68	0.01	0.62	0.01	0.55	0.02	0.45	0.02	0.32	0.03	0.22	0.04	0.11
Cyprus	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.64	0.02	0.49	0.03	0.33	0.04	0.14
Croatia	0.00	1.00	0.01	0.88	0.01	0.75	0.02	0.62	0.03	0.47	0.04	0.31	0.05	0.13
Denmark	0.00	1.00	0.01	0.91	0.01	0.80	0.02	0.68	0.03	0.53	0.04	0.37	0.05	0.16
Slovak Republic	0.00	1.00	0.01	0.88	0.01	0.76	0.02	0.62	0.03	0.47	0.04	0.31	0.04	0.13
Slovenia	0.00	1.00	0.01	0.88	0.01	0.75	0.02	0.61	0.03	0.46	0.04	0.29	0.05	0.12
Spain	0.00	1.00	0.01	0.89	0.01	0.76	0.02	0.63	0.03	0.48	0.03	0.31	0.04	0.13
Estonia	0.00	1.00	0.01	0.90	0.01	0.79	0.02	0.66	0.03	0.51	0.04	0.35	0.05	0.15
Finland	0.00	1.00	0.01	0.88	0.01	0.76	0.02	0.62	0.03	0.47	0.04	0.31	0.05	0.13
France	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.64	0.03	0.49	0.04	0.32	0.05	0.14
Greece	0.00	0.68	0.01	0.63	0.01	0.55	0.02	0.45	0.02	0.34	0.03	0.23	0.04	0.11
Hungary	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.64	0.03	0.49	0.03	0.33	0.04	0.14
Ireland	0.00	1.00	0.01	0.88	0.01	0.75	0.02	0.61	0.03	0.46	0.04	0.30	0.05	0.12
Italy	0.00	1.00	0.01	0.88	0.01	0.76	0.02	0.62	0.03	0.47	0.04	0.31	0.05	0.13
Latvia	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.63	0.03	0.48	0.03	0.32	0.04	0.13
Lithuania	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.64	0.02	0.49	0.03	0.33	0.04	0.14
Luxembourg	0.00	1.00	0.01	0.90	0.01	0.79	0.02	0.67	0.03	0.52	0.04	0.35	0.05	0.15
Malta	0.00	1.00	0.01	0.90	0.01	0.79	0.02	0.66	0.03	0.51	0.03	0.34	0.04	0.15
Netherlands	0.00	1.00	0.01	0.89	0.01	0.76	0.02	0.63	0.03	0.48	0.04	0.32	0.05	0.13
Poland	0.00	1.00	0.01	0.90	0.01	0.79	0.02	0.66	0.03	0.51	0.04	0.34	0.05	0.15
Portugal	0.00	1.00	0.01	0.89	0.01	0.77	0.02	0.63	0.03	0.49	0.04	0.32	0.05	0.14
United Kingdom	0.00	1.00	0.01	0.89	0.01	0.76	0.02	0.63	0.03	0.48	0.04	0.31	0.05	0.13
Czech Republic	0.00	1.00	0.01	0.88	0.01	0.76	0.02	0.62	0.03	0.47	0.04	0.31	0.05	0.13
Romania	0.00	0.59	0.01	0.49	0.01	0.46	0.02	0.36	0.02	0.29	0.03	0.19	0.04	0.10
Sweden	0.00	1.00	0.01	0.90	0.01	0.79	0.02	0.66	0.03	0.52	0.04	0.35	0.05	0.15

Table C-2: minimum and maximum weights in each country for each scenario of β_j

Countries	β_j= 1		β_j=0,8		β_j=0,6		β_j=0,4		β_j=0,2		β_j=0,1	
	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i	Min w_i	Max w_i
Germany	0.01	0.89	0.01	0.84	0.01	0.64	0.01	0.43	0.01	0.23	0.01	0.13
Austria	0.01	0.89	0.01	0.84	0.01	0.65	0.01	0.44	0.01	0.23	0.01	0.13
Belgium	0.01	0.87	0.01	0.82	0.01	0.62	0.01	0.41	0.01	0.21	0.01	0.11
Bulgaria	0.01	0.62	0.01	0.59	0.01	0.50	0.01	0.42	0.01	0.22	0.01	0.12
Cyprus	0.01	0.89	0.01	0.84	0.01	0.63	0.01	0.42	0.01	0.23	0.01	0.13
Croatia	0.01	0.88	0.01	0.83	0.01	0.63	0.01	0.43	0.01	0.22	0.01	0.12
Denmark	0.01	0.91	0.01	0.87	0.01	0.69	0.01	0.49	0.01	0.27	0.01	0.15
Slovak Republic	0.01	0.88	0.01	0.83	0.01	0.63	0.01	0.42	0.01	0.22	0.01	0.12
Slovenia	0.01	0.88	0.01	0.83	0.01	0.62	0.01	0.42	0.01	0.22	0.01	0.12
Spain	0.01	0.89	0.01	0.84	0.01	0.63	0.01	0.43	0.01	0.22	0.01	0.12
Estonia	0.01	0.90	0.01	0.86	0.01	0.67	0.01	0.47	0.01	0.26	0.01	0.14
Finland	0.01	0.88	0.01	0.83	0.01	0.63	0.01	0.43	0.01	0.22	0.01	0.12
France	0.01	0.89	0.01	0.85	0.01	0.66	0.01	0.46	0.01	0.25	0.01	0.13
Greece	0.01	0.63	0.01	0.59	0.01	0.52	0.01	0.42	0.01	0.22	0.01	0.12
Hungary	0.01	0.89	0.01	0.84	0.01	0.65	0.01	0.45	0.01	0.24	0.01	0.13
Ireland	0.01	0.88	0.01	0.83	0.01	0.63	0.01	0.43	0.01	0.22	0.01	0.12
Italy	0.01	0.88	0.01	0.83	0.01	0.63	0.01	0.42	0.01	0.22	0.01	0.12
Latvia	0.01	0.89	0.01	0.84	0.01	0.64	0.01	0.43	0.01	0.23	0.01	0.12
Lithuania	0.01	0.89	0.01	0.84	0.01	0.63	0.01	0.43	0.01	0.23	0.01	0.13
Luxembourg	0.01	0.90	0.01	0.86	0.01	0.66	0.01	0.46	0.01	0.25	0.01	0.14
Malta	0.01	0.90	0.01	0.85	0.01	0.66	0.01	0.45	0.01	0.25	0.01	0.14
Netherlands	0.01	0.89	0.01	0.84	0.01	0.63	0.01	0.43	0.01	0.23	0.01	0.13
Poland	0.01	0.90	0.01	0.85	0.01	0.66	0.01	0.46	0.01	0.25	0.01	0.14
Portugal	0.01	0.89	0.01	0.84	0.01	0.63	0.01	0.42	0.01	0.23	0.01	0.13
United Kingdom	0.01	0.89	0.01	0.84	0.01	0.64	0.01	0.44	0.01	0.23	0.01	0.13
Czech Republic	0.01	0.88	0.01	0.84	0.01	0.64	0.01	0.43	0.01	0.23	0.01	0.12
Romania	0.01	0.49	0.01	0.50	0.01	0.48	0.01	0.36	0.01	0.21	0.01	0.12
Sweden	0.01	0.90	0.01	0.86	0.01	0.67	0.01	0.47	0.01	0.26	0.01	0.14

APPENDIX D: POSSIBLE VALUES OF COMPANY INDICATORS FOR EACH FIRM

This appendix shows the tables with the possible values associated with each company indicator for each firm.

Table D-1: Possible values of each company indicator in firm 1

Firm 1					
Company Indicators	**Possible values**				
I'$_1$	1.00				
I'$_2$	0.75				
I'$_3$	0.63				
I'$_4$	0.00	0.25	0.50	0.75	1.00
I'$_5$	0.34				
I'$_6$	0.79				
I'$_7$	0.54				
I'$_8$	0.00	0.50	1.00		
I'$_9$	0.68				
I'$_{10}$	0.95				
I'$_{11}$	0.61				
I'$_{12}$	1.00				
I'$_{13}$	0.00	0.50	1.00		
I'$_{14}$	1.00				
I'$_{15}$	0.67				
I'$_{16}$	1.00				

Note: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-2: Possible values of each company indicator in firm 2

Firm 2							
Company Indicators	**Possible values**						
I'$_1$	0.04						
I'$_2$	0.00						
I'$_3$	0.54						
I'$_4$	0.50	0.75	1.00				
I'$_5$	0.17	0.29	0.42	0.54	0.67	0.79	0.92
I'$_6$	0.00	0.17	0.33	0.50	0.67	0.83	1.00
I'$_7$	0.05	0.17	0.30	0.42	0.55		
I'$_8$	0.01						
I'$_9$	0.80						
I'$_{10}$	0.00	0.50	1.00				
I'$_{11}$	0.22						
I'$_{12}$	0.85						
I'$_{13}$	0.00	0.00	0.00				
I'$_{14}$	0.61						
I'$_{15}$	1.00						
I'$_{16}$	0.06						

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-3: Possible values of each company indicator in firm 3

Firm 3							
Company Indicators	**Company Indicators**						
I'_1	0.28						
I'_2	0.21						
I'_3	0.00	0.50	1.00				
I'_4	0.00	0.25	0.50	0.75	1.00		
I'_5	0.11	0.23	0.36	0.48	0.61	0.73	0.86
I'_6	0.00	0.17	0.33	0.50	0.67	0.83	1.00
I'_7	0.25	0.37	0.50	0.62	0.75		
I'_8	0.00	0.50	1.00				
I'_9	0.26						
I'_{10}	0.00	0.50	1.00				
I'_{11}	0.73						
I'_{12}	0.00	0.50	1.00				
I'_{13}	0.00	0.50	1.00				
I'_{14}	0.28						
I'_{15}	0.00	0.50	1.00				
I'_{16}	0.13						

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-4: Possible values of each company indicator in firm 4

Firm 4					
Company Indicators	**Possible values**				
I'_1	0.72				
I'_2	0.67				
I'_3	0.00				
I'_4	0.33	0.58	0.83		
I'_5	0.32	0.44	0.57	0.69	0.82
I'_6	0.57	0.90			
I'_7	0.31	0.56			
I'_8	0.00	0.50	1.00		
I'_9	0.58				
I'_{10}	0.00	0.50	1.00		
I'_{11}	0.58				
I'_{12}	0.00	0.50	1.00		
I'_{13}	0.00				
I'_{14}	0.00	0.50	1.00		
I'_{15}	0.00	0.50	1.00		
I'_{16}	0.15				

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-5: Possible values of each company indicator in firm 5

Firm 5							
Company Indicators	**Possible values**						
I'_1	0.02						
I'_2	0.52						
I'_3	0.64						
I'_4	0.00	0.25	0.50	0.75	1.00		
I'_5	0.10	0.23	0.35	0.48	0.60	0.73	0.85
I'_6	0.14	0.47					
I'_7	0.26	0.51					
I'_8	1.00						
I'_9	0.65						
I'_{10}	0.00	0.50	1.00				
I'_{11}	0.33						
I'_{12}	0.85						
I'_{13}	0.00	0.50	1.00				
I'_{14}	0.00	0.50	1.00				
I'_{15}	0.82						
I'_{16}	0.07						

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-6: Possible values of each company indicator in firm 6

Firm 6									
Company Indicators	**Possible values**								
I'_1	0.15								
I'_2	0.68								
I'_3	0.70								
I'_4	0.00	0.25	0.50	0.75	1.00				
I'_5	0.00	0.13	0.25	0.38	0.50	0.63	0.75	0.88	1.00
I'_6	0.16	0.33	0.49	0.66	0.83				
I'_7	0.20	0.32	0.45	0.57	0.70				
I'_8	0.00	0.50	1.00						
I'_9	0.95								
I'_{10}	0.00	0.50	1.00						
I'_{11}	0.00	0.50	1.00						
I'_{12}	0.85								
I'_{13}	0.00	0.50	1.00						
I'_{14}	0.00	0.50	1.00						
I'_{15}	0.00	0.50	1.00						
I'_{16}	0.11								

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-7: Possible values of each company indicator in the firm 7

Firm 7							
Company Indicators	**Possible values**						
I'_1	0.12						
I'_2	0.64						
I'_3	0.80						
I'_4	0.00	0.25	0.50	0.75	1.00		
I'_5	0.03	0.16	0.28	0.41	0.53	0.66	0.78
I'_6	0.04	0.38					
I'_7	0.26	0.38	0.51	0.63	0.76		
I'_8	0.00	0.50	1.00				
I'_9	0.69						
I'_{10}	0.00	0.50	1.00				
I'_{11}	0.40						
I'_{12}	0.00	0.50	1.00				
I'_{13}	0.00	0.50	1.00				
I'_{14}	0.00	0.50	1.00				
I'_{15}	0.00	0.50	1.00				
I'_{16}	0.11						

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

Table D-8: Possible values of each company indicator in the firm 8

Firm 8					
Company Indicators	**Possible values**				
I'_1	0.00				
I'_2	1.00				
I'_3	1.00				
I'_4	0.00	0.25	0.50	0.75	1.00
I'_5	0.61				
I'_6	0.49				
I'_7	0.61				
I'_8	0.00	0.50	1.00		
I'_9	0.40				
I'_{10}	0.91				
I'_{11}	0.67				
I'_{12}	0.00				
I'_{13}	0.96				
I'_{14}	0.00	0.50	1.00		
I'_{15}	0.00	0.50	1.00		
I'_{16}	0.00				

Note: Company indicators: I_1': New staff hiring; I_2': Temporary contracts; I_3': Employee turnover; I_4': Benefits; I_5': Chronic disease; I_6': Fatal accidents at work; I_7': Non-fatal injuries at work; I_8': Social value; I_9': Female labor force participation; I_{10}': Wage gap; I_{11}': Women in executive management positions; I_{12}': Disabled; I_{13}': Salary distribution; I_{14}': Technical training; I_{15}': Social ethics, social awareness and human rights; I_{16}': Research and Development.

SOURCE: Own elaboration

APPENDIX E: SCENARIOS TO SIMULATE THE CORPORATE SOCIAL RESPONSIBILITY GROUP

This appendix shows the scenarios of each firm to perform the sensitivity analysis in the corporate social responsibility group

Table E-1: Possible scenarios for Firm 1

Firm 1	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 1_1	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.711
Scenario 1_2	1.00	0.75	0.63	1	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.736
Scenario 1_3	1.00	0.75	0.63	1	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.779
Scenario 1_4	1.00	0.75	0.63	1	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.751
Scenario 1_5	1.00	0.75	0.63	0.75	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.741
Scenario 1_6	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.768
Scenario 1_7	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.738
Scenario 1_8	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.681
Scenario 1_9	1.00	0.75	0.63	0.25	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.742
Scenario 1_10	1.00	0.75	0.63	1	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.713
Scenario 1_11	1.00	0.75	0.63	0	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.755
Scenario 1_12	1.00	0.75	0.63	0	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.670
Scenario 1_13	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.711
Scenario 1_14	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.728
Scenario 1_15	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.722
Scenario 1_16	1.00	0.75	0.63	0	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.713
Scenario 1_17	1.00	0.75	0.63	1	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.755
Scenario 1_18	1.00	0.75	0.63	0	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.670
Scenario 1_19	1.00	0.75	0.63	0	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.713
Scenario 1_20	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.726
Scenario 1_21	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.723
Scenario 1_22	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.715
Scenario 1_23	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.700
Scenario 1_24	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.726
Scenario 1_25	1.00	0.75	0.63	0.5	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.753

Table E-2: Possible scenarios for Firm 2

Firm 2	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 2_1	0.04	0.00	0.54	0	0.92	0.83	0.17	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.422
Scenario 2_2	0.04	0.00	0.54	0.5	0.79	0.83	0.17	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.413
Scenario 2_3	0.04	0.00	0.54	0	0.17	0.5	0.17	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.377
Scenario 2_4	0.04	0.00	0.54	0	0.54	0	0.17	0.01	0.80	0.5	0.22	0.85	1	0.61	1.00	0.06	0.394
Scenario 2_5	0.04	0.00	0.54	1	0.79	1	0.17	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.463
Scenario 2_6	0.04	0.00	0.54	0.5	0.67	0.5	0.05	0.01	0.80	0.5	0.22	0.85	0.5	0.61	1.00	0.06	0.405
Scenario 2_7	0.04	0.00	0.54	1	0.67	0.67	0.3	0.01	0.80	1	0.22	0.85	1	0.61	1.00	0.06	0.505
Scenario 2_8	0.04	0.00	0.54	0	0.79	0.67	0.55	0.01	0.80	0.5	0.22	0.85	1	0.61	1.00	0.06	0.474
Scenario 2_9	0.04	0.00	0.54	0	0.67	1	0.17	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.398
Scenario 2_10	0.04	0.00	0.54	0.5	0.54	0.83	0.3	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.399
Scenario 2_11	0.04	0.00	0.54	0	0.42	0.33	0.17	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.360
Scenario 2_12	0.04	0.00	0.54	1	0.42	0.83	0.05	0.01	0.80	0.5	0.22	0.85	0.5	0.61	1.00	0.06	0.432
Scenario 2_13	0.04	0.00	0.54	0.5	0.92	0.5	0.55	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.425
Scenario 2_14	0.04	0.00	0.54	0	0.29	0.67	0.42	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.396
Scenario 2_15	0.04	0.00	0.54	1	0.54	1	0.55	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.479
Scenario 2_16	0.04	0.00	0.54	0.5	0.67	0	0.17	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.399
Scenario 2_17	0.04	0.00	0.54	0	0.17	0	0.05	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.300
Scenario 2_18	0.04	0.00	0.54	0	0.42	0.5	0.42	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.419
Scenario 2_19	0.04	0.00	0.54	0	0.79	0.5	0.3	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.395
Scenario 2_20	0.04	0.00	0.54	0	0.17	1	0.05	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.344
Scenario 2_21	0.04	0.00	0.54	0.5	0.42	0	0.55	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.428
Scenario 2_22	0.04	0.00	0.54	1	0.17	0.33	0.55	0.01	0.80	0.5	0.22	0.85	1	0.61	1.00	0.06	0.481
Scenario 2_23	0.04	0.00	0.54	1	0.92	0.67	0.17	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.435
Scenario 2_24	0.04	0.00	0.54	0.5	0.17	0.17	0.3	0.01	0.80	0.5	0.22	0.85	0.5	0.61	1.00	0.06	0.401
Scenario 2_25	0.04	0.00	0.54	1	0.29	0.5	0.17	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.403
Scenario 2_26	0.04	0.00	0.54	1	0.42	0.17	0.17	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.414
Scenario 2_27	0.04	0.00	0.54	1	0.79	0.33	0.05	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.379
Scenario 2_28	0.04	0.00	0.54	0	0.67	0.33	0.05	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.352
Scenario 2_29	0.04	0.00	0.54	0	0.54	0.17	0.17	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.355
Scenario 2_30	0.04	0.00	0.54	1	0.92	0	0.05	0.01	0.80	0.5	0.22	0.85	0.5	0.61	1.00	0.06	0.412
Scenario 2_31	0.04	0.00	0.54	0.5	0.29	1	0.05	0.01	0.80	1	0.22	0.85	1	0.61	1.00	0.06	0.458
Scenario 2_32	0.04	0.00	0.54	0.5	0.92	1	0.42	0.01	0.80	0.5	0.22	0.85	0	0.61	1.00	0.06	0.453
Scenario 2_33	0.04	0.00	0.54	1	0.29	0	0.3	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.375
Scenario 2_34	0.04	0.00	0.54	0.5	0.54	0.33	0.42	0.01	0.80	1	0.22	0.85	0.5	0.61	1.00	0.06	0.455

Firm 2	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 2_35	0.04	0.00	0.54	0	0.29	0.17	0.55	0.01	0.80	0	0.22	0.85	0.5	0.61	1.00	0.06	0.391
Scenario 2_36	0.04	0.00	0.54	0	0.79	0	0.42	0.01	0.80	1	0.22	0.85	0.5	0.61	1.00	0.06	0.428
Scenario 2_37	0.04	0.00	0.54	0	0.54	0.67	0.05	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.342
Scenario 2_38	0.04	0.00	0.54	0.5	0.42	0.67	0.05	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.360
Scenario 2_39	0.04	0.00	0.54	0.5	0.79	0.17	0.05	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.397
Scenario 2_40	0.04	0.00	0.54	1	0.17	0.83	0.42	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.468
Scenario 2_41	0.04	0.00	0.54	0	0.92	0.33	0.3	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.410
Scenario 2_42	0.04	0.00	0.54	0	0.67	0.83	0.55	0.01	0.80	1	0.22	0.85	0	0.61	1.00	0.06	0.451
Scenario 2_43	0.04	0.00	0.54	0	0.42	1	0.3	0.01	0.80	0.5	0.22	0.85	1	0.61	1.00	0.06	0.448
Scenario 2_44	0.04	0.00	0.54	0.5	0.29	0.33	0.17	0.01	0.80	0	0.22	0.85	1	0.61	1.00	0.06	0.400
Scenario 2_45	0.04	0.00	0.54	0.5	0.17	0.67	0.17	0.01	0.80	1	0.22	0.85	0.5	0.61	1.00	0.06	0.429
Scenario 2_46	0.04	0.00	0.54	0	0.29	0.83	0.05	0.01	0.80	1	0.22	0.85	0.5	0.61	1.00	0.06	0.405
Scenario 2_47	0.04	0.00	0.54	1	0.54	0.5	0.05	0.01	0.80	1	0.22	0.85	1	0.61	1.00	0.06	0.465
Scenario 2_48	0.04	0.00	0.54	0	0.92	0.17	0.05	0.01	0.80	1	0.22	0.85	1	0.61	1.00	0.06	0.421
Scenario 2_49	0.04	0.00	0.54	1	0.67	0.17	0.42	0.01	0.80	0	0.22	0.85	0	0.61	1.00	0.06	0.409

Table E-3: Possible scenarios for Firm 3

Firm 3	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 3_1	0.28	0.21	1	1	0.11	0.67	0.75	1	0.26	0.5	0.73	0.5	0.5	0.28	0.5	0.13	0.542
Scenario 3_2	0.28	0.21	0.5	0.25	0.86	0	0.37	0	0.26	1	0.73	1	0.5	0.28	1	0.13	0.479
Scenario 3_3	0.28	0.21	0	0.5	0.23	0.17	0.75	1	0.26	0.5	0.73	1	0	0.28	1	0.13	0.458
Scenario 3_4	0.28	0.21	0	0.5	0.11	0	0.5	0	0.26	0.5	0.73	0.5	1	0.28	1	0.13	0.363
Scenario 3_5	0.28	0.21	1	0	0.36	0.17	0.5	0	0.26	0.5	0.73	0	0	0.28	0.5	0.13	0.333
Scenario 3_6	0.28	0.21	1	0.75	0.23	0.83	0.62	0.5	0.26	1	0.73	0	0.5	0.28	0	0.13	0.441
Scenario 3_7	0.28	0.21	0.5	0.5	0.86	0.83	0.62	0	0.26	0.5	0.73	0.5	1	0.28	0	0.13	0.445
Scenario 3_8	0.28	0.21	0.5	1	0.86	0	0.62	0	0.26	0	0.73	0	0	0.28	0.5	0.13	0.323
Scenario 3_9	0.28	0.21	0.5	0.75	0.11	0.17	0.25	1	0.26	0	0.73	0.5	0.5	0.28	0.5	0.13	0.378
Scenario 3_10	0.28	0.21	0.5	0.5	0.48	0.67	0.62	1	0.26	1	0.73	1	0	0.28	1	0.13	0.550
Scenario 3_11	0.28	0.21	0	0	0.73	0	0.62	1	0.26	1	0.73	0.5	0.5	0.28	0.5	0.13	0.387
Scenario 3_12	0.28	0.21	0.5	0.25	0.11	0.17	0.37	0.5	0.26	0.5	0.73	0.5	0	0.28	0	0.13	0.324
Scenario 3_13	0.28	0.21	0	0.75	0.36	1	0.62	0.5	0.26	0	0.73	1	1	0.28	0	0.13	0.453
Scenario 3_14	0.28	0.21	1	0.5	0.11	0.67	0.62	0	0.26	0	0.73	0.5	1	0.28	1	0.13	0.495
Scenario 3_15	0.28	0.21	0	0	0.11	0	0.25	0	0.26	0	0.73	0	0	0.28	0	0.13	0.134
Scenario 3_16	0.28	0.21	1	1	0.73	0.33	0.5	0.5	0.26	0	0.73	1	1	0.28	1	0.13	0.592
Scenario 3_17	0.28	0.21	1	0	0.86	0.17	0.37	0.5	0.26	0.5	0.73	0.5	0	0.28	0.5	0.13	0.418
Scenario 3_18	0.28	0.21	0	1	0.23	0.17	0.62	0	0.26	0.5	0.73	0	0	0.28	1	0.13	0.299
Scenario 3_19	0.28	0.21	0	0.25	0.61	1	0.5	0	0.26	0.5	0.73	1	0.5	0.28	1	0.13	0.454
Scenario 3_20	0.28	0.21	1	0.25	0.73	0.67	0.25	0.5	0.26	1	0.73	0.5	0	0.28	0	0.13	0.429
Scenario 3_21	0.28	0.21	0.5	0.75	0.11	0.17	0.25	1	0.26	0.5	0.73	1	0	0.28	0	0.13	0.415
Scenario 3_22	0.28	0.21	1	0.25	0.48	0	0.37	0	0.26	1	0.73	1	0.5	0.28	0	0.13	0.473
Scenario 3_23	0.28	0.21	0	0.25	0.86	0.67	0.25	1	0.26	0	0.73	0	1	0.28	0	0.13	0.284
Scenario 3_24	0.28	0.21	0.5	0.5	0.23	0.33	0.37	0.5	0.26	0.5	0.73	0	0.5	0.28	0	0.13	0.305
Scenario 3_25	0.28	0.21	0.5	0.25	0.61	0.83	0.5	0.5	0.26	0	0.73	0.5	0	0.28	0.5	0.13	0.388
Scenario 3_26	0.28	0.21	1	0	0.86	0.5	0.75	0.5	0.26	1	0.73	1	1	0.28	0	0.13	0.582
Scenario 3_27	0.28	0.21	0.5	0.75	0.73	0.5	0.5	0	0.26	0.5	0.73	0	0	0.28	0	0.13	0.312
Scenario 3_28	0.28	0.21	0.5	0.25	0.36	0	0.75	1	0.26	0.5	0.73	0	1	0.28	0	0.13	0.369
Scenario 3_29	0.28	0.21	0.5	0.25	0.73	0.17	0.75	0	0.26	0	0.73	1	0.5	0.28	0.5	0.13	0.459
Scenario 3_30	0.28	0.21	1	0.75	0.23	0	0.37	0.5	0.26	0.5	0.73	1	1	0.28	0.5	0.13	0.532
Scenario 3_31	0.28	0.21	0	0	0.73	0	0.62	1	0.26	0.5	0.73	0	1	0.28	1	0.13	0.350
Scenario 3_32	0.28	0.21	1	0.75	0.48	0.83	0.75	0	0.26	0	0.73	0	0	0.28	1	0.13	0.430
Scenario 3_33	0.28	0.21	0.5	0.75	0.73	0.17	0.37	0	0.26	1	0.73	0.5	1	0.28	1	0.13	0.463
Scenario 3_34	0.28	0.21	0	0.75	0.86	0.33	0.25	1	0.26	0.5	0.73	0.5	0.5	0.28	1	0.13	0.400

Firm 3	**I_1'**	**I_2'**	**I_3'**	**I_4'**	**I_5'**	**I_6'**	**I_7'**	**I_8'**	**I_9'**	**I_{10}'**	**I_{11}'**	**I_{12}'**	**I_{13}'**	**I_{14}'**	**I_{15}'**	**I_{16}'**	**CI_{G2}**
Scenario 3_35	0.28	0.21	0.5	0.25	0.11	0.5	0.5	1	0.26	1	0.73	0	1	0.28	1	0.13	0.424
Scenario 3_36	0.28	0.21	1	0.25	0.11	0.33	0.62	0	0.26	0.5	0.73	1	0.5	0.28	0.5	0.13	0.506
Scenario 3_37	0.28	0.21	1	0.25	0.23	0	0.62	0.5	0.26	0	0.73	0.5	0	0.28	1	0.13	0.432
Scenario 3_38	0.28	0.21	1	0.5	0.61	0.5	0.62	1	0.26	0.5	0.73	1	0	0.28	0.5	0.13	0.557
Scenario 3_39	0.28	0.21	0	0.75	0.86	1	0.5	1	0.26	1	0.73	1	0	0.28	0.5	0.13	0.495
Scenario 3_40	0.28	0.21	1	0.5	0.36	0.17	0.25	0	0.26	1	0.73	0.5	1	0.28	0	0.13	0.433
Scenario 3_41	0.28	0.21	0.5	0.5	0.23	1	0.25	0	0.26	0	0.73	0.5	1	0.28	0.5	0.13	0.393
Scenario 3_42	0.28	0.21	0	0.75	0.61	0.67	0.37	0	0.26	1	0.73	0	0	0.28	0.5	0.13	0.291
Scenario 3_43	0.28	0.21	0	0.5	0.11	0	0.75	0.5	0.26	1	0.73	0	0.5	0.28	0.5	0.13	0.319
Scenario 3_44	0.28	0.21	1	0	0.61	0.17	0.62	1	0.26	1	0.73	0	1	0.28	0	0.13	0.436
Scenario 3_45	0.28	0.21	1	0.75	0.48	0	0.5	0	0.26	0.5	0.73	0.5	1	0.28	0.5	0.13	0.472
Scenario 3_46	0.28	0.21	0.5	1	0.36	0.83	0.5	1	0.26	1	0.73	0.5	0.5	0.28	1	0.13	0.520
Scenario 3_47	0.28	0.21	0	1	0.48	0.17	0.25	0.5	0.26	1	0.73	1	1	0.28	0.5	0.13	0.455
Scenario 3_48	0.28	0.21	0.5	0	0.23	0.67	0.5	0.5	0.26	0	0.73	1	1	0.28	0.5	0.13	0.468
Scenario 3_49	0.28	0.21	0	0.5	0.23	0.5	0.37	0	0.26	1	0.73	0.5	1	0.28	0.5	0.13	0.371
Scenario 3_50	0.28	0.21	0.5	0.75	0.11	0.17	0.62	0.5	0.26	1	0.73	1	1	0.28	1	0.13	0.553
Scenario 3_51	0.28	0.21	0	0.25	0.36	0.33	0.62	0.5	0.26	1	0.73	0.5	0	0.28	0.5	0.13	0.358
Scenario 3_52	0.28	0.21	0	0.25	0.48	0.5	0.25	0.5	0.26	0.5	0.73	0.5	0	0.28	1	0.13	0.331
Scenario 3_53	0.28	0.21	0.5	0.75	0.11	0.5	0.62	0.5	0.26	0	0.73	0	0.5	0.28	0.5	0.13	0.351
Scenario 3_54	0.28	0.21	1	0.25	0.23	0.83	0.25	1	0.26	0.5	0.73	0	1	0.28	0.5	0.13	0.425
Scenario 3_55	0.28	0.21	0.5	0	0.23	1	0.75	0.5	0.26	1	0.73	0.5	0	0.28	1	0.13	0.466
Scenario 3_56	0.28	0.21	0.5	1	0.61	0	0.25	0.5	0.26	0.5	0.73	1	1	0.28	0	0.13	0.462
Scenario 3_57	0.28	0.21	0.5	0	0.23	0.67	0.5	0	0.26	0.5	0.73	1	0.5	0.28	0	0.13	0.422
Scenario 3_58	0.28	0.21	0	0	0.11	0.83	0.25	0	0.26	1	0.73	1	0.5	0.28	0.5	0.13	0.387
Scenario 3_59	0.28	0.21	0	0.25	0.23	0.17	0.62	0	0.26	0	0.73	1	0.5	0.28	0	0.13	0.348
Scenario 3_60	0.28	0.21	1	0.5	0.86	0.17	0.5	0.5	0.26	0	0.73	0	0.5	0.28	1	0.13	0.417
Scenario 3_61	0.28	0.21	0.5	0	0.48	1	0.62	1	0.26	0.5	0.73	0.5	0.5	0.28	0	0.13	0.433
Scenario 3_62	0.28	0.21	0	0	0.11	0.83	0.37	0.5	0.26	0.5	0.73	1	1	0.28	1	0.13	0.446
Scenario 3_63	0.28	0.21	1	0	0.36	0.5	0.25	0	0.26	0	0.73	1	0.5	0.28	1	0.13	0.474
Scenario 3_64	0.28	0.21	1	0.5	0.73	1	0.25	0.5	0.26	0.5	0.73	0	0.5	0.28	0.5	0.13	0.417
Scenario 3_65	0.28	0.21	0	0	0.11	0	0.5	0.5	0.26	0	0.73	0.5	0	0.28	0	0.13	0.245
Scenario 3_66	0.28	0.21	1	0.75	0.23	0	0.25	1	0.26	0	0.73	1	0	0.28	1	0.13	0.494
Scenario 3_67	0.28	0.21	0	1	0.23	0.5	0.37	1	0.26	0	0.73	0.5	0.5	0.28	0	0.13	0.341
Scenario 3_68	0.28	0.21	0	0.5	0.73	0.83	0.37	1	0.26	0	0.73	1	0	0.28	0	0.13	0.392

Firm 3	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 3_69	0.28	0.21	0.5	0	0.23	0.33	0.25	0	0.26	1	0.73	0	0	0.28	1	0.13	0.297
Scenario 3_70	0.28	0.21	0.5	0.5	0.61	0	0.25	0.5	0.26	1	0.73	0	0.5	0.28	1	0.13	0.359
Scenario 3_71	0.28	0.21	0	0.5	0.48	0.17	0.5	0.5	0.26	0	0.73	0	0.5	0.28	0	0.13	0.245
Scenario 3_72	0.28	0.21	1	0.25	0.11	1	0.37	1	0.26	0	0.73	0	1	0.28	1	0.13	0.445
Scenario 3_73	0.28	0.21	0	0.75	0.36	0.67	0.37	0.5	0.26	0.5	0.73	0	0.5	0.28	1	0.13	0.329
Scenario 3_74	0.28	0.21	0.5	0	0.48	0.33	0.37	1	0.26	0	0.73	0	1	0.28	0.5	0.13	0.338
Scenario 3_75	0.28	0.21	0.5	0.5	0.36	0	0.37	1	0.26	0	0.73	1	0	0.28	0.5	0.13	0.422
Scenario 3_76	0.28	0.21	1	0.75	0.23	0	0.5	1	0.26	1	0.73	0.5	0.5	0.28	0	0.13	0.475
Scenario 3_77	0.28	0.21	0	0.75	0.61	0.33	0.75	0	0.26	0	0.73	0.5	1	0.28	0	0.13	0.364
Scenario 3_78	0.28	0.21	0	0.25	0.23	0.17	0.5	1	0.26	1	0.73	0	1	0.28	0.5	0.13	0.334
Scenario 3_79	0.28	0.21	1	0	0.61	0.17	0.37	1	0.26	0	0.73	0.5	0.5	0.28	1	0.13	0.456
Scenario 3_80	0.28	0.21	1	1	0.11	1	0.37	0	0.26	1	0.73	0	0	0.28	0	0.13	0.385
Scenario 3_81	0.28	0.21	1	0.5	0.11	0.33	0.5	1	0.26	1	0.73	1	0	0.28	0	0.13	0.515

Table E-4: Possible scenarios for Firm 4

Firm 4	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 4_1	0.72	0.67	0.00	0.33	0.32	0.57	0.31	0	0.58	0.5	0.58	0	0.00	1	1	0.15	0.375
Scenario 4_2	0.72	0.67	0.00	0.83	0.32	0.57	0.56	0.5	0.58	1	0.58	0.5	0.00	0.5	0	0.15	0.458
Scenario 4_3	0.72	0.67	0.00	0.33	0.44	0.9	0.56	0.5	0.58	0.5	0.58	1	0.00	0	1	0.15	0.526
Scenario 4_4	0.72	0.67	0.00	0.83	0.44	0.9	0.31	0	0.58	1	0.58	1	0.00	0	0	0.15	0.472
Scenario 4_5	0.72	0.67	0.00	0.83	0.82	0.57	0.56	1	0.58	0.5	0.58	0	0.00	0	0.5	0.15	0.412
Scenario 4_6	0.72	0.67	0.00	0.33	0.57	0.9	0.56	0	0.58	1	0.58	0	0.00	0.5	0.5	0.15	0.401
Scenario 4_7	0.72	0.67	0.00	0.33	0.69	0.9	0.56	1	0.58	0	0.58	0.5	0.00	1	0	0.15	0.463
Scenario 4_8	0.72	0.67	0.00	0.33	0.32	0.57	0.31	0	0.58	0	0.58	0	0.00	0	0	0.15	0.263
Scenario 4_9	0.72	0.67	0.00	0.58	0.44	0.57	0.56	0.5	0.58	0	0.58	0	0.00	1	0.5	0.15	0.392
Scenario 4_10	0.72	0.67	0.00	0.58	0.44	0.57	0.31	0	0.58	0	0.58	0.5	0.00	0.5	0.5	0.15	0.387
Scenario 4_11	0.72	0.67	0.00	0.33	0.69	0.57	0.31	1	0.58	1	0.58	0.5	0.00	0	0.5	0.15	0.443
Scenario 4_12	0.72	0.67	0.00	0.58	0.69	0.9	0.31	0.5	0.58	0.5	0.58	0	0.00	0.5	0	0.15	0.362
Scenario 4_13	0.72	0.67	0.00	0.58	0.32	0.9	0.31	1	0.58	0	0.58	1	0.00	0	0.5	0.15	0.478
Scenario 4_14	0.72	0.67	0.00	0.83	0.69	0.57	0.56	0	0.58	0	0.58	1	0.00	1	1	0.15	0.545
Scenario 4_15	0.72	0.67	0.00	0.83	0.69	0.57	0.31	0	0.58	0.5	0.58	1	0.00	0.5	0.5	0.15	0.491
Scenario 4_16	0.72	0.67	0.00	0.58	0.57	0.57	0.31	1	0.58	0.5	0.58	1	0.00	1	0	0.15	0.512
Scenario 4_17	0.72	0.67	0.00	0.58	0.57	0.57	0.56	0	0.58	0.5	0.58	0.5	0.00	0	0	0.15	0.395
Scenario 4_18	0.72	0.67	0.00	0.33	0.44	0.57	0.31	1	0.58	0.5	0.58	0.5	0.00	0.5	1	0.15	0.460
Scenario 4_19	0.72	0.67	0.00	0.83	0.44	0.57	0.31	1	0.58	1	0.58	0	0.00	1	0	0.15	0.411
Scenario 4_20	0.72	0.67	0.00	0.83	0.57	0.9	0.31	1	0.58	0	0.58	0	0.00	0.5	1	0.15	0.416
Scenario 4_21	0.72	0.67	0.00	0.33	0.82	0.57	0.31	0.5	0.58	0	0.58	1	0.00	0.5	0	0.15	0.448
Scenario 4_22	0.72	0.67	0.00	0.58	0.69	0.57	0.31	0.5	0.58	1	0.58	0	0.00	0	1	0.15	0.395
Scenario 4_23	0.72	0.67	0.00	0.83	0.57	0.57	0.31	0.5	0.58	0	0.58	0.5	0.00	0	1	0.15	0.424
Scenario 4_24	0.72	0.67	0.00	0.58	0.82	0.9	0.31	0	0.58	1	0.58	0.5	0.00	1	1	0.15	0.502
Scenario 4_25	0.72	0.67	0.00	0.83	0.32	0.9	0.31	0.5	0.58	0.5	0.58	0.5	0.00	1	0.5	0.15	0.470
Scenario 4_26	0.72	0.67	0.00	0.33	0.57	0.57	0.31	0.5	0.58	1	0.58	1	0.00	1	0.5	0.15	0.527
Scenario 4_27	0.72	0.67	0.00	0.58	0.32	0.57	0.56	1	0.58	1	0.58	1	0.00	0.5	1	0.15	0.579

Table E-5: Possible scenarios for Firm 5

Firm 5	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 5_1	0.02	0.52	0.64	0.75	0.23	0.14	0.51	1.00	0.65	0.5	0.33	0.85	0	0	0.82	0.07	0.490
Scenario 5_2	0.02	0.52	0.64	0	0.48	0.14	0.26	1.00	0.65	0.5	0.33	0.85	0	0.5	0.82	0.07	0.460
Scenario 5_3	0.02	0.52	0.64	0.25	0.35	0.14	0.51	1.00	0.65	0.5	0.33	0.85	0	0	0.82	0.07	0.472
Scenario 5_4	0.02	0.52	0.64	0	0.35	0.47	0.51	1.00	0.65	0	0.33	0.85	0.5	0.5	0.82	0.07	0.500
Scenario 5_5	0.02	0.52	0.64	0	0.73	0.47	0.26	1.00	0.65	1	0.33	0.85	0	0	0.82	0.07	0.482
Scenario 5_6	0.02	0.52	0.64	0.25	0.23	0.14	0.26	1.00	0.65	1	0.33	0.85	0	0	0.82	0.07	0.461
Scenario 5_7	0.02	0.52	0.64	0.75	0.85	0.47	0.26	1.00	0.65	1	0.33	0.85	0	1	0.82	0.07	0.561
Scenario 5_8	0.02	0.52	0.64	0	0.48	0.14	0.51	1.00	0.65	0	0.33	0.85	0	1	0.82	0.07	0.489
Scenario 5_9	0.02	0.52	0.64	0	0.23	0.47	0.51	1.00	0.65	0	0.33	0.85	0	0	0.82	0.07	0.451
Scenario 5_10	0.02	0.52	0.64	0	0.35	0.14	0.51	1.00	0.65	1	0.33	0.85	0.5	0.5	0.82	0.07	0.527
Scenario 5_11	0.02	0.52	0.64	0.5	0.73	0.14	0.26	1.00	0.65	0	0.33	0.85	0	0	0.82	0.07	0.447
Scenario 5_12	0.02	0.52	0.64	0.25	0.1	0.47	0.26	1.00	0.65	0	0.33	0.85	1	1	0.82	0.07	0.519
Scenario 5_13	0.02	0.52	0.64	0	0.85	0.14	0.51	1.00	0.65	0	0.33	0.85	1	0	0.82	0.07	0.504
Scenario 5_14	0.02	0.52	0.64	0.75	0.48	0.14	0.26	1.00	0.65	0	0.33	0.85	0	0.5	0.82	0.07	0.471
Scenario 5_15	0.02	0.52	0.64	0.25	0.73	0.14	0.51	1.00	0.65	0.5	0.33	0.85	1	0.5	0.82	0.07	0.553
Scenario 5_16	0.02	0.52	0.64	1	0.23	0.14	0.51	1.00	0.65	1	0.33	0.85	0.5	1	0.82	0.07	0.587
Scenario 5_17	0.02	0.52	0.64	0.25	0.85	0.47	0.51	1.00	0.65	1	0.33	0.85	0	0.5	0.82	0.07	0.546
Scenario 5_18	0.02	0.52	0.64	0	0.23	0.47	0.26	1.00	0.65	0.5	0.33	0.85	1	0.5	0.82	0.07	0.512
Scenario 5_19	0.02	0.52	0.64	0.25	0.35	0.47	0.26	1.00	0.65	0	0.33	0.85	1	0	0.82	0.07	0.485
Scenario 5_20	0.02	0.52	0.64	0.25	0.6	0.14	0.26	1.00	0.65	1	0.33	0.85	0	0.5	0.82	0.07	0.495
Scenario 5_21	0.02	0.52	0.64	0.25	0.23	0.14	0.26	1.00	0.65	0	0.33	0.85	0.5	1	0.82	0.07	0.486
Scenario 5_22	0.02	0.52	0.64	0.25	0.1	0.14	0.51	1.00	0.65	0.5	0.33	0.85	1	1	0.82	0.07	0.554
Scenario 5_23	0.02	0.52	0.64	0.75	0.35	0.47	0.26	1.00	0.65	1	0.33	0.85	1	0	0.82	0.07	0.547
Scenario 5_24	0.02	0.52	0.64	0.25	0.48	0.47	0.26	1.00	0.65	1	0.33	0.85	0.5	0	0.82	0.07	0.507
Scenario 5_25	0.02	0.52	0.64	1	0.48	0.47	0.26	1.00	0.65	0	0.33	0.85	1	0	0.82	0.07	0.521
Scenario 5_26	0.02	0.52	0.64	0.5	0.85	0.14	0.26	1.00	0.65	0.5	0.33	0.85	0.5	0	0.82	0.07	0.495
Scenario 5_27	0.02	0.52	0.64	0.25	0.73	0.14	0.26	1.00	0.65	0	0.33	0.85	0.5	0.5	0.82	0.07	0.481
Scenario 5_28	0.02	0.52	0.64	0.25	0.6	0.14	0.26	1.00	0.65	0	0.33	0.85	0	0	0.82	0.07	0.432
Scenario 5_29	0.02	0.52	0.64	0	0.6	0.47	0.26	1.00	0.65	0.5	0.33	0.85	0.5	1	0.82	0.07	0.523
Scenario 5_30	0.02	0.52	0.64	0.5	0.23	0.47	0.26	1.00	0.65	0	0.33	0.85	1	0.5	0.82	0.07	0.513
Scenario 5_31	0.02	0.52	0.64	0.25	0.48	0.47	0.51	1.00	0.65	0.5	0.33	0.85	0.5	0	0.82	0.07	0.515
Scenario 5_32	0.02	0.52	0.64	0.5	0.1	0.47	0.51	1.00	0.65	1	0.33	0.85	0	0.5	0.82	0.07	0.531
Scenario 5_33	0.02	0.52	0.64	0	0.1	0.14	0.26	1.00	0.65	0	0.33	0.85	0	0	0.82	0.07	0.404
Scenario 5_34	0.02	0.52	0.64	0.5	0.48	0.14	0.51	1.00	0.65	1	0.33	0.85	1	1	0.82	0.07	0.598

Firm 5	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 5_35	0.02	0.52	0.64	0	0.73	0.47	0.51	1.00	0.65	0	0.33	0.85	0	1	0.82	0.07	0.512
Scenario 5_36	0.02	0.52	0.64	0	0.6	0.14	0.26	1.00	0.65	1	0.33	0.85	1	1	0.82	0.07	0.552
Scenario 5_37	0.02	0.52	0.64	1	0.1	0.47	0.26	1.00	0.65	0.5	0.33	0.85	0	0.5	0.82	0.07	0.504
Scenario 5_38	0.02	0.52	0.64	1	0.73	0.14	0.51	1.00	0.65	1	0.33	0.85	1	0	0.82	0.07	0.584
Scenario 5_39	0.02	0.52	0.64	0.25	0.85	0.47	0.51	1.00	0.65	0	0.33	0.85	0	1	0.82	0.07	0.526
Scenario 5_40	0.02	0.52	0.64	0.5	0.6	0.47	0.51	1.00	0.65	0	0.33	0.85	0.5	0	0.82	0.07	0.509
Scenario 5_41	0.02	0.52	0.64	0.5	0.35	0.14	0.26	1.00	0.65	0.5	0.33	0.85	0	1	0.82	0.07	0.498
Scenario 5_42	0.02	0.52	0.64	1	0.85	0.14	0.26	1.00	0.65	0	0.33	0.85	0.5	0.5	0.82	0.07	0.517
Scenario 5_43	0.02	0.52	0.64	0.75	0.73	0.47	0.26	1.00	0.65	0.5	0.33	0.85	0.5	1	0.82	0.07	0.560
Scenario 5_44	0.02	0.52	0.64	0.75	0.6	0.14	0.51	1.00	0.65	0	0.33	0.85	1	0.5	0.82	0.07	0.550
Scenario 5_45	0.02	0.52	0.64	0	0.85	0.14	0.26	1.00	0.65	0.5	0.33	0.85	1	0	0.82	0.07	0.497
Scenario 5_46	0.02	0.52	0.64	1	0.35	0.14	0.26	1.00	0.65	0	0.33	0.85	0	1	0.82	0.07	0.499
Scenario 5_47	0.02	0.52	0.64	0.75	0.1	0.14	0.51	1.00	0.65	0	0.33	0.85	0.5	0	0.82	0.07	0.488
Scenario 5_48	0.02	0.52	0.64	1	0.6	0.47	0.51	1.00	0.65	0.5	0.33	0.85	0	0	0.82	0.07	0.527
Scenario 5_49	0.02	0.52	0.64	0	0.1	0.14	0.26	1.00	0.65	1	0.33	0.85	0.5	0	0.82	0.07	0.469

Table E-6: Possible scenarios for Firm 6

Firm 6	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 6_1	0.15	0.68	0.70	0.5	0.88	0.16	0.32	0	0.95	0	0	0.85	1	0.5	1	0.11	0.530
Scenario 6_2	0.15	0.68	0.70	0.5	0.88	0.83	0.57	1	0.95	0	1	0.85	1	1	1	0.11	0.692
Scenario 6_3	0.15	0.68	0.70	0.25	0.25	0.83	0.57	1	0.95	0	1	0.85	0	0.5	0.5	0.11	0.567
Scenario 6_4	0.15	0.68	0.70	0.5	0	0.33	0.57	0	0.95	1	0.5	0.85	0.5	1	0.5	0.11	0.574
Scenario 6_5	0.15	0.68	0.70	0.25	1	0.33	0.2	0.5	0.95	0	0.5	0.85	1	0	0.5	0.11	0.513
Scenario 6_6	0.15	0.68	0.70	0	0.13	0.33	0.32	0	0.95	0.5	1	0.85	1	0.5	0.5	0.11	0.532
Scenario 6_7	0.15	0.68	0.70	1	0.13	0.49	0.57	0.5	0.95	0.5	0	0.85	1	0	0.5	0.11	0.563
Scenario 6_8	0.15	0.68	0.70	0.5	0.75	0.83	0.2	0	0.95	1	0.5	0.85	0	0	0.5	0.11	0.513
Scenario 6_9	0.15	0.68	0.70	0.25	0.13	0.66	0.45	1	0.95	1	0	0.85	0.5	0	0	0.11	0.517
Scenario 6_10	0.15	0.68	0.70	0.25	0.63	0.49	0.45	0	0.95	0	0	0.85	0.5	1	0.5	0.11	0.514
Scenario 6_11	0.15	0.68	0.70	0.5	0.75	0.66	0.2	1	0.95	1	0	0.85	0	0.5	0.5	0.11	0.543
Scenario 6_12	0.15	0.68	0.70	0.75	0.38	0.49	0.7	0	0.95	1	0.5	0.85	1	0.5	0.5	0.11	0.620
Scenario 6_13	0.15	0.68	0.70	0.5	0.63	0.49	0.32	0.5	0.95	0.5	0	0.85	0	1	0	0.11	0.503
Scenario 6_14	0.15	0.68	0.70	1	0.25	0.16	0.32	0.5	0.95	1	1	0.85	0.5	0.5	1	0.11	0.612
Scenario 6_15	0.15	0.68	0.70	0.5	0.13	0.49	0.32	0	0.95	0	0	0.85	0	0	1	0.11	0.451
Scenario 6_16	0.15	0.68	0.70	0	0.63	0.16	0.2	0.5	0.95	1	1	0.85	1	0	1	0.11	0.570
Scenario 6_17	0.15	0.68	0.70	0.25	0.75	0.33	0.57	0	0.95	0.5	1	0.85	0.5	1	1	0.11	0.614
Scenario 6_18	0.15	0.68	0.70	0.5	1	0.66	0.45	0	0.95	0.5	1	0.85	0.5	1	0	0.11	0.586
Scenario 6_19	0.15	0.68	0.70	0	0.75	0.33	0.32	1	0.95	0	1	0.85	1	1	0	0.11	0.567
Scenario 6_20	0.15	0.68	0.70	0	0.38	0.66	0.57	0.5	0.95	0	0.5	0.85	0.5	0.5	0	0.11	0.511
Scenario 6_21	0.15	0.68	0.70	0	0.13	0.83	0.2	0	0.95	1	0.5	0.85	0.5	1	0	0.11	0.513
Scenario 6_22	0.15	0.68	0.70	1	0.88	0.66	0.2	0	0.95	0.5	1	0.85	0.5	1	0.5	0.11	0.599
Scenario 6_23	0.15	0.68	0.70	0.25	0.88	0.49	0.32	0	0.95	1	0.5	0.85	0	0	0	0.11	0.481
Scenario 6_24	0.15	0.68	0.70	0.5	0.38	0.16	0.45	0.5	0.95	1	1	0.85	1	0	0.5	0.11	0.587
Scenario 6_25	0.15	0.68	0.70	0.75	0.75	0.16	0.45	0.5	0.95	1	1	0.85	0	1	0.5	0.11	0.607
Scenario 6_26	0.15	0.68	0.70	0.5	0.5	0.33	0.2	0.5	0.95	0	0.5	0.85	0.5	0.5	1	0.11	0.529
Scenario 6_27	0.15	0.68	0.70	0.5	1	0.16	0.7	1	0.95	0.5	0.5	0.85	0.5	0	0	0.11	0.565
Scenario 6_28	0.15	0.68	0.70	0.5	0.38	0.33	0.32	1	0.95	1	0	0.85	1	1	0.5	0.11	0.598
Scenario 6_29	0.15	0.68	0.70	0.25	0.63	0.33	0.7	1	0.95	0	1	0.85	0.5	0	0.5	0.11	0.575
Scenario 6_30	0.15	0.68	0.70	0.5	0	0.49	0.57	0.5	0.95	1	1	0.85	0.5	0.5	0.5	0.11	0.600
Scenario 6_31	0.15	0.68	0.70	0.25	0.88	0.16	0.7	0.5	0.95	1	1	0.85	0	1	0	0.11	0.594
Scenario 6_32	0.15	0.68	0.70	1	0.63	0.66	0.2	1	0.95	1	0	0.85	1	1	1	0.11	0.653
Scenario 6_33	0.15	0.68	0.70	1	0	0.33	0.45	0.5	0.95	0	0.5	0.85	0	1	0	0.11	0.512
Scenario 6_34	0.15	0.68	0.70	0	0	0.66	0.7	0	0.95	0.5	1	0.85	1	0.5	1	0.11	0.609

Firm 6	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 6_35	0.15	0.68	0.70	0.75	0.25	0.33	0.7	1	0.95	1	0	0.85	0.5	0	1	0.11	0.605
Scenario 6_36	0.15	0.68	0.70	0.75	1	0.49	0.32	0.5	0.95	1	1	0.85	0	1	1	0.11	0.639
Scenario 6_37	0.15	0.68	0.70	0.75	0	0.49	0.2	1	0.95	0	1	0.85	0	0.5	0	0.11	0.499
Scenario 6_38	0.15	0.68	0.70	1	0.5	0.16	0.45	1	0.95	0.5	0.5	0.85	0	0.5	0.5	0.11	0.564
Scenario 6_39	0.15	0.68	0.70	1	1	0.33	0.57	0	0.95	1	0.5	0.85	0	0	1	0.11	0.587
Scenario 6_40	0.15	0.68	0.70	0.75	0	0.66	0.32	1	0.95	1	0	0.85	0.5	0	0.5	0.11	0.544
Scenario 6_41	0.15	0.68	0.70	0	0.25	0.16	0.57	0	0.95	0	0	0.85	0	0	0.5	0.11	0.423
Scenario 6_42	0.15	0.68	0.70	0.75	0.88	0.33	0.2	0.5	0.95	0.5	0	0.85	0.5	0.5	0.5	0.11	0.527
Scenario 6_43	0.15	0.68	0.70	0.75	0.38	0.16	0.57	0	0.95	0	0	0.85	0.5	1	0	0.11	0.502
Scenario 6_44	0.15	0.68	0.70	0	0.88	0.33	0.45	1	0.95	1	0	0.85	0	0.5	0	0.11	0.516
Scenario 6_45	0.15	0.68	0.70	0.25	0.5	0.66	0.57	1	0.95	1	0	0.85	1	1	0	0.11	0.609
Scenario 6_46	0.15	0.68	0.70	0.75	0.88	0.66	0.57	0.5	0.95	0	0.5	0.85	1	0	1	0.11	0.611
Scenario 6_47	0.15	0.68	0.70	0.75	0.75	0.66	0.45	0.5	0.95	0	0.5	0.85	1	0	0	0.11	0.544
Scenario 6_48	0.15	0.68	0.70	0.5	0.63	0.16	0.57	1	0.95	0.5	0.5	0.85	0	0.5	0	0.11	0.536
Scenario 6_49	0.15	0.68	0.70	0.25	0.25	0.66	0.32	0.5	0.95	0	0.5	0.85	0	1	0.5	0.11	0.512
Scenario 6_50	0.15	0.68	0.70	0.75	0.63	0.83	0.45	0	0.95	1	0.5	0.85	1	0.5	1	0.11	0.640
Scenario 6_51	0.15	0.68	0.70	0.75	0.63	0.33	0.57	0	0.95	0.5	1	0.85	0	0	0	0.11	0.516
Scenario 6_52	0.15	0.68	0.70	0.25	0	0.16	0.32	1	0.95	0.5	0.5	0.85	1	1	1	0.11	0.592
Scenario 6_53	0.15	0.68	0.70	0.25	0	0.83	0.45	0.5	0.95	0.5	0	0.85	1	0	1	0.11	0.552
Scenario 6_54	0.15	0.68	0.70	0.5	0.13	0.66	0.7	0.5	0.95	0	0.5	0.85	0	1	1	0.11	0.586
Scenario 6_55	0.15	0.68	0.70	1	0.38	0.83	0.32	1	0.95	0	1	0.85	0.5	0	0	0.11	0.553
Scenario 6_56	0.15	0.68	0.70	0.5	0.25	0.66	0.45	0	0.95	0.5	1	0.85	1	0.5	0	0.11	0.562
Scenario 6_57	0.15	0.68	0.70	0	0.25	0.49	0.45	0	0.95	1	0.5	0.85	0.5	1	1	0.11	0.579
Scenario 6_58	0.15	0.68	0.70	0.25	0.38	0.49	0.2	1	0.95	0.5	0.5	0.85	0	0.5	1	0.11	0.538
Scenario 6_59	0.15	0.68	0.70	0.25	0.5	0.33	0.32	0	0.95	1	0.5	0.85	1	0.5	0	0.11	0.529
Scenario 6_60	0.15	0.68	0.70	0.75	0.13	0.16	0.57	1	0.95	0.5	0.5	0.85	1	1	0.5	0.11	0.622
Scenario 6_61	0.15	0.68	0.70	0.75	0.5	0.16	0.2	0	0.95	0	0	0.85	0.5	1	1	0.11	0.513
Scenario 6_62	0.15	0.68	0.70	0	1	0.66	0.57	1	0.95	1	0	0.85	0	0.5	1	0.11	0.596
Scenario 6_63	0.15	0.68	0.70	0.25	1	0.16	0.45	0	0.95	0	0	0.85	1	0.5	0.5	0.11	0.514
Scenario 6_64	0.15	0.68	0.70	0	0.5	0.83	0.7	0.5	0.95	0.5	0	0.85	0	1	0.5	0.11	0.559
Scenario 6_65	0.15	0.68	0.70	0.75	0.13	0.33	0.45	1	0.95	0	1	0.85	0	0.5	1	0.11	0.574
Scenario 6_66	0.15	0.68	0.70	0.5	0.25	0.33	0.2	0.5	0.95	0.5	0	0.85	1	0	0	0.11	0.472
Scenario 6_67	0.15	0.68	0.70	0	1	0.49	0.2	1	0.95	0	1	0.85	1	1	0.5	0.11	0.594
Scenario 6_68	0.15	0.68	0.70	0.75	0.5	0.66	0.32	0	0.95	0.5	1	0.85	0	0	0.5	0.11	0.523

Firm 6	**I_1'**	**I_2'**	**I_3'**	**I_4'**	**I_5'**	**I_6'**	**I_7'**	**I_8'**	**I_9'**	**I_{10}'**	**I_{11}'**	**I_{12}'**	**I_{13}'**	**I_{14}'**	**I_{15}'**	**I_{16}'**	**CI_{G2}**
Scenario 6_69	0.15	0.68	0.70	0	0.5	0.49	0.57	0.5	0.95	1	1	0.85	1	0	0	0.11	0.573
Scenario 6_70	0.15	0.68	0.70	1	0.75	0.49	0.7	0	0.95	0	0	0.85	1	0.5	0	0.11	0.556
Scenario 6_71	0.15	0.68	0.70	0	0.63	0.66	0.32	0.5	0.95	0	0.5	0.85	0.5	0.5	0.5	0.11	0.516
Scenario 6_72	0.15	0.68	0.70	0	0.88	0.49	0.45	1	0.95	0.5	0.5	0.85	0.5	0	0.5	0.11	0.550
Scenario 6_73	0.15	0.68	0.70	0.25	0.75	0.49	0.57	0.5	0.95	0.5	0	0.85	0.5	0.5	1	0.11	0.575
Scenario 6_74	0.15	0.68	0.70	0.75	1	0.83	0.32	0.5	0.95	0.5	0	0.85	0.5	0.5	0	0.11	0.542
Scenario 6_75	0.15	0.68	0.70	0.5	0.5	0.49	0.45	1	0.95	0	1	0.85	0.5	0	1	0.11	0.584
Scenario 6_76	0.15	0.68	0.70	0.25	0.38	0.66	0.2	0	0.95	0.5	1	0.85	0	0	1	0.11	0.508
Scenario 6_77	0.15	0.68	0.70	0.25	0.13	0.16	0.2	0.5	0.95	1	1	0.85	0.5	0.5	0	0.11	0.513
Scenario 6_78	0.15	0.68	0.70	0	0.75	0.16	0.32	1	0.95	0.5	0.5	0.85	0.5	0	1	0.11	0.541
Scenario 6_79	0.15	0.68	0.70	0	0	0.16	0.2	0	0.95	0	0	0.85	0	0	0	0.11	0.349
Scenario 6_80	0.15	0.68	0.70	0	0.38	0.33	0.45	0.5	0.95	0.5	0	0.85	0	1	1	0.11	0.529
Scenario 6_81	0.15	0.68	0.70	0.75	0.25	0.49	0.2	1	0.95	0.5	0.5	0.85	1	1	0	0.11	0.575

Table E-7: Possible scenarios for Firm 7

Firm 7	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 7_1	0.12	0.64	0.80	0.75	0.16	0.04	0.63	0.5	0.69	1	0.40	1	0.5	0	0	0.11	0.545
Scenario 7_2	0.12	0.64	0.80	1	0.53	0.04	0.76	1	0.69	0.5	0.40	0.5	1	0	0	0.11	0.541
Scenario 7_3	0.12	0.64	0.80	0	0.41	0.04	0.51	0.5	0.69	1	0.40	1	1	0	0.5	0.11	0.556
Scenario 7_4	0.12	0.64	0.80	0.5	0.53	0.04	0.38	0.5	0.69	1	0.40	1	0.5	1	0.5	0.11	0.587
Scenario 7_5	0.12	0.64	0.80	0.25	0.16	0.04	0.38	0.5	0.69	0	0.40	0.5	0.5	1	1	0.11	0.482
Scenario 7_6	0.12	0.64	0.80	0.25	0.53	0.04	0.51	0	0.69	0	0.40	0	0	0.5	1	0.11	0.382
Scenario 7_7	0.12	0.64	0.80	1	0.28	0.38	0.26	0	0.69	1	0.40	0.5	0	1	0	0.11	0.470
Scenario 7_8	0.12	0.64	0.80	0.25	0.03	0.04	0.63	0	0.69	0.5	0.40	1	1	1	0.5	0.11	0.570
Scenario 7_9	0.12	0.64	0.80	0.5	0.28	0.38	0.51	1	0.69	0	0.40	1	1	0.5	0.5	0.11	0.587
Scenario 7_10	0.12	0.64	0.80	0.25	0.16	0.38	0.38	0	0.69	1	0.40	0.5	1	0	0.5	0.11	0.475
Scenario 7_11	0.12	0.64	0.80	0.5	0.03	0.38	0.51	0	0.69	1	0.40	0.5	0	0.5	0.5	0.11	0.471
Scenario 7_12	0.12	0.64	0.80	0.25	0.41	0.38	0.26	0	0.69	1	0.40	0.5	0	0	1	0.11	0.448
Scenario 7_13	0.12	0.64	0.80	0.25	0.03	0.04	0.76	0	0.69	0.5	0.40	1	0.5	1	0	0.11	0.538
Scenario 7_14	0.12	0.64	0.80	0.25	0.41	0.04	0.51	0.5	0.69	0	0.40	0.5	0	1	0.5	0.11	0.458
Scenario 7_15	0.12	0.64	0.80	0.5	0.03	0.04	0.51	0.5	0.69	0	0.40	0.5	1	0	1	0.11	0.483
Scenario 7_16	0.12	0.64	0.80	0.25	0.53	0.04	0.63	1	0.69	1	0.40	0	0	1	0	0.11	0.448
Scenario 7_17	0.12	0.64	0.80	0.5	0.16	0.04	0.63	1	0.69	1	0.40	0	0	0	1	0.11	0.451
Scenario 7_18	0.12	0.64	0.80	0	0.03	0.04	0.63	0.5	0.69	1	0.40	1	0.5	0.5	1	0.11	0.579
Scenario 7_19	0.12	0.64	0.80	0.25	0.03	0.38	0.26	1	0.69	0	0.40	1	0.5	0	0.5	0.11	0.495
Scenario 7_20	0.12	0.64	0.80	0	0.03	0.38	0.76	1	0.69	0	0.40	1	1	0	1	0.11	0.588
Scenario 7_21	0.12	0.64	0.80	0.5	0.41	0.04	0.76	0	0.69	0	0.40	0	0.5	1	1	0.11	0.461
Scenario 7_22	0.12	0.64	0.80	0	0.41	0.04	0.38	1	0.69	0.5	0.40	0.5	0	0.5	0	0.11	0.426
Scenario 7_23	0.12	0.64	0.80	0.75	0.41	0.38	0.63	0.5	0.69	0.5	0.40	0	0.5	0.5	0.5	0.11	0.466
Scenario 7_24	0.12	0.64	0.80	0.5	0.66	0.38	0.38	0	0.69	1	0.40	0.5	0.5	0.5	1	0.11	0.526
Scenario 7_25	0.12	0.64	0.80	0.25	0.66	0.38	0.63	1	0.69	0	0.40	1	0	0	0	0.11	0.510
Scenario 7_26	0.12	0.64	0.80	0	0.53	0.38	0.63	0	0.69	1	0.40	0.5	1	1	1	0.11	0.573
Scenario 7_27	0.12	0.64	0.80	0	0.66	0.04	0.26	0	0.69	0.5	0.40	1	0	1	1	0.11	0.518
Scenario 7_28	0.12	0.64	0.80	0.5	0.16	0.38	0.76	0.5	0.69	0.5	0.40	0	0	0.5	0	0.11	0.414
Scenario 7_29	0.12	0.64	0.80	0.25	0.66	0.04	0.76	0.5	0.69	1	0.40	1	0	0.5	0.5	0.11	0.578
Scenario 7_30	0.12	0.64	0.80	0	0.78	0.04	0.26	1	0.69	0.5	0.40	0.5	0.5	0	1	0.11	0.476
Scenario 7_31	0.12	0.64	0.80	0.75	0.03	0.04	0.26	1	0.69	1	0.40	0	0.5	0.5	1	0.11	0.461
Scenario 7_32	0.12	0.64	0.80	0	0.53	0.38	0.38	0.5	0.69	0.5	0.40	0	0	0	0.5	0.11	0.365
Scenario 7_33	0.12	0.64	0.80	0.75	0.16	0.04	0.26	0	0.69	0	0.40	0	0	1	0.5	0.11	0.360

Firm 7	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 7_34	0.12	0.64	0.80	0.75	0.53	0.04	0.26	0.5	0.69	0	0.40	0.5	1	0.5	0.5	0.11	0.480
Scenario 7_35	0.12	0.64	0.80	0.75	0.66	0.04	0.38	0	0.69	0	0.40	0	1	0	1	0.11	0.418
Scenario 7_36	0.12	0.64	0.80	1	0.16	0.04	0.38	0.5	0.69	1	0.40	1	0	0	1	0.11	0.553
Scenario 7_37	0.12	0.64	0.80	0.25	0.28	0.04	0.38	0	0.69	0	0.40	0	0.5	0.5	0	0.11	0.333
Scenario 7_38	0.12	0.64	0.80	0.5	0.78	0.04	0.51	0.5	0.69	1	0.40	1	0	1	0	0.11	0.562
Scenario 7_39	0.12	0.64	0.80	0.75	0.28	0.04	0.63	1	0.69	0.5	0.40	0.5	0	0	0.5	0.11	0.485
Scenario 7_40	0.12	0.64	0.80	0.75	0.16	0.04	0.51	0	0.69	0.5	0.40	1	0	0.5	0	0.11	0.490
Scenario 7_41	0.12	0.64	0.80	0.5	0.41	0.04	0.26	1	0.69	1	0.40	0	0.5	0	0	0.11	0.393
Scenario 7_42	0.12	0.64	0.80	1	0.16	0.38	0.51	1	0.69	0	0.40	1	0.5	1	1	0.11	0.627
Scenario 7_43	0.12	0.64	0.80	0.25	0.78	0.38	0.51	0.5	0.69	0.5	0.40	0	1	0	0	0.11	0.421
Scenario 7_44	0.12	0.64	0.80	0.75	0.78	0.38	0.38	1	0.69	0	0.40	1	0	0.5	1	0.11	0.578
Scenario 7_45	0.12	0.64	0.80	0.75	0.16	0.04	0.76	1	0.69	1	0.40	0	1	0	0.5	0.11	0.499
Scenario 7_46	0.12	0.64	0.80	0.5	0.78	0.04	0.26	0	0.69	0.5	0.40	1	0	0	0.5	0.11	0.475
Scenario 7_47	0.12	0.64	0.80	0	0.66	0.04	0.51	1	0.69	1	0.40	0	1	0.5	0	0.11	0.453
Scenario 7_48	0.12	0.64	0.80	0.25	0.16	0.04	0.26	1	0.69	0.5	0.40	0.5	0.5	0.5	0.5	0.11	0.463
Scenario 7_49	0.12	0.64	0.80	0.5	0.53	0.38	0.26	1	0.69	0	0.40	1	0.5	0.5	0	0.11	0.520
Scenario 7_50	0.12	0.64	0.80	0.75	0.41	0.38	0.38	1	0.69	0	0.40	1	1	1	0	0.11	0.585
Scenario 7_51	0.12	0.64	0.80	1	0.78	0.04	0.63	0.5	0.69	0	0.40	0.5	0.5	0.5	0	0.11	0.493
Scenario 7_52	0.12	0.64	0.80	0.5	0.03	0.04	0.38	1	0.69	0.5	0.40	0.5	1	1	0.5	0.11	0.527
Scenario 7_53	0.12	0.64	0.80	0	0.16	0.04	0.38	0	0.69	0.5	0.40	1	0.5	0.5	0.5	0.11	0.491
Scenario 7_54	0.12	0.64	0.80	0	0.78	0.04	0.63	0	0.69	0	0.40	0	1	0.5	0.5	0.11	0.415
Scenario 7_55	0.12	0.64	0.80	1	0.03	0.04	0.38	1	0.69	1	0.40	0	0	0.5	0.5	0.11	0.437
Scenario 7_56	0.12	0.64	0.80	0.25	0.28	0.38	0.63	0.5	0.69	0.5	0.40	0	0.5	0	1	0.11	0.443
Scenario 7_57	0.12	0.64	0.80	1	0.41	0.04	0.63	0	0.69	0.5	0.40	1	1	0.5	1	0.11	0.618
Scenario 7_58	0.12	0.64	0.80	0.25	0.16	0.04	0.51	1	0.69	0.5	0.40	0.5	1	0.5	1	0.11	0.538
Scenario 7_59	0.12	0.64	0.80	0.75	0.53	0.04	0.51	0	0.69	0.5	0.40	1	0.5	0	1	0.11	0.553
Scenario 7_60	0.12	0.64	0.80	0.75	0.03	0.04	0.38	0.5	0.69	0	0.40	0.5	0	0	0	0.11	0.384
Scenario 7_61	0.12	0.64	0.80	1	0.03	0.04	0.51	0	0.69	0	0.40	0	0.5	0	0.5	0.11	0.374
Scenario 7_62	0.12	0.64	0.80	0.5	0.16	0.04	0.63	0	0.69	0	0.40	0	1	1	0	0.11	0.413
Scenario 7_63	0.12	0.64	0.80	0.25	0.03	0.04	0.26	0.5	0.69	1	0.40	1	1	0.5	0	0.11	0.523
Scenario 7_64	0.12	0.64	0.80	0	0.28	0.04	0.51	1	0.69	1	0.40	0	0.5	1	0.5	0.11	0.463
Scenario 7_65	0.12	0.64	0.80	0.75	0.66	0.04	0.51	1	0.69	0.5	0.40	0.5	0.5	1	0	0.11	0.526
Scenario 7_66	0.12	0.64	0.80	0	0.16	0.38	0.63	1	0.69	0	0.40	1	0	1	0.5	0.11	0.550
Scenario 7_67	0.12	0.64	0.80	0	0.16	0.04	0.26	0.5	0.69	0	0.40	0.5	1	1	0	0.11	0.433

Firm 7	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 7_68	0.12	0.64	0.80	0.5	0.03	0.04	0.63	1	0.69	0.5	0.40	0.5	0	1	1	0.11	0.533
Scenario 7_69	0.12	0.64	0.80	0.25	0.78	0.04	0.38	1	0.69	1	0.40	0	1	1	1	0.11	0.523
Scenario 7_70	0.12	0.64	0.80	0.75	0.03	0.38	0.63	0	0.69	1	0.40	0.5	1	0.5	0	0.11	0.518
Scenario 7_71	0.12	0.64	0.80	0.75	0.03	0.38	0.51	0.5	0.69	0.5	0.40	0	0	1	1	0.11	0.462
Scenario 7_72	0.12	0.64	0.80	0	0.28	0.04	0.76	0.5	0.69	0	0.40	0.5	0	0.5	1	0.11	0.474
Scenario 7_73	0.12	0.64	0.80	0	0.03	0.04	0.26	0	0.69	0	0.40	0	0	0	0	0.11	0.256
Scenario 7_74	0.12	0.64	0.80	0.5	0.16	0.38	0.26	0.5	0.69	0.5	0.40	0	1	0.5	1	0.11	0.453
Scenario 7_75	0.12	0.64	0.80	0.75	0.78	0.38	0.76	0	0.69	1	0.40	0.5	0.5	1	0.5	0.11	0.580
Scenario 7_76	0.12	0.64	0.80	0.75	0.28	0.04	0.26	0.5	0.69	1	0.40	1	1	1	1	0.11	0.623
Scenario 7_77	0.12	0.64	0.80	0	0.03	0.38	0.38	0.5	0.69	0.5	0.40	0	0.5	1	0	0.11	0.390
Scenario 7_78	0.12	0.64	0.80	0.5	0.66	0.04	0.63	0.5	0.69	0	0.40	0.5	0.5	0	0.5	0.11	0.471
Scenario 7_79	0.12	0.64	0.80	0	0.16	0.38	0.51	0	0.69	1	0.40	0.5	0.5	0	0	0.11	0.432
Scenario 7_80	0.12	0.64	0.80	1	0.66	0.38	0.26	0.5	0.69	0.5	0.40	0	1	1	0.5	0.11	0.489
Scenario 7_81	0.12	0.64	0.80	0.5	0.28	0.04	0.38	0	0.69	0.5	0.40	1	1	0	0	0.11	0.494

Table E-8: Possible scenarios for Firm 8

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8_1	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.572
Scenario 8_2	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.583
Scenario 8_3	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.518
Scenario 8_4	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.580
Scenario 8_5	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.553
Scenario 8_6	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.548
Scenario 8_7	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.472
Scenario 8_8	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.545
Scenario 8_9	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.483
Scenario 8_10	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.537
Scenario 8_11	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.545
Scenario 8_12	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.534
Scenario 8_13	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.491
Scenario 8_14	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.583
Scenario 8_15	0.00	1.00	1.00	0.75	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.564
Scenario 8_16	0.00	1.00	1.00	1	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.602
Scenario 8_17	0.00	1.00	1.00	0.5	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.575
Scenario 8_18	0.00	1.00	1.00	0	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.557
Scenario 8_19	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.537
Scenario 8_20	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.553
Scenario 8_21	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.515
Scenario 8_22	0.00	1.00	1.00	0.25	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.546
Scenario 8_23	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.548
Scenario 8_24	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	1	1	0.00	0.583
Scenario 8_25	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.518

APPENDIX F: SCENARIOS TO COMPARE SME AND MNE IN THE CORPORATE SOCIAL RESPONSIBILITY GROUP

This appendix shows the tables with the scenarios to compare SME and MNE in the sensitivity analysis of the corporate social responsibility group.

Table F-1: Possible scenarios for Firm 1

Firm 1	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 1_1	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.711
Scenario 1_2	1.00	0.75	0.63	1	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.736
Scenario 1_3	1.00	0.75	0.63	1	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.779
Scenario 1_4	1.00	0.75	0.63	1	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.751
Scenario 1_5	1.00	0.75	0.63	0.75	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.741
Scenario 1_6	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.768
Scenario 1_7	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.738
Scenario 1_8	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.681
Scenario 1_9	1.00	0.75	0.63	0.25	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.742
Scenario 1_10	1.00	0.75	0.63	1	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.713
Scenario 1_11	1.00	0.75	0.63	0	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.755
Scenario 1_12	1.00	0.75	0.63	0	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.670
Scenario 1_13	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.711
Scenario 1_14	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	1	1.00	0.67	1.00	0.728
Scenario 1_15	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.722
Scenario 1_16	1.00	0.75	0.63	0	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.713
Scenario 1_17	1.00	0.75	0.63	1	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.755
Scenario 1_18	1.00	0.75	0.63	0	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.670
Scenario 1_19	1.00	0.75	0.63	0	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.713
Scenario 1_20	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.726
Scenario 1_21	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.723
Scenario 1_22	1.00	0.75	0.63	0.5	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.715
Scenario 1_23	1.00	0.75	0.63	0.25	0.34	0.79	0.54	0.5	0.68	0.95	0.61	1.00	0	1.00	0.67	1.00	0.700
Scenario 1_24	1.00	0.75	0.63	0.75	0.34	0.79	0.54	0	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.726
Scenario 1_25	1.00	0.75	0.63	0.5	0.34	0.79	0.54	1	0.68	0.95	0.61	1.00	0.5	1.00	0.67	1.00	0.753

Table F-2: Possible scenarios of Firm 8 for the social measure A

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8A_1	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.572
Scenario 8A_2	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.583
Scenario 8A_3	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.518
Scenario 8A_4	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.580
Scenario 8A_5	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.553
Scenario 8A_6	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.548
Scenario 8A_7	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.472
Scenario 8A_8	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.545
Scenario 8A_9	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.483
Scenario 8A_10	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.537
Scenario 8A_11	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.545
Scenario 8A_12	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.534
Scenario 8A_13	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.491
Scenario 8A_14	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.583
Scenario 8A_15	0.00	1.00	1.00	0.75	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.564
Scenario 8A_16	0.00	1.00	1.00	1	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.602
Scenario 8A_17	0.00	1.00	1.00	0.5	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.575
Scenario 8A_18	0.00	1.00	1.00	0	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.557
Scenario 8A_19	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.537
Scenario 8A_20	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.553
Scenario 8A_21	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.515
Scenario 8A_22	0.00	1.00	1.00	0.25	0.61	0.49	0.61	1	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.546
Scenario 8A_23	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.548
Scenario 8A_24	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	0.00	0.96	1	1	0.00	0.583
Scenario 8A_25	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.518

Table F-3: Possible scenarios of Firm 8 for the social measure B

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8B_1	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.700
Scenario 8B_2	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.710
Scenario 8B_3	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.646
Scenario 8B_4	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.708
Scenario 8B_5	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.681
Scenario 8B_6	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.676
Scenario 8B_7	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.600
Scenario 8B_8	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.673
Scenario 8B_9	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.611
Scenario 8B_10	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.665
Scenario 8B_11	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.673
Scenario 8B_12	0.00	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.662
Scenario 8B_13	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.619
Scenario 8B_14	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.711
Scenario 8B_15	0.00	1.00	1.00	0.75	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.692
Scenario 8B_16	0.00	1.00	1.00	1	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.730
Scenario 8B_17	0.00	1.00	1.00	0.5	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.703
Scenario 8B_18	0.00	1.00	1.00	0	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.684
Scenario 8B_19	0.00	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.664
Scenario 8B_20	0.00	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.681
Scenario 8B_21	0.00	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.643
Scenario 8B_22	0.00	1.00	1.00	0.25	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.673
Scenario 8B_23	0.00	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.676
Scenario 8B_24	0.00	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	1	1	0.00	0.711
Scenario 8B_25	0.00	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.646

Table F-4: Possible scenarios of Firm 8 for the social measure C

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8C_1	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.731
Scenario 8C_2	0.58	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.742
Scenario 8C_3	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.677
Scenario 8C_4	0.58	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.739
Scenario 8C_5	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.712
Scenario 8C_6	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.707
Scenario 8C_7	0.58	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.631
Scenario 8C_8	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.704
Scenario 8C_9	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.642
Scenario 8C_10	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.696
Scenario 8C_11	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.704
Scenario 8C_12	0.58	1.00	1.00	1	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.693
Scenario 8C_13	0.58	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.650
Scenario 8C_14	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.742
Scenario 8C_15	0.58	1.00	1.00	0.75	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.723
Scenario 8C_16	0.58	1.00	1.00	1	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.761
Scenario 8C_17	0.58	1.00	1.00	0.5	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.734
Scenario 8C_18	0.58	1.00	1.00	0	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.716
Scenario 8C_19	0.58	1.00	1.00	1	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.696
Scenario 8C_20	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.712
Scenario 8C_21	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.674
Scenario 8C_22	0.58	1.00	1.00	0.25	0.61	0.49	0.61	1	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.705
Scenario 8C_23	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.707
Scenario 8C_24	0.58	1.00	1.00	0	0.61	0.49	0.61	0.5	0.40	0.91	0.67	1.00	0.96	1	1	0.00	0.742
Scenario 8C_25	0.58	1.00	1.00	0	0.61	0.49	0.61	0	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.677

Table F-5: Possible scenarios of Firm 8 for the social measure D

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8D_1	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	1	0.5	0.00	0.746
Scenario 8D_2	0.58	1.00	1.00	1	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	1	0.5	0.00	0.757
Scenario 8D_3	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0	0.5	0.00	0.692
Scenario 8D_4	0.58	1.00	1.00	1	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.755
Scenario 8D_5	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0	1	0.00	0.728
Scenario 8D_6	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.723
Scenario 8D_7	0.58	1.00	1.00	0	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0	0	0.00	0.647
Scenario 8D_8	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0.5	0	0.00	0.720
Scenario 8D_9	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0	0	0.00	0.657
Scenario 8D_10	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0	0.5	0.00	0.712
Scenario 8D_11	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	1	0	0.00	0.720
Scenario 8D_12	0.58	1.00	1.00	1	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0	0	0.00	0.709
Scenario 8D_13	0.58	1.00	1.00	0	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0	0	0.00	0.666
Scenario 8D_14	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0.5	1	0.00	0.758
Scenario 8D_15	0.58	1.00	1.00	0.75	0.61	0.49	0.61	1	0.80	0.91	0.67	1.00	0.96	0.5	0	0.00	0.739
Scenario 8D_16	0.58	1.00	1.00	1	0.61	0.49	0.61	1	0.80	0.91	0.67	1.00	0.96	0	1	0.00	0.776
Scenario 8D_17	0.58	1.00	1.00	0.5	0.61	0.49	0.61	1	0.80	0.91	0.67	1.00	0.96	1	0	0.00	0.750
Scenario 8D_18	0.58	1.00	1.00	0	0.61	0.49	0.61	1	0.80	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.731
Scenario 8D_19	0.58	1.00	1.00	1	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0.5	0	0.00	0.711
Scenario 8D_20	0.58	1.00	1.00	0.25	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0.5	1	0.00	0.728
Scenario 8D_21	0.58	1.00	1.00	0.5	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0.5	0	0.00	0.690
Scenario 8D_22	0.58	1.00	1.00	0.25	0.61	0.49	0.61	1	0.80	0.91	0.67	1.00	0.96	0	0.5	0.00	0.720
Scenario 8D_23	0.58	1.00	1.00	0.75	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	0	0.5	0.00	0.722
Scenario 8D_24	0.58	1.00	1.00	0	0.61	0.49	0.61	0.5	0.80	0.91	0.67	1.00	0.96	1	1	0.00	0.758
Scenario 8D_25	0.58	1.00	1.00	0	0.61	0.49	0.61	0	0.80	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.693

Table F-6: Possible scenarios of Firm 8 for the social measure E

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8E_1	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.623
Scenario 8E_2	0.00	1.00	1.00	1	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	1	0.5	0.00	0.633
Scenario 8E_3	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.569
Scenario 8E_4	0.00	1.00	1.00	1	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.631
Scenario 8E_5	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.604
Scenario 8E_6	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.599
Scenario 8E_7	0.00	1.00	1.00	0	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.523
Scenario 8E_8	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.596
Scenario 8E_9	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.534
Scenario 8E_10	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.588
Scenario 8E_11	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.596
Scenario 8E_12	0.00	1.00	1.00	1	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.585
Scenario 8E_13	0.00	1.00	1.00	0	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0	0	0.00	0.542
Scenario 8E_14	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.634
Scenario 8E_15	0.00	1.00	1.00	0.75	0.86	0.82	0.86	1	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.615
Scenario 8E_16	0.00	1.00	1.00	1	0.86	0.82	0.86	1	0.40	0.91	0.67	0.00	0.96	0	1	0.00	0.653
Scenario 8E_17	0.00	1.00	1.00	0.5	0.86	0.82	0.86	1	0.40	0.91	0.67	0.00	0.96	1	0	0.00	0.626
Scenario 8E_18	0.00	1.00	1.00	0	0.86	0.82	0.86	1	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.607
Scenario 8E_19	0.00	1.00	1.00	1	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.587
Scenario 8E_20	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0.5	1	0.00	0.604
Scenario 8E_21	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0.5	0	0.00	0.566
Scenario 8E_22	0.00	1.00	1.00	0.25	0.86	0.82	0.86	1	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.596
Scenario 8E_23	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	0	0.5	0.00	0.598
Scenario 8E_24	0.00	1.00	1.00	0	0.86	0.82	0.86	0.5	0.40	0.91	0.67	0.00	0.96	1	1	0.00	0.634
Scenario 8E_25	0.00	1.00	1.00	0	0.86	0.82	0.86	0	0.40	0.91	0.67	0.00	0.96	0.5	0.5	0.00	0.569

Table F-7: Possible scenarios of Firm 8 for the social measure F

Firm 8	I_1'	I_2'	I_3'	I_4'	I_5'	I_6'	I_7'	I_8'	I_9'	I_{10}'	I_{11}'	I_{12}'	I_{13}'	I_{14}'	I_{15}'	I_{16}'	CI_{G2}
Scenario 8F_1	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.750
Scenario 8F_2	0.00	1.00	1.00	1	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	1	0.5	0.00	0.761
Scenario 8F_3	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.696
Scenario 8F_4	0.00	1.00	1.00	1	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.759
Scenario 8F_5	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.731
Scenario 8F_6	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.727
Scenario 8F_7	0.00	1.00	1.00	0	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.651
Scenario 8F_8	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.723
Scenario 8F_9	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.661
Scenario 8F_10	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.716
Scenario 8F_11	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.724
Scenario 8F_12	0.00	1.00	1.00	1	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.713
Scenario 8F_13	0.00	1.00	1.00	0	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0	0	0.00	0.670
Scenario 8F_14	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.762
Scenario 8F_15	0.00	1.00	1.00	0.75	0.86	0.82	0.86	1	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.743
Scenario 8F_16	0.00	1.00	1.00	1	0.86	0.82	0.86	1	0.40	0.91	0.67	1.00	0.96	0	1	0.00	0.780
Scenario 8F_17	0.00	1.00	1.00	0.5	0.86	0.82	0.86	1	0.40	0.91	0.67	1.00	0.96	1	0	0.00	0.754
Scenario 8F_18	0.00	1.00	1.00	0	0.86	0.82	0.86	1	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.735
Scenario 8F_19	0.00	1.00	1.00	1	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.715
Scenario 8F_20	0.00	1.00	1.00	0.25	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0.5	1	0.00	0.732
Scenario 8F_21	0.00	1.00	1.00	0.5	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0.5	0	0.00	0.694
Scenario 8F_22	0.00	1.00	1.00	0.25	0.86	0.82	0.86	1	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.724
Scenario 8F_23	0.00	1.00	1.00	0.75	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	0	0.5	0.00	0.726
Scenario 8F_24	0.00	1.00	1.00	0	0.86	0.82	0.86	0.5	0.40	0.91	0.67	1.00	0.96	1	1	0.00	0.762
Scenario 8F_25	0.00	1.00	1.00	0	0.86	0.82	0.86	0	0.40	0.91	0.67	1.00	0.96	0.5	0.5	0.00	0.697

APPENDIX G: CORPORATE SOCIAL RESPONSIBILITY AS EVALUATION FACTOR IN BIDDING SPECIFICATIONS

The information that should be included in bidding specifications to define and assess the corporate social responsibility evaluation factor has been established as follow. The information that should be adapted to each project has been highlighted in red.

EVALUATION FACTOR: CORPORATE SOCIAL RESPONSIBILITY

Description:

The evaluation factor 'Corporate social responsibility' has to be assessed through the composite indicator 'CI_{G2}' defined in Equation X-X. This composite indicator is formed by the summation of weighted company indicators. The result of the composite indicator varies from 0 to 1 depending on the social parameters data submitted by each offeror.

$$CI_{G2} = \sum_{i=1}^{n} I'_{ij} \cdot w_i \qquad \text{(X-X)}$$

Where:

- I'_{ij} represent the normalized values of each company indicator (i) associated with each construction company (j) involved in the procurement procedure.
- w_i are the weights assigned to each company indicator (i) for ________ (country where the project is procured).

The composite indicator to assess the corporate social responsibility criteria collects sixteen (16) company indicators. These indicators are:

- I'_1: New staff hiring
- I'_2: Temporary contracts
- I'_3: Employee turnover
- I'_4: Benefits
- I'_5: Chronic disease
- I'_6: Fatal accidents at work
- I'_7: Non-fatal injuries at work
- I'_8: Social value
- I'_9: Female labor force participation
- I'_{10}: Wage gap
- I'_{11}: Women in executive management positions
- I'_{12}: Disabled
- I'_{13}: Salary distribution
- I'_{14}: Technical training
- I'_{15}: Social ethics, social awareness and human rights
- I'_{16}: Research and development

The equations to calculate these company indicators are defined in Appendix __.

The normalization parameters to be considered in these equations to calculate the company indicators are as follows.

Normalization parameters	Value
λ_1	
λ_2	
λ_3	
λ_4	
λ_5	
λ_6	
λ_7	
λ_8	
λ_9	
λ_{10}	
λ_{11}	
λ_{12}	
λ_{13}	
λ_{14}	
λ_{15}	
λ_{16}	

The percentage weightings applicable to assess the corporate social responsibility are as follows.

Company indicators	**Weights**
I'_1 :New hires	w_1:
I'_2 :Temporary contracts	w_2:
I'_3 :Employee turnover	w_3:
I'_4 :Social Benefits	w_4:
I'_5 :Chronic disease	w_5:
I'_6 :Fatal accidents at work	w_6:
I'_7 :Non-fatal injuries at work	w_7:
I'_8 :Social value	w_8:
I'_9 :Female labor force participation	w_9:
I'_{10} :Wage gap	w_{10}:
I'_{11} :Women in executive management positions	w_{11}:
I'_{12} :Disabled	w_{12}:
I'_{13} :Salary distribution	w_{13}:
I'_{14} :Technical training	w_{14}:
I'_{15} :Social ethics, social awareness and human rights	w_{15}:
I'_{16} :Research and development	w_{16}:
TOTAL	1

Submittal Requirement:

Contractor shall provide the information gathered in Appendix __. Only the information of the company in Spain has to be considered.

APPENDIX H: EQUATIONS TO CALCULATE THE COMPANY INDICATORS

The information that should be included in bidding specifications to define the company indicators has been established as follow. The definition of each company indicator gathers:

- The equation to calculate the company indicator.
- The equation to calculate the basic indicators
- The definition of the social parameters of each basic indicator

Indicator	$I_1{}'$: New staff hiring
Definition	The equation to assess the company indicator "New staff hiring" ($I_1{}'$) is: If $I_1 \leq \lambda_1$, $I_1{}' = I_1 \cdot \frac{1}{\lambda_1}$; else $I_1{}' = 1$ $I_1 = \frac{\mathrm{A}}{\mathrm{B}}$ $I_1{}'$: Company indicator I_1: Basic indicator λ_1: Normalization parameter Social parameters: • A: Total number of new staff hiring in the company over the last year (part-time and full-time staff) • B: Maximum number of workers in the company over the last year (part-time and full-time staff)

Indicator	$I_2{}'$: Temporary contracts
Definition	The equation to assess the company indicator "Temporary contracts" ($I_2{}'$) is: If $\mathrm{I}_2 \leq \lambda_2$, $\mathrm{I}_2{}' = 1 - \mathrm{I}_2 \cdot \frac{1}{\lambda_2}$; else $\mathrm{I}_2{}' = 0$ $\mathrm{I}_2 = \frac{\mathrm{C}}{\mathrm{B}}$ $I_2{}'$: Company indicator I_2: Basic indicators λ_2: Normalization parameters Social parameters: • C: Total number of temporary workers in the company over the last year • B : Maximum number of workers in the company over the last year (part-time and full-time staff)

Indicator	$I_3{}'$: Employee turnover
Definition	The equation to assess the company indicator "Employee turnover" ($I_3{}'$) is: If $\mathrm{I}_3 \leq \lambda_3$, $\mathrm{I}_3{}' = 1 - \mathrm{I}_3 \cdot \frac{1}{\lambda_3}$; else $\mathrm{I}_3{}' = 0$ $\mathrm{I}_3 = \frac{\mathrm{D}}{\mathrm{B}}$

	${I_3}'$: Company indicator I_3: Basic indicators λ_3: Normalization parameters Social parameters: • D: Maximum number of leaving over the last year (part-time and full-time staff) • B : Maximum number of workers in the company over the last year (part-time and full-time staff)

Indicator	${I_4}'$:Benefits
Definition	The equation to assess the company indicator “Benefits” (${I_4}'$) is: $\mathrm{I'}_4 = \frac{1}{2}(\mathrm{I'}_{41} + \mathrm{I'}_{42})$ $\mathrm{I}_{41} = \frac{\mathrm{E}_0}{\mathrm{E}_1}$; If $\mathrm{I}_{41} \leq \lambda_4$, $\mathrm{I'}_{41} = \mathrm{I}_{41} \cdot \frac{1}{\lambda_{41}}$; else $\mathrm{I'}_{41} = 1$ $\mathrm{I}_{42} = \frac{\mathrm{E}_2}{\mathrm{E}_3}$; If $\mathrm{E}_3 > 0$, $\mathrm{I'}_{42} = \mathrm{I}_{42} \cdot \frac{1}{\lambda_{42}}$; else $\mathrm{I'}_{42} = 1$ I'_4: Company indicator I'_{41}, I'_{42}: Standardized indicators I_{41}, I_{42}: Basic indicators $\lambda_{41}, \lambda_{42}$: Normalization parameters Social parameters: • E_0 : annual investment in health of employees over last year; considering social security, medical insurance, dental insurance, paramedical insurance including preventive medicine, medicine insurance, wage insurance, paid maternity and paternity leave, paid sick leave • E_1: Revenue over last year • E_2: the number of employees who, over last two years, returned to work after parental leave ended who were still employed twelve months after their return to work • E_3: the number of employees that were entitled to parental leave over last two years

Indicator	${I_5}'$: Chronic disease
Definition	The equation to assess the company indicator “Chronic disease” (${I_5}'$) is: ${\mathrm{I}_5}' = \frac{1}{4}(\mathrm{I'}_{51} + \mathrm{I'}_{52} + \mathrm{I'}_{53} + \mathrm{I}_{54})$ $\mathrm{I}_{51} = \frac{\mathrm{F}_0}{\mathrm{F}_1}$; If $\mathrm{I}_{51} \leq \lambda_{51}$, $\mathrm{I'}_{51} = 1 - \mathrm{I}_{51} \cdot \frac{1}{\lambda_{51}}$; else $\mathrm{I'}_{51} = 0$ $\mathrm{I}_{52} = \frac{\mathrm{F}_2}{\mathrm{F}_3} \cdot 200{,}000$; If $\mathrm{I}_{52} \leq \lambda_{52}$, $\mathrm{I'}_{52} = 1 - \mathrm{I}_{52} \cdot \frac{1}{\lambda_{52}}$; else $\mathrm{I'}_{52} = 0$ $\mathrm{I}_{53} = \frac{\mathrm{F}_4}{\mathrm{F}_3}$; If $\mathrm{I}_{53} \leq \lambda_{53}$, $\mathrm{I'}_{53} = \mathrm{I}_{53} \cdot \frac{1}{\lambda_{53}}$; else $\mathrm{I'}_{53} = 1$ I_{54} : If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $\mathrm{I}_{54} = 1$; else $I_{54} = 0$ ${I_5}'$: Company indicator $I'_{51}, I'_{52}, I'_{53}$: Standardized indicators $I_{51}, I_{52}, I_{53}, I_{54}$: Basic indicators $\lambda_{51}, \lambda_{52}, \lambda_{53}$: Normalization parameters Social parameters: • F_0: The number of days missed due to illness over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_1: Total number of workers in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom

	the organization is liable for the general safety of the working environment • F_2: The number of occupational disease over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_3: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_4: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment An occupational disease is a disease arising from the work situation or activity, or from a work-related injury

Indicator	$I_6{}'$: Fatal accidents at work
Definition	The equation to assess the company indicator "Fatal accidents at work" ($I_6{}'$) is: $\mathrm{I_6}' = \frac{1}{3}(\mathrm{I'}_{61} + \mathrm{I'}_{53} + \mathrm{I}_{54})$ $\mathrm{I}_{61} = \frac{\mathrm{G}}{\mathrm{F_3}}$; If $\mathrm{I}_{61} \leq \lambda_6$, $\mathrm{I'}_{61} = 1 - \mathrm{I}_{61} \cdot \frac{1}{\lambda_6}$; else $\mathrm{I'}_{61} = 0$ $\mathrm{I}_{53} = \frac{\mathrm{F_4}}{\mathrm{F_3}}$; If $\mathrm{I}_{53} \leq \lambda_{53}$, $\mathrm{I'}_{53} = \mathrm{I}_{53} \cdot \frac{1}{\lambda_{53}}$; else $\mathrm{I'}_{53} = 1$ I_{54} : If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $\mathrm{I}_{54} = 1$; else $I_{54} = 0$ $I_6{}'$: Company indicator I'_{61}, I'_{53}: Standardized indicators I_{61}, I_{53}, I_{54} : Basic indicators λ_6, λ_{53}: Normalization parameters Social parameters: • G: Number of fatalities over last year considering total staff and supervised workers to whom the organization is liable for the general safety of the working environment • F_3: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_4: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment A Fatality is the death of a worker occurring in the current reporting period, arising from an occupational injury or disease sustained or contracted while are employed in the organization

Indicator	$I_7{}'$: Non-fatal injuries at work
Definition	The equation to assess the company indicator "Non-fatal injuries at work" ($I_7{}'$) is: $\mathrm{I_7}' = \frac{1}{4}(\mathrm{I'}_{71} + \mathrm{I'}_{72} + \mathrm{I'}_{53} + \mathrm{I}_{54})$ $\mathrm{I}_{71} = \frac{\mathrm{H_0}}{\mathrm{F_3}} \cdot 100{,}000{,}000$; If $\mathrm{I}_{71} \leq \lambda_{71}$, $\mathrm{I'}_{71} = 1 - \mathrm{I}_{71} \cdot \frac{1}{\lambda_{71}}$; else $\mathrm{I'}_{71} = 0$

	$I_{72} = \frac{H_1}{F_3} \cdot 1{,}000$; If $I_{72} \leq \lambda_{72}$, $I'_{72} = 1 - I_{72} \cdot \frac{1}{\lambda_{72}}$; else $I'_{72} = 0$ $I_{53} = \frac{F_4}{F_3}$; If $I_{53} \leq \lambda_{53}$, $I'_{53} = I_{53} \cdot \frac{1}{\lambda_{53}}$; else $I'_{53} = 1$ I_{54} : If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent $I_{54} = 1$; else $I_{54} = 0$ I_7': Company indicator $I'_{71}, I'_{72}\ I'_{53}$: Standardized indicators $I_{71}, I_{72}, I_{53}, I_{54}$: Basic indicators $\lambda_{71}, \lambda_{72}, \lambda_{53}$: Normalization parameters Social parameters: • H_0: The number of accidents involving sick leave over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment. • H_1: The number of working days lost due to sick leave accidents registered over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_3: Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment • F_4: Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment

Indicator	I_8' : Social value
Definition	The equation to assess the company indicator "Social value" (I_8') is: If $I_8 \leq \lambda_8$, $I_8' = I_8 \cdot \frac{1}{\lambda_8}$; else $I_8' = 1$ $I_8 = \frac{K_0}{K_1}$ I_8': Company indicator I_8: Basic Indicator λ_8: Normalization parameter Social parameters: • K_0: Total number of hours that employees have spent with social programs and voluntary activities during working hours of the last year, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)

Indicator	I_9' : Female labor force participation
Definition	The equation to assess the company indicator "Female labor force participation" (I_9') is: If $I_9 \leq \lambda_9$, $I_9' = I_9 \cdot \frac{1}{\lambda_9}$; else $I_9' = 1$ $I_9 = \frac{L}{B}$ I_9': Company indicator I_9: Basic indicator λ_9: Normalization parameter Social parameters:

	• L: Total number of women employees in the company over the last year (part-time and full-time staff) • B: Maximum number of workers in the company over the last year (part-time and full-time staff)

Indicator	$I_{10}{}'$: Wage gap
Definition	The equation to assess the company indicator "Wage gap" ($I_{10}{}'$) is: If $\mathrm{I}_{10} = 0$, $\mathrm{I'}_{10} = 1$; else $\mathrm{I'}_{10} = 1 - \mathrm{I}_{10}$ $\mathrm{I}_{10} = \frac{1}{\mathrm{n}} \cdot \sum_{\mathrm{i}=1}^{\mathrm{n}} \left(\frac{\max(\mathrm{a,b})_{\mathrm{i}} - \min(\mathrm{a,b})_{\mathrm{i}}}{\max(\mathrm{a,b})_{\mathrm{i}}} \right)$ $I_{10}{}'$: Company indicator I_{10}: Basic indicator Social parameters: $\mathrm{a} = \mathrm{S}_{\mathrm{W\,i}}/\mathrm{H}_{\mathrm{w\,i}}$ • $\mathrm{S}_{\mathrm{W\,i}}$: Total of basic salary and remuneration of women employees in "i" job category, over the last year • $\mathrm{H}_{\mathrm{w\,i}}$: Number of worked hours by women employees in "i" job category, over the last year $\mathrm{b} = \mathrm{S}_{\mathrm{M\,i}}/\mathrm{H}_{\mathrm{M\,i}}$ • S_{Mi}: Total of basic salary and remuneration of men employees in "i" job category, over the last year • $\mathrm{H}_{\mathrm{M\,i}}$: Number of worked hours by men employees in "i" job category, over the last year i: job categories in the company. Only the "n" categories where are both women and men employed must be considered. (Categories: (1) senior management; (2) executive and managers; (3) graduates; (4) administrative; (5) operatives)

Indicator	$I_{11}{}'$: Women in executive management positions
Definition	The equation to assess the company indicator "Women in executive management positions" ($I_{11}{}'$) is: If $\mathrm{I}_{11} \leq \lambda_{11}$, $\mathrm{I}_{11}{}' = \mathrm{I}_{11} \cdot \frac{1}{\lambda_{11}}$; else $\mathrm{I}_{11}{}' = 1$ $\mathrm{I}_{11} = \frac{\mathrm{N}_0}{\mathrm{N}_1}$ $I_{11}{}'$: Company indicator I_{11}: Basic indicator λ_{11}: Normalization parameter Social parameters: • N_0: Number of women in executive management positions in the Company over the last year • N_1: Number of workers in executive management positions in the company over the last year Executive management position refers to company directors, vice president, senior vice president, C-level executive (Chief Accounting Officer-CAO, Chief Operating Officer-COO, Chief Financial Officer-CFO and Chief Technology Officer-CTO) and Chief Executive Officer (CEO)

Indicator	$I_{12}{}'$: Disabled
Definition	The equation to assess the company indicator "Disabled" ($I_{12}{}'$) is: If $\mathrm{I}_{12} \leq \lambda_{12}$, $\mathrm{I}_{12}{}' = \mathrm{I}_{12} \cdot \frac{1}{\lambda_{12}}$; else $\mathrm{I}_{12}{}' = 1$ $\mathrm{I}_{12} = \frac{\mathrm{P}}{\mathrm{K}_1}$

	$I_{12}{}'$: Company indicator I_{12}: Basic indicator λ_{12}: Normalization parameter Social parameters: • P: Total number of workers in the company over the last year, registered as disabled (part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)

Indicator	$I_{13}{}'$: Salary distribution
Definition	The equation to assess the company indicator "Salary distribution" ($I_{13}{}'$) is: If $\mathrm{I}_{13} \leq \lambda_{13}$, $\mathrm{I}'_{13} = 1 - \mathrm{I}_{13} \cdot \frac{1}{\lambda_{13}}$; else $\mathrm{I}'_{13} = 0$ $\mathrm{I}_{13} = \frac{\mathrm{Q}_1}{\mathrm{Q}_2}$ $I_{13}{}'$: Company indicator I_{13}: Basic indicator λ_{13}: Normalization parameter Social parameters: • Q_1: Annual total compensation of the highest-paid individual in the company, over last year, considering total staff (temporal, part-time and full-time staff) • Q_2 : Median annual total compensation for all employees except the highest-paid individual, over last year, considering total staff (temporal, part-time and full-time staff) Total compensation compiles: - Base salary: guaranteed, short term, non-variable cash compensation - Cash compensation: sum of base salary + cash allowances + bonuses + commissions + cash profit-sharing + other forms of variable cash payments - Direct compensation: sum of total cash compensation + total fair value of all annual long-term incentives (such as stock option awards, restricted stock shares or units, performance stock shares or units, phantom stock shares, stock appreciation rights, and long-term cash awards)

Indicator	$I_{14}{}'$: Technical training
Definition	The equation to assess the company indicator "Technical training" ($I_{14}{}'$) is: If $\mathrm{I}_{14} \leq \lambda_{14}$, $\mathrm{I}_{14}{}' = \mathrm{I}_{14} \cdot \frac{1}{\lambda_{14}}$; else $\mathrm{I}_{14}{}' = 1$ $\mathrm{I}_{14} = \frac{\mathrm{T}}{\mathrm{K}_1}$ $I_{14}{}'$: Company indicator I_{14}: Basic indicator λ_{14}: Normalization parameter Social parameters: • T : Annual investment in workers technical training in the company over the last year, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)

Indicator	$I_{15}{}'$: Social ethics, social awareness and human rights
Definition	The equation to assess the company indicator "Social ethics, social awareness and human rights" ($I_{15}{}'$) is: If $\mathrm{I}_{15} \leq \lambda_{15}$, $\mathrm{I}_{15}{}' = \mathrm{I}_{15} \cdot \frac{1}{\lambda_{15}}$; else $\mathrm{I}_{15}{}' = 1$ $\mathrm{I}_{15} = \frac{\mathrm{S}}{\mathrm{K}_1}$ $I_{15}{}'$: Company indicator

	I_{15}: Basic indicator λ_{15}: Normalization parameter Social parameters: • S: Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, social awareness, human rights and social aspects of construction, considering total staff (temporal, part-time and full-time staff) • K_1 : Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)

Indicator	$I_{16}{}'$: Research and Development
Definition	The equation to assess the company indicator "Research and Development" ($I_{16}{}'$) is: If $I_{16} \leq \lambda_{16}$, $I_{16}{}' = I_{16} \cdot \frac{1}{\lambda_{16}}$; else $I_{16}{}' = 1$ $I_{16} = \frac{R}{E_1}$ $I_{16}{}'$: Company indicator I_{16}: Basic indicator λ_{16}: Normalization parameter Social parameters: • R: Annual investment in research and innovation projects over the last year • E_1: Revenue over last year

APPENDIX I: NORMALIZATION PARAMETERS FOR A SPECIFIC COUNTRY

This Appendix gathers the Forms I-1 and I-2. These have been defined to assist procurers in defining the normalization parameters through the analysis of GRI reports.

Form I-1 to obtain the social parameters of each GRI report:

Social Parameters	Report 1	Report 2	Report 3	Report …	Report …	Report …	Report …
A							
B							
C							
D							
E_0							
E_1							
E_2							
E_3							
F_0							
F_1							
F_2							
F_3							
F_4							
G							
H_0							
H_1							
K_0							
K_1							
L							
$S_{W\,1}$							
$S_{W\,2}$							
$S_{W\,3}$							
$S_{W\,4}$							
$S_{W\,5}$							
$H_{W\,1}$							
$H_{W\,2}$							
$H_{W\,3}$							
$H_{W\,4}$							
$H_{W\,5}$							
$a_1= S_{W\,1}/ H_{W\,1}$							
$a_2= S_{W\,2}/ H_{W\,2}$							
$a_3= S_{W\,3}/ H_{W\,3}$							
$a_4= S_{W\,4}/ H_{W\,4}$							

Social Parameters	Report 1	Report 2	Report 3	Report …	Report …	Report …	Report …
$a_5 = S_{W5} / H_{W5}$							
S_{M1}							
S_{M2}							
S_{M3}							
S_{M4}							
S_{M5}							
H_{M1}							
H_{M2}							
H_{M3}							
H_{M4}							
H_{M5}							
$b_1 = S_{M1} / H_{M1}$							
$b_2 = S_{M2} / H_{M2}$							
$b_3 = S_{M3} / H_{M3}$							
$b_4 = S_{M4} / H_{M4}$							
$b_5 = S_{M5} / H_{M5}$							
N_0							
N_1							
P							
Q_1							
Q_2							
T							
S							
R							

Note:

The values of each social parameter should be given to two decimal places. The definition of each social parameter is:

Social Parameter	Definition
A	Total number of new hires in the company over the last year (part-time and full-time staff)
B	Maximum number of workers in the company over the last year (part-time and full-time staff)
C	Total number of temporary workers in the company over the last year
D	Maximum number of leaving over the last year (part-time and full-time staff)
E_0	Annual investment (M€) in health of employees over last year; considering social security, medical insurance, dental insurance, paramedical insurance including preventive medicine, medicine insurance, wage insurance, paid maternity and paternity leave, paid sick leave
E_1	Revenue over last year (€M)
E_2	The number of employees who, over last two years, returned to work after parental leave ended who were still employed twelve months after their return to work
E_3	The number of employees that were entitled to parental leave over last two years
F_0	The number of days missed due to illness over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
F_1	Total number of workers in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment

Social Parameter	Definition
F_2	The number of occupational disease over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
F_3	Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
F_4	Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
I_{54}	If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent I_{54}=1 ; else I_{54}=0
G	Number of fatalities over last year considering total staff and supervised workers to whom the organization is liable for the general safety of the working environment
H_0	The number of accidents involving sick leave over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment.
H_1	The number of working days lost due to sick leave accidents registered over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment
K_0	Total number of hours that employees have spent with social programs and voluntary activities during working hours of the last year, considering total staff (temporal, part-time and full-time staff)
K_1	Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)
L	Total number of women employees in the company over the last year (part-time and full-time staff)
$S_{W\,1}$	Total of basic salary and remuneration of women employees in senior management category
$S_{W\,2}$	Total of basic salary and remuneration of women employees in executive and managers category
$S_{W\,3}$	Total of basic salary and remuneration of women employees in graduates category (excluding senior management, executives and managers)
$S_{W\,4}$	Total of basic salary and remuneration of women employees in administrative category
$S_{W\,5}$	Total of basic salary and remuneration of women employees in operatives category
$H_{W\,1}$	Number of worked hours by women employees in senior management category
$H_{W\,2}$	Number of worked hours by women employees in executive and managers category
$H_{W\,3}$	Number of worked hours by women employees in graduates category (excluding senior management, executives and managers)
$H_{W\,4}$	Number of worked hours by women employees in administrative category
$H_{W\,5}$	Number of worked hours by women employees in operatives category
$S_{M\,1}$	Total of basic salary and remuneration of men employees in senior management category
$S_{M\,2}$	Total of basic salary and remuneration of men employees in executive and managers category
$S_{M\,3}$	Total of basic salary and remuneration of men employees in graduates category (excluding senior management, executives and managers)
$S_{M\,4}$	Total of basic salary and remuneration of men employees in administrative category
$S_{M\,5}$	Total of basic salary and remuneration of men employees in operatives category
$H_{M\,1}$	Number of worked hours by men employees in senior management category
$H_{M\,2}$	Number of worked hours by men employees in executive and managers category
$H_{M\,3}$	Number of worked hours by men employees in graduates category (excluding senior management, executives and managers)
$H_{M\,4}$	Number of worked hours by men employees in administrative category

APPENDIX I: NORMALIZATION PARAMETERS FOR A SPECIFIC COUNTRY

Social Parameter	Definition
$H_{M\ 5}$	Number of worked hours by men employees in operatives category
N_0	Number of women in executive management positions (senior management, executive and managers) in the Company over the last year
N_1	Number of workers in executive management positions (senior management, executive and managers) in the company over the last year
P	Total number of workers in the company over the last year, registered as disabled (part-time and full-time staff)
Q_1	Annual total compensation of the highest-paid individual in the company, over last year, considering total staff (temporal, part-time and full-time staff)
Q_2	Median annual total compensation for all employees except the highest-paid individual, over last year, considering total staff (temporal, part-time and full-time staff) Total compensation: - Base salary: guaranteed, short term, non-variable cash compensation - Cash compensation: the sum of base salary + cash allowances + bonuses + commissions + cash profit-sharing + other forms of variable cash payments - Direct compensation: sum of total cash compensation + total fair value of all annual long-term incentives (such as stock option awards, restricted stock shares or units, performance stock shares or units, phantom stock shares, stock appreciation rights, and long-term cash awards)
T	Annual investment in workers technical training in the company over the last year, considering total staff (temporal, part-time and full-time staff)
S	Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, social awareness, human rights and social aspects of construction, considering total staff (temporal, part-time and full-time staff)
R	Annual investment (M€) in research and innovation projects over the last year

Form I-2 to obtain the normalization parameters for the country

Basic Indicators (I_i)	Report 1	Report 2	Report 3	Report …	$\lambda_i = Max(I_i)$**
I_1=A/B					
I_2=C/B					
I_3=D/B					
$I_{41}= E_0/ E_1$					
$I_{42}= E_2/ E_3$					
$I_{51}= F_0/ F_1$					
$I_{52}= F_2/ F_3$					
$I_{53}= F_4/ F_3$					
$I_{61}=G/ F_3$					
$I_{71}= H_0/F_3 \cdot 100{,}000{,}000$					
$I_{72}= H_1/F_3 \cdot 1{,}000$					
$I_8= K_0/ K_1$					
$I_9= L/B$					
I_{10}*					
$I_{11}= N_0/ N_1$					
$I_{12}= P/ K_1$					
$I_{13}= Q_1/ Q_2$					
$I_{14}= T/ K_1$					
$I_{15}= S/ K_1$					
$I_{16}= R/ E_1$					

*: $I_{10} = \frac{1}{n} \cdot \sum_{i=1}^{n} \left(\frac{\max(a,b)_i - \min(a,b)_i}{\max(a,b)_i} \right)$

**: The procurers may fix other value for some of the normalization parameters (λ_i) according to the social preferences established by the Agency, Government, etc.

APPENDIX J: WEIGHTS IN CORPORATE SOCIAL RESPONSIBILITY GROUP

This appendix shows the weights of each company indicator for each European country.

Table J-1: Weights for each European country

	Weights for each company indicator in corporate social responsibility group															
Country	W_1	W_2	W_3	W_4	W_5	W_6	W_7	W_8	W_9	W_{10}	W_{11}	W_{12}	W_{13}	W_{14}	W_{15}	W_{16}
Austria	0.04	0.05	0.11	0.05	0.04	0.05	0.11	0.05	0.05	0.13	0.11	0.04	0.05	0.05	0.05	0.04
Belgium	0.05	0.05	0.05	0.11	0.05	0.05	0.11	0.05	0.05	0.04	0.11	0.05	0.04	0.05	0.05	0.10
Bulgaria	0.04	0.04	0.04	0.05	0.05	0.05	0.04	0.13	0.04	0.04	0.04	0.04	0.04	0.11	0.13	0.12
Croatia	0.05	0.11	0.05	0.05	0.05	0.04	0.04	0.11	0.04	0.04	0.05	0.05	0.04	0.05	0.12	0.12
Cyprus	0.04	0.05	0.12	0.13	0.04	0.05	0.04	0.04	0.04	0.04	0.11	0.04	0.04	0.05	0.05	0.13
Czech Republic	0.04	0.05	0.05	0.05	0.05	0.05	0.04	0.05	0.05	0.13	0.12	0.11	0.04	0.04	0.10	0.05
Denmark	0.04	0.05	0.16	0.05	0.04	0.04	0.11	0.04	0.04	0.10	0.12	0.05	0.04	0.05	0.04	0.04
Estonia	0.04	0.04	0.11	0.10	0.05	0.05	0.04	0.05	0.04	0.15	0.05	0.11	0.05	0.04	0.05	0.05
Finland	0.05	0.06	0.13	0.12	0.04	0.04	0.11	0.05	0.04	0.11	0.05	0.04	0.04	0.04	0.04	0.04
France	0.05	0.11	0.05	0.05	0.04	0.10	0.14	0.04	0.04	0.10	0.05	0.05	0.04	0.05	0.05	0.05
Germany	0.04	0.05	0.10	0.04	0.04	0.04	0.12	0.04	0.05	0.13	0.11	0.05	0.05	0.05	0.04	0.04
Greece	0.13	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.04	0.05	0.13	0.12	0.12
Hungary	0.04	0.04	0.05	0.11	0.13	0.05	0.04	0.05	0.05	0.04	0.04	0.11	0.04	0.05	0.12	0.05
Ireland	0.04	0.05	0.11	0.11	0.04	0.05	0.04	0.04	0.05	0.05	0.05	0.12	0.04	0.04	0.05	0.11
Italy	0.05	0.05	0.04	0.05	0.04	0.05	0.04	0.04	0.13	0.04	0.11	0.04	0.05	0.05	0.12	0.11
Latvia	0.04	0.04	0.05	0.12	0.12	0.04	0.04	0.11	0.04	0.05	0.04	0.05	0.04	0.05	0.05	0.13
Lithuania	0.04	0.04	0.06	0.05	0.12	0.13	0.04	0.05	0.04	0.04	0.04	0.13	0.04	0.04	0.05	0.11
Luxembourg	0.04	0.04	0.05	0.10	0.04	0.04	0.13	0.04	0.04	0.04	0.15	0.04	0.05	0.04	0.04	0.11
Malta	0.04	0.04	0.04	0.04	0.04	0.11	0.05	0.05	0.14	0.04	0.05	0.04	0.04	0.04	0.11	0.13
Netherlands	0.04	0.13	0.11	0.04	0.04	0.04	0.05	0.04	0.05	0.11	0.12	0.04	0.04	0.04	0.05	0.05
Poland	0.04	0.14	0.04	0.12	0.05	0.04	0.04	0.05	0.10	0.04	0.04	0.04	0.05	0.05	0.05	0.12
Portugal	0.04	0.11	0.05	0.05	0.04	0.13	0.13	0.05	0.04	0.05	0.04	0.04	0.04	0.05	0.05	0.10
Romania	0.04	0.04	0.04	0.05	0.06	0.13	0.04	0.12	0.05	0.04	0.04	0.04	0.13	0.05	0.05	0.13
Slovak Republic	0.04	0.04	0.05	0.11	0.05	0.04	0.04	0.05	0.04	0.05	0.05	0.12	0.04	0.04	0.12	0.13
Slovenia	0.04	0.12	0.05	0.05	0.05	0.12	0.05	0.05	0.10	0.04	0.04	0.05	0.04	0.05	0.11	0.05
Spain	0.05	0.12	0.11	0.04	0.04	0.04	0.11	0.04	0.04	0.04	0.04	0.13	0.05	0.04	0.05	0.05
Sweden	0.05	0.12	0.15	0.04	0.04	0.04	0.05	0.04	0.04	0.10	0.05	0.05	0.10	0.05	0.04	0.04
United Kingdom	0.04	0.04	0.12	0.05	0.04	0.04	0.04	0.04	0.05	0.13	0.10	0.05	0.05	0.04	0.05	0.11

Note: $W_{1:}$ New staff hiring; W_2: Temporary contracts; W_3: Employee turnover; W_4: Benefits; W_5: Chronic disease; W_6: Fatal accidents at work; W_7: Non-fatal injuries at work; W_8: Social value; W_9: Female labor force participation; W_{10}: Wage gap; W_{11}: Women in executive management positions; W_{12}: Disabled; W_{13}: Salary distribution; W_{14}: Technical training; W_{15}: Social ethics, social awareness and human rights; and, W_{16}: Research and Development

APPENDIX K: SOCIAL PARAMETERS

Form to collect the social parameters of each company involved in the procurement procedure.

For each construction company involved in the procurement procedure, the procurer has to collect the information gathered in this Form. These social parameters need to be calculated taking into account the entire company in the country where the project is procured. The values of each parameter should be given to two decimal places.

Firm:		
Social Parameter	**Definition**	**Value**
A	Total number of new hires in the company over the last year (part-time and full-time staff)	
B	Maximum number of workers in the company over the last year (part-time and full-time staff)	
C	Total number of temporary workers in the company over the last year	
D	Maximum number of leaving over the last year (part-time and full-time staff)	
E_0	Annual investment (M€) in health of employees over last year; considering social security, medical insurance, dental insurance, paramedical insurance including preventive medicine, medicine insurance, wage insurance, paid maternity and paternity leave, paid sick leave	
E_1	Revenue over last year (€M)	
E_2	The number of employees who, over last two years, returned to work after parental leave ended who were still employed twelve months after their return to work	
E_3	The number of employees that were entitled to parental leave over last two years	
F_0	The number of days missed due to illness over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment	
F_1	Total number of workers in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment	
F_2	The number of occupational disease over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety	

Firm:		
Social Parameter	**Definition**	**Value**
	of the working environment	
F_3	Total number of worked hours in the company over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment	
F_4	Total number of hours, over last year, of staff time used for giving or receiving formal training about health and safety aspects of construction over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment	
I_{54}	If the company is currently certificated to OHSAS 18001, ISO45001:2018 or equivalent, I_{54}=1; else I_{54}=0	
G	Number of fatalities over last year considering total staff and supervised workers to whom the organization is liable for the general safety of the working environment	
H_0	The number of accidents involving sick leave over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment.	
H_1	The number of working days lost due to sick leave accidents registered over last year, considering total staff (temporal, part-time and full-time staff) and supervised workers to whom the organization is liable for the general safety of the working environment	
K_0	Total number of hours that employees have spent with social programs and voluntary activities during working hours of the last year, considering total staff (temporal, part-time and full-time staff)	
K_1	Maximum number of workers in the company over the last year, considering total staff (temporal, part-time and full-time staff)	
L	Total number of women employees in the company over the last year (part-time and full-time staff)	
$S_{W\,1}$	Total of basic salary and remuneration of women employees in senior management category	
$S_{W\,2}$	Total of basic salary and remuneration of women employees in executive and managers category	
$S_{W\,3}$	Total of basic salary and remuneration of women employees in graduates category (excluding senior management, executives and managers)	
$S_{W\,4}$	Total of basic salary and remuneration of women employees in administrative category	
$S_{W\,5}$	Total of basic salary and remuneration of women employees in operatives category	
$H_{W\,1}$	Number of worked hours by women employees in senior	

Firm:		
Social Parameter	**Definition**	**Value**
	management category	
H_{W2}	Number of worked hours by women employees in executive and managers category	
H_{W3}	Number of worked hours by women employees in graduates category (excluding senior management, executives and managers)	
H_{W4}	Number of worked hours by women employees in administrative category	
H_{W5}	Number of worked hours by women employees in operatives category	
S_{M1}	Total of basic salary and remuneration of men employees in senior management category	
S_{M2}	Total of basic salary and remuneration of men employees in executive and managers category	
S_{M3}	Total of basic salary and remuneration of men employees in graduates category (excluding senior management, executives and managers)	
S_{M4}	Total of basic salary and remuneration of men employees in administrative category	
S_{M5}	Total of basic salary and remuneration of men employees in operatives category	
H_{M1}	Number of worked hours by men employees in senior management category	
H_{M2}	Number of worked hours by men employees in executive and managers category	
H_{M3}	Number of worked hours by men employees in graduates category (excluding senior management, executives and managers)	
H_{M4}	Number of worked hours by men employees in administrative category	
H_{M5}	Number of worked hours by men employees in operatives category	
N_0	Number of women in executive management positions (senior management, executive and managers) in the Company over the last year	
N_1	Number of workers in executive management positions (senior management, executive and managers) in the company over the last year	
P	Total number of workers in the company over the last year, registered as disabled (part-time and full-time staff)	
Q_1	Annual total compensation of the highest-paid individual in the company, over last year, considering total staff (temporal, part-time and full-time staff)	
Q_2	Median annual total compensation for all employees except the highest-paid individual, over last year, considering total staff (temporal, part-time and full-time staff)	

Firm:		
Social Parameter	**Definition**	**Value**
	Total compensation: - Base salary: guaranteed, short term, non-variable cash compensation - Cash compensation: the sum of base salary + cash allowances + bonuses + commissions + cash profit-sharing + other forms of variable cash payments - Direct compensation: sum of total cash compensation + total fair value of all annual long-term incentives (such as stock option awards, restricted stock shares or units, performance stock shares or units, phantom stock shares, stock appreciation rights, and long-term cash awards)	
T	Annual investment in workers technical training in the company over the last year, considering total staff (temporal, part-time and full-time staff)	
S	Total hours of staff time used, over last year, for giving or receiving formal training on code of ethics, social awareness, human rights and social aspects of construction, considering total staff (temporal, part-time and full-time staff)	
R	Annual investment (M€) in research and innovation projects over the last year	

APPENDIX L: SOCIAL COMMITMENT IN THE PROJECT AS EVALUATION FACTOR IN BIDDING SPECIFICATIONS

The information that should be included in bidding specifications to define and assess the social commitment in the project evaluation factor has been established as follow. The information that should be adapted to each project has been highlighted in red.

EVALUATION FACTOR: SOCIAL COMMITMENT IN THE PROJECT

Description:

The evaluation factor 'Social commitment in the project' has to be assessed through the composite indicator 'CI_{G3}' defined in Equation X-Y. This composite indicator is formed by the summation of weighted company indicators. The result of the composite indicator varies from 0 to 1 depending on the information associated with each indicator submitted by each offeror.

$$CI_{G3\,j} = \sum_{i=1}^{m} P_{ij} \cdot W_i \qquad \text{(X-Y)}$$

Where:

- P_{ij} represent the values of each indicator (i) associated with each construction company (j) involved in the procurement procedure.
- W_i are the weights assigned to each indicator (i).

The composite indicator to assess the evaluation factor 'Social commitment in the project' collects seven (7) indicators. These indicators are:

- P_1: Cultural heritage appraisal and management plan
- P_2: Collaboration with cultural preservationists
- P_3: Industry participation plan
- P_4: Work health and safety management officer
- P_5: Workplace health and safety management plan
- P_6: Community relations program
- P_7: Effects on neighbors

The definition of these indicators and the method established for their assessment can be found in Appendix __.

The percentage weightings applicable to assess the corporate social responsibility are as follows.

Company indicators	**Weights**
P_1: Cultural heritage appraisal and management plan	W_1:
P_2: Collaboration with cultural preservationists	W_2:
P_3: Industry participation plan	W_3:
P_4: Work health and safety management officer	W_4:
P_5: Workplace health and safety management plan	W_5:
P_6: Community relations program	W_6:
P_7: Effects on neighbors	W_7:
TOTAL	**1**

Submittal Requirement:

Contractor shall provide the information gathered in Appendix __.

APPENDIX M: INDICATORS AND SUB-INDICATORS TO ASSESS THE SOCIAL COMMITMENT IN THE PROJECT

The information that should be included in bidding specifications to define the indicators has been established as follow. The definitions gather:

- Submittal Requirement
- Assessment method

P_1: **CULTURAL HERITAGE APPRAISAL AND MANAGEMENT PLAN**

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Cultural heritage appraisal and management plan. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{11}: Review of previous cultural environment investigations.
- P_{12}: Scope of cultural environment mitigation.
- P_{13}: Methodology of archaeological mitigation defining indications about how the mitigation works are going to be implemented managed and monitored.
- P_{14}: Definition of protection measures are going to put in place to avoid accidental damage and instruction that the site staff is going to receive.
- P_{15}: A plan to address unanticipated cultural resource or archaeological discoveries.
- P_{16}: Means of communication between the general contractor's personnel and the departmental representative.
- P_{17}: A training plan customized to the project referred to conservation skills to protect the cultural environment that provides construction personnel the knowledge to identify environmental historic issues and the best practice methods to minimize environmental impacts. The training plan must contain:
  - List of the types of project personnel to be trained, defining the list by job-type or by employer need (without defining employee names).
  - Description of the types, goals and objectives of training to be given in the project.
  - The method to track training efforts, including dates, means (online, classroom, field training, etc.), topics, the identification of those participating in training, and attendance numbers.
  - The process to measure training effectiveness and productivity measurement.
- P_{18}: In case a cultural environment recording work is produced during the project, the company commits to make an active publicity for this report to ensure the public knows about it. Only the public access should be scoped out if archaeological or other appropriate expert working on the find advises that public access is inappropriate or advises against publicity.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-1.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-1: Criteria to assess each sub-indicator of the indicator P_1

Sub-indicators	Level	Definition	Score
P_{11}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the review performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The review is poor and need major improvements	0.00
	None	None shown	X
P_{12}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{13}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{14}.	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{15}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{16}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{17}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{18}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

P_2: CULTURAL ENVIRONMENT PROFESSIONAL

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Cultural environment professional. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{21}: Curriculum vitae of the cultural environment professional that is going to be part of the project team.
- P_{22}: Years of experience in similar works of the cultural environment professional.
- P_{23}: Definition of responsibilities of the cultural environment professional.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-2.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-2: Criteria to assess each sub-indicator of the indicator P_2

Sub-indicators	Level	Definition	Score
P_{21}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{22}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Less than "x" years of experience. X must be defined by the agency	0.00
	None	None shown	X
P_{23}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

P_3: INDUSTRY PARTICIPATION PLAN

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Industry participation plan. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{31}: Community employment needs.
- P_{32}: How local services and suppliers will be utilized. Defining the opportunities for local participation, gathering:
  - Enhancements to business and industry capability.
  - Opportunities for networks and alliances.
  - Integration of local industry into global supply chains.
- P_{33}: Communication strategy and reporting methodology:
  - Outlining how the proponent will inform local industry about particular opportunities.
  - Including structural tender documents to ensure that local suppliers are provided the same opportunity as existing supply chain partners to participate in the project.
  - Framework for reporting against key elements of the Industry participation plan and schedule of report submissions.
- P_{34}: The minimum ratio of participation of local firms in the project that the company undertakes to comply.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-3.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-3: Criteria to assess each sub-indicator of the indicator P_3

Sub-indicators	Level	Definition	Score
P_{31}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{32}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition proposed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{33}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{34}	Excellent	The ratio maximum established by law or proposed by the procurer	1.00
	Good	The ratio is greater than the average of the companies' ratio	0.66
	Moderate	The ratio is equal to the average of the companies' ratio	0.33
	Poor	The ratio is lower than the average of the companies' ratio	0.00
	None	None shown	X

P_4: WORKPLACE HEALTH AND SAFETY MANAGEMENT PLAN

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Workplace health and safety management plan. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{41}: Details of the management structure and responsibilities
- P_{42}: Workplace health and safety risk assessment:
  - Identification of project-specific high risks construction activities.
  - Definition of control measures to mitigate risks and hazards identified.
  - Procedures for informing other contractors and employees of health and safety hazards.
- P_{43}: Proposal for inspections at work-sites, defining:
  - Regular workplace health and safety inspections.
  - Proposal of a standard workplace inspection checklist.
- P_{44}: Communication:
  - Procedure by which contractors and employees can report hazards at the workplace.
  - Procedures for communications between the project team, other contractors and site operatives.
  - System for recording and analyzing health and safety performance statistics.
  - Procedure by which information on company health and safety performance is regularly provided to employees.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-4.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-4: Criteria to assess each sub-indicator of the indicator P_4

Sub-indicators	Level	Definition	Score
P_{41}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{42}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{43}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{44}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

P_5: WORKPLACE HEALTH AND SAFETY MANAGEMENT OFFICER

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Workplace health and safety management officer. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{51}: Curriculum vitae of the work health and safety management officer that is going to be part of the project team, defining site-related working experience specific to the activities associated with the project.
- P_{52}: Definition of occupational health and safety regulations in the workplace.
- P_{53}: Definition of responsibilities of the work health and safety management officer, regarding:
  - Being responsible for completing contractor's health and safety training sessions and ensuring that personnel not successfully completing required training are not permitted to enter the construction site to perform work.
  - Implementing, enforcing in detail and monitoring site-specific contractor's health and prevention program.
  - Being at the construction site at all times during the execution of work, report directly to the site supervisor and act according to his instructions.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-5.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-5: Criteria to assess each sub-indicator of the indicator P_5

Sub-indicators	Level	Definition	Score
P_{51}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{52}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{53}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

P_6: **COMMUNITY RELATIONS PROGRAM**

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Community relations program. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{61}: The person from the project team responsible for communicating with the stakeholder groups.
- P_{62}: Inclusion of the opinion of the stakeholders in project decision-making processes:
  - Lists of stakeholder groups identified as key compared to total potential.
  - Procedures and periodicity for communicating with the stakeholder groups.
  - Methods to include the opinion of the stakeholders in project decision-making processes.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-6.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-6: Criteria to assess each sub-indicator of the indicator P_6

Sub-indicators	Level	Definition	Score
P_{61}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{62}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

P_7: **EFFECTS ON NEIGHBORS**

Submittal Requirement:

Contractor shall provide the following information to assess the indicator Effects on neighbors. Each bullet represents a sub-indicator. The information associated with each sub-indicator must be linked to the subject matter of the project.

- P_{71}: Traffic management plan during the construction works. This must consider the following:
  - Construction materials delivery.
  - Construction waste removals.
  - Construction lift or crane locations, set-up and operations.
  - Coordination between pedestrian access and construction traffic.
  - Requirements for construction traffic control measures such as temporary barriers, temporary signage, flagmen, etc.
- P_{72}: Control measures to put in place in order to minimize noise, dust and pollution during the construction works.
- P_{73}: Measures to improve users' safety during construction works.

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-7.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-7: Criteria to assess each sub-indicator of the indicator P_7

Sub-indicators	Level	Definition	Score
P_{71}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{72}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{73}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

APPENDIX N: CHARACTERIZING THE PROJECT

The following form has been defined to indicate the level associated with each project factor, depending on the project characteristics. Both the definition of the project factors and each one of their associated levels are presented below. Based on this, the procurer has to mark checkboxes that characterize the project.

Form to characterize the project.

Project factors		Levels associated with the project		
Contract size		☐ > 10,000,000€	☐ 1,000,000€ - 10,000,000€	☐ < 1,000,000€
Project complexity		☐ High	☐ Medium	☐ Low
Social context	Cultural environment	☐ High	☐ Medium	☐ Low
	Industry competence	☐ High	☐ Medium	☐ Low
	Territory	☐ High	☐ Medium	☐ Low

DEFINITION OF PROJECT FACTORS AND ASSOCIATED LEVELS:

Contract size is determined by the initial budget of the construction project. Three levels have been established for this project factor:

- > 10,000,000€
- 1,000,000€ - 10,000,000€
- < 1,000,000€

Project complexity represents the project difficulty and project risk. This factor depends on aspects such as scope, constraints, construction method, site conditions, budget, funding constraints and specialty materials. The level of complexity for a specific project must be defined comparing the project to other projects awarded by the same procurer. Based on this, three levels exist for this project factor:

- High: This project is highly complex compared to the average of projects awarded by the procurer.

- Medium: This project is complex compared to the average of projects awarded by the procurer.
- Low: This project is not complex compared to the average of projects awarded by the procurer.

Social context represents the social characteristics of the site and surrounding areas of the project. This project factor collects three sub-factors: (1) Cultural environment; (2) Industry competence; and (3) Territory.

1. **Cultural environment** represents the risk of damaging heritage sites. Three levels are defined depending on the risk to find historic resources in the region of the project:
    - High: Previous studies have determined that the risk of damaging historic resources exists, there have been several discoveries in the region of the project, or there are areas to be protected.
    - Medium: Previous studies have determined a medium level regarding the risk of damaging historic resources or there have not been previous studies to determine the risk of damaging historic resources; however, there has been any discovery in the region of the project.
    - Low: Previous studies have determined a low level regarding the risk of damaging historic resources or there has not been any discovery in the region of the project.
2. **Industry competence** represents the industry characteristics or abilities associated with the local firms' levels of competence in engineering, contracting and consulting referred to the project to be awarded. This project factor is measured as the trust between the agency and the industry to involve local firms in the project. Three levels have been established:
    - High: the level of competence of the local industry to perform works gathered in the project is high; consequently, the procurer has a high level of confidence into the industry to be involved in the works.
    - Medium: the level of competence of the local industry to perform works gathered in the project is medium; consequently, the procurer has a medium level of confidence into the industry to be involved in the works.
    - Low: The level of competence of the local industry is low or the procurer does not know about the technical capabilities of the local industry to perform works gathered in the project; consequently, the procurer has a low level of confidence into the industry to be involved in the works.
3. **Territory** assesses the negative social consequences derived from the construction project in the territory, depending mainly on aspects related to the project distances to residential areas, the project dependency on traffic

pattern and changes in living standards due to the project. Three levels were defined based on the negative effects that the project could have on the territory:

- High: during the development of the project, construction works produce important negative effects in the territory.
- Medium: during the development of the project, construction works produce negative effects in the territory.
- Low: during the development of the project, construction works hardly produce negative effects in the territory.

APPENDIX O: LEVEL OF IMPORTANCE OF EACH INDICATOR OF SOCIAL COMMITMENT IN THE PROJECT GROUP

The importance of each indicator in the composite indicator needs to be defined depending on the project characteristics established in Appendix N. Table O-1 establishes the relationships between the indicators and each level of the projects factors according to the following levels:

- "-" represents the indicator is the least recommended for the project and, thus, it does not influence the project success;
- "+" informs that the indicator is recommended for the project; and,
- "++" highlights that the indicator is highly recommended for the project.

The procurer has to select the rows associated with the levels of the project factors marked in the form of Appendix N. This information has to me moved to Appendix P.

APPENDIX O: LEVEL OF IMPORTANCE OF EACH INDICATOR OF SOCIAL COMMITMENT IN THE PROJECT GROUP

Table O-1: Relationships between the indicators and each level of the projects factors

	Indicators of social commitment in the project group						
Levels in each project factor	**P_1**	**P_2**	**P_3**	**P_4**	**P_5**	**P_6**	**P_7**
Contract size							
> 10,000,000€	+	-	++	++	++	+	+
1,000,000€ - 10,000,000€	+	-	+	++	++	+	+
< 1,000,000€	-	-	+	+	+	+	+
Project complexity							
High	+	-	+	++	++	+	+
Medium	+	-	+	++	++	+	+
Low	-	-	++	+	+	+	+
Social context							
Cultural environment							
High	++	++	-	-	-	-	-
Medium	+	+	-	-	-	-	-
Low	-	-	-	-	-	-	-
Industry competence							
High	-	-	++	+	+	-	-
Medium	-	-	+	+	+	-	-
Low	-	-	+	++	++	-	-
Territory							
High	-	-	-	-	-	++	++
Medium	-	-	-	-	-	++	++
Low	-	-	-	-	-	+	+

Note:
P_1: Cultural heritage appraisal and management plans; P_2: Collaboration with cultural preservationists; P_3: Industry participation plan; P_4: Workplace health and safety management plans; P_5: Work health and safety management officer; P_6: Community relations program; and, P_7: Effects on neighbors.
"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.

APPENDIX P: WEIGHT OF EACH INDICATOR IN SOCIAL COMMITMENT IN THE PROJECT GROUP

The procurer has to complete the form following this process:

1. Filling the white rows in Table P-1 with the rows selected from Table O-1 (in Appendix O).

2. Filling the row 'maximum rating' with the maximum rating obtained for each indicator. To select the maximum rating is important to highlight that "++" is better than "+", and "+" is better than "-".

3. Converting the maximum ratings of each indicator into numerical scores according to the following rules:

- "-"represents a value of "0", since this rating determines that the use of this subcategory does not influence the project success.
- "+" represents a value of "1". This score highlights that the use of this category could be important for the project and, thus, it is recommended.
- "++" represents a value of "2", because this rating highlights the importance of the subcategory for the project.

The row 'scoring results' has to be filled with the pertinent numerical values associated with the maximum rating of each indicator.

4. Obtaining the weight of each indicator. Based on the score results, the weight of each indicator is obtained by the proportion of the score of each indicator with respect to the total of scoring results. The sum of the weights has to be 1.

Form to calculate the weight of each indicator in social commitment in the project group.

APPENDIX P: WEIGHT OF EACH INDICATOR IN SOCIAL COMMITMENT IN THE PROJECT GROUP

Table P-1: Form to define the weight of each indicator

		Level of importance for each indicator							
Project factors		P_1	P_2	P_3	P_4	P_5	P_6	P_7	
Contract size									
Project complexity									
Social context	Cultural environment								
	Industry competence								
	Territory								
Maximum rating									**Total**
Scoring results									
Weights									

Note: P1: Cultural heritage appraisal and management plans; P2: Collaboration with cultural preservationists; P3: Industry participation plan; P4: Workplace health and safety management plans; P5: Work health and safety management officer; P6: Community relations program; and, P7: Effects on neighbors.

"-": the indicator is the least recommended for the project and, thus, it does not influence the project success; "+": the indicator is recommended for the project; and, "++": the indicator is highly recommended for the project.

APPENDIX Q: BASIC INDICATORS ASSESSMENT

This Appendix gathers the Form to obtain the basic indicators for each offeror. The basic indicators are calculated based on the social parameters collected from each offeror.

Form to calculate the basic indicators of each offeror

Basic Indicators (I_i)	Offeror 1	Offeror 2	Offeror 3	Offeror …
I_1=A/B				
I_2=C/B				
I_3=D/B				
I_{41}= E_0/ E_1				
I_{42}= E_2/ E_3				
I_{51}= F_0/ F_1				
I_{52}= F_2/ F_3				
I_{53}= F_4/ F_3				
I_{61}=G/ F_3				
I_{71}= H_0/F_3· 100,000,000				
I_{72}= H_1/F_3· 1,000				
I_8= K_0/ K_1				
I_9= L/B				
I_{10}*				
I_{11}= N_0/ N_1				
I_{12}= P/ K_1				
I_{13}= Q_1/ Q_2				
I_{14}= T/ K_1				
I_{15}= S/ K_1				
I_{16}= R/ E_1				

*: $\mathrm{I}_{10} = \frac{1}{n} \cdot \sum_{i=1}^{n} \left(\frac{\max(a,b)_i - \min(a,b)_i}{\max(a,b)_i} \right)$

APPENDIX R: COMPANY INDICATORS ASSESSMENT

This Appendix gathers the Form to obtain the company indicators for each offeror. The company indicators are calculated based on the data in Appendix Q, and the normalization parameters established in the bidding specifications.

Form to calculate the company indicators

Company Indicators (I_i')	**Offeror 1**	**Offeror 2**	**Offeror 3**	**Offeror …**
I_1'				
I_2'				
I_3'				
I_4'				
I_5'				
I_6'				
I_7'				
I_8'				
I_9'				
I_{10}'				
I_{11}'				
I_{12}'				
I_{13}'				
I_{14}'				
I_{15}'				
I_{16}'				

<u>Note:</u>

The values of each company indicator should be given to four decimal places. The equations associated with each company indicator are:

Company indicator	**Equations**
I_1' : New staff hiring	If $I_1 \leq \lambda_1$, $I_1' = I_1 \cdot \frac{1}{\lambda_1}$; else $I_1' = 1$
I_2' : Temporary contracts	If $I_2 \leq \lambda_2$, $I_2' = 1 - I_2 \cdot \frac{1}{\lambda_2}$; else $I_2' = 0$
I_3' : Employee turnover	If $I_3 \leq \lambda_3$, $I_3' = 1 - I_3 \cdot \frac{1}{\lambda_3}$; else $I_3' = 0$
I_4' :Benefits	$I'_4 = \frac{1}{2}(I'_{41} + I'_{42})$ If $I_{41} \leq \lambda_4$, $I'_{41} = I_{41} \cdot \frac{1}{\lambda_{41}}$; else $I'_{41} = 1$

Company indicator	Equations
	If $E_3 > 0$, $I'_{42} = I_{42} \cdot \frac{1}{\lambda_{42}}$; else $I'_{42} = 1$
I_5' : Chronic disease	$I_5' = \frac{1}{4}(I'_{51} + I'_{52} + I'_{53} + I_{54})$ If $I_{51} \leq \lambda_{51}$, $I'_{51} = 1 - I_{51} \cdot \frac{1}{\lambda_{51}}$; else $I'_{51} = 0$ If $I_{52} \leq \lambda_{52}$, $I'_{52} = 1 - I_{52} \cdot \frac{1}{\lambda_{52}}$; else $I'_{52} = 0$ $I'_{53} = I_{53} \cdot \frac{1}{\lambda_{53}}$; else $I'_{53} = 1$
I_6' : Fatal accidents at work	$I_6' = \frac{1}{3}(I'_{61} + I'_{53} + I_{54})$ If $I_{61} \leq \lambda_6$, $I'_{61} = 1 - I_{61} \cdot \frac{1}{\lambda_6}$; else $I'_{61} = 0$ If $I_{53} \leq \lambda_{53}$, $I'_{53} = I_{53} \cdot \frac{1}{\lambda_{53}}$; else $I'_{53} = 1$
I_7' : Non-fatal injuries at work	$I_7' = \frac{1}{4}(I'_{71} + I'_{72} + I'_{53} + I_{54})$ If $I_{71} \leq \lambda_{71}$, $I'_{71} = 1 - I_{71} \cdot \frac{1}{\lambda_{71}}$; else $I'_{71} = 0$ If $I_{72} \leq \lambda_{72}$, $I'_{72} = 1 - I_{72} \cdot \frac{1}{\lambda_{72}}$; else $I'_{72} = 0$ If $I_{53} \leq \lambda_{53}$, $I'_{53} = I_{53} \cdot \frac{1}{\lambda_{53}}$; else $I'_{53} = 1$
I_8' : Social value	If $I_8 \leq \lambda_8$, $I_8' = I_8 \cdot \frac{1}{\lambda_8}$; else $I_8' = 1$
I_9' : Female labor force participation	If $I_9 \leq \lambda_9$, $I_9' = I_9 \cdot \frac{1}{\lambda_9}$; else $I_9' = 1$
I_{10}' : Wage gap	If $I_{10} = 0$, $I'_{10} = 1$; else $I'_{10} = 1 - I_{10}$
I_{11}' : Women in executive management positions	If $I_{11} \leq \lambda_{11}$, $I_{11}' = I_{11} \cdot \frac{1}{\lambda_{11}}$; else $I_{11}' = 1$
I_{12}' : Disabled	If $I_{12} \leq \lambda_{12}$, $I_{12}' = I_{12} \cdot \frac{1}{\lambda_{12}}$; else $I_{12}' = 1$
I_{13}' : Salary distribution	If $I_{13} \leq \lambda_{13}$, $I'_{13} = 1 - I_{13} \cdot \frac{1}{\lambda_{13}}$; else $I'_{13} = 0$
I_{14}' : Technical training	If $I_{14} \leq \lambda_{14}$, $I_{14}' = I_{14} \cdot \frac{1}{\lambda_{14}}$; else $I_{14}' = 1$
I_{15}' : Social ethics, social awareness and human rights	If $I_{15} \leq \lambda_{15}$, $I_{15}' = I_{15} \cdot \frac{1}{\lambda_{15}}$; else $I_{15}' = 1$
I_{16}' : Research and Development	If $I_{16} \leq \lambda_{16}$, $I_{16}' = I_{16} \cdot \frac{1}{\lambda_{16}}$; else $I_{16}' = 1$

APPENDIX S: ASSESSMENT OF CORPORATE SOCIAL RESPONSIBILITY OF EACH OFFEROR

This Appendix gathers the Form to obtain the corporate social responsibility of each offeror. The results of the company indicators for each offeror (see Appendix R) and the weights established in bidding specifications are needed to assess the corporate social responsibility through the composite indicator defined in the form.

Form to calculate the corporate social responsibility of each offeror.

I_i'	**Offeror 1**	**Offeror 2**	**Offeror 3**	**Offeror …**	**W_i**	**Value**
I_1'					W_1	
I_2'					W_2	
I_3'					W_3	
I_4'					W_4	
I_5'					W_5	
I_6'					W_6	
I_7'					W_7	
I_8'					W_8	
I_9'					W_9	
I_{10}'					W_{10}	
I_{11}'					W_{11}	
I_{12}'					W_{12}	
I_{13}'					W_{13}	
I_{14}'					W_{14}	
I_{15}'					W_{15}	
I_{16}'					W_{16}	
Corporate Social Responsibility	**Offeror 1**	**Offeror 2**	**Offeror 3**	**Offeror …**		
$CI_{G2\ \text{Firm j}} = \sum_{i=1}^{i} I'_{i\ \text{Firm j}} \cdot w_i$						

APPENDIX T: ASSESSMENT OF THE INDICATORS IN SOCIAL COMMITMENT IN THE PROJECT GROUP

This form has been defined to assess the indicators and sub-indictors through the information submitted by the construction companies.

Indicators assessment form

Indicators (P_i) and Sub-indicators (P_{ij})	Offeror 1		Offeror 2		Offeror …	
	Level	Score	Level	Score	Level	Score
P_{11}						
P_{12}						
P_{13}						
P_{14}						
P_{15}						
P_{16}						
P_{17}						
P_{18}						
$\mathbf{P_1}$	**Average**		**Average**		**Average**	
P_{21}						
P_{22}						
P_{23}						
$\mathbf{P_2}$	**Average**		**Average**		**Average**	
P_{31}						
P_{32}						
P_{33}						
P_{34}						
$\mathbf{P_3}$	**Average**		**Average**		**Average**	
P_{41}						
P_{42}						
P_{43}						
P_{44}						
$\mathbf{P_4}$	**Average**		**Average**		**Average**	
P_{51}						
P_{52}						
P_{53}						
$\mathbf{P_5}$	**Average**		**Average**		**Average**	
P_{61}						
P_{62}						
$\mathbf{P_6}$	**Average**		**Average**		**Average**	
P_{71}						
P_{72}						
P_{73}						
$\mathbf{P_7}$	**Average**		**Average**		**Average**	

Note:

The methods to assess each indicator are:

P_1: CULTURAL HERITAGE APPRAISAL AND MANAGEMENT PLAN

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-1.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-1: Criteria to assess each sub-indicator of the indicator P_1

Sub-indicators	Level	Definition	Score
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the review performed by the other companies	0.66
P_{11}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The review is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{12}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{13}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{14}.	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{15}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{16}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
P_{17}	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{18}	Excellent	Outstanding compared to the other companies	1.00

	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{11}: Review of previous cultural environment investigations.
- P_{12}: Scope of cultural environment mitigation.
- P_{13}: Methodology of archaeological mitigation defining indications about how the mitigation works are going to be implemented managed and monitored.
- P_{14}: Definition of protection measures are going to put in place to avoid accidental damage and instruction that the site staff is going to receive.
- P_{15}: A plan to address unanticipated cultural resource or archaeological discoveries.
- P_{16}: Means of communication between the general contractor's personnel and the departmental representative.
- P_{17}: A training plan customized to the project referred to conservation skills to protect the cultural environment that provides construction personnel the knowledge to identify environmental historic issues and the best practice methods to minimize environmental impacts. The training plan must contain:
  - List of the types of project personnel to be trained, defining the list by job-type or by employer need (without defining employee names).
  - Description of the types, goals and objectives of training to be given in the project.
  - The method to track training efforts, including dates, means (online, classroom, field training, etc.), topics, the identification of those participating in training, and attendance numbers.
  - The process to measure training effectiveness and productivity measurement.
- P_{18}: In case a cultural environment recording work is produced during the project, the company commits to make an active publicity for this report to ensure the public knows about it. Only the public access should be scoped out if archaeological or other appropriate expert working on the find advises that public access is inappropriate or advises against publicity.

P_2: CULTURAL ENVIRONMENT PROFESSIONAL

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-2.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-2: Criteria to assess each sub-indicator of the indicator P_2

Sub-indicators	Level	Definition	Score
P_{21}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{22}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66

	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Less than "x" years of experience. X must be defined by the agency	0.00
	None	None shown	X
P_{23}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{21}: Curriculum vitae of the cultural environment professional that is going to be part of the project team.
- P_{22}: Years of experience in similar works of the cultural environment professional.
- P_{23}: Definition of responsibilities of the cultural environment professional.

P_3: INDUSTRY PARTICIPATION PLAN

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-3.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-3: Criteria to assess each sub-indicator of the indicator P_3

Sub-indicators	Level	Definition	Score
P_{31}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{32}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition proposed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{33}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{34}	Excellent	The ratio maximum established by law or proposed by the procurer	1.00
	Good	The ratio is greater than the average of the companies' ratio	0.66
	Moderate	The ratio is equal to the average of the companies' ratio	0.33
	Poor	The ratio is lower than the average of the companies' ratio	0.00

	None	None shown	X

Note:

- P_{31}: Community employment needs.
- P_{32}: How local services and suppliers will be utilized. Defining the opportunities for local participation, gathering:
  - Enhancements to business and industry capability.
  - Opportunities for networks and alliances.
  - Integration of local industry into global supply chains.
- P_{33}: Communication strategy and reporting methodology:
  - Outlining how the proponent will inform local industry about particular opportunities.
  - Including structural tender documents to ensure that local suppliers are provided the same opportunity as existing supply chain partners to participate in the project.
  - Framework for reporting against key elements of the Industry participation plan and schedule of report submissions.
- P_{34}: The minimum ratio of participation of local firms in the project that the company undertakes to comply.

P_4: **WORKPLACE HEALTH AND SAFETY MANAGEMENT PLAN**

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-4.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-4: Criteria to assess each sub-indicator of the indicator P_4

Sub-indicators	Level	Definition	Score
P_{41}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{42}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{43}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{44}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{41}: Details of the management structure and responsibilities
- P_{42}: Workplace health and safety risk assessment:
  - Identification of project-specific high risks construction activities.
  - Definition of control measures to mitigate risks and hazards identified.
  - Procedures for informing other contractors and employees of health and safety hazards.
- P_{43}: Proposal for inspections at work-sites, defining:
  - Regular workplace health and safety inspections.
  - Proposal of a standard workplace inspection checklist.
- P_{44}: Communication:
  - Procedure by which contractors and employees can report hazards at the workplace.
  - Procedures for communications between the project team, other contractors and site operatives.
  - System for recording and analyzing health and safety performance statistics.
  - Procedure by which information on company health and safety performance is regularly provided to employees.

P_5: **WORKPLACE HEALTH AND SAFETY MANAGEMENT OFFICER**

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-5.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-5: Criteria to assess each sub-indicator of the indicator P_5

Sub-indicators	Level	Definition	Score
P_{51}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{52}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{53}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{51}: Curriculum vitae of the work health and safety management officer that is going to be part of the project team, defining site-related working experience specific to the activities associated with the project.

- P_{52}: Definition of occupational health and safety regulations in the workplace.
- P_{53}: Definition of responsibilities of the work health and safety management officer, regarding:
  - Being responsible for completing contractor's health and safety training sessions and ensuring that personnel not successfully completing required training are not permitted to enter the construction site to perform work.
  - Implementing, enforcing in detail and monitoring site-specific contractor's health and prevention program.
  - Being at the construction site at all times during the execution of work, report directly to the site supervisor and act according to his instructions.

P_6: **COMMUNITY RELATIONS PROGRAM**

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-6.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-6: Criteria to assess each sub-indicator of the indicator P_6

Sub-indicators	Level	Definition	Score
P_{61}	Excellent	Outstanding compared to the other companies	1.00
	Good	Better than the professional proposed by the other companies	0.66
	Moderate	Equal to the professional proposed by the other companies	0.33
	Poor	Lack of experience	0.00
	None	None shown	X
P_{62}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{61}: The person from the project team responsible for communicating with the stakeholder groups.
- P_{62}: Inclusion of the opinion of the stakeholders in project decision-making processes:
  - Lists of stakeholder groups identified as key compared to total potential.
  - Procedures and periodicity for communicating with the stakeholder groups.
  - Methods to include the opinion of the stakeholders in project decision-making processes.

P_7: **EFFECTS ON NEIGHBORS**

Assessment Method:

Each sub-indicator is assessed according to five levels: excellent, good, moderate, poor and none. The definition of each level and its associated score is in Table M-7.

The total score of the indicator must be calculated as the average of the scores obtained for each sub-indicator. In case a section is assessed as none level ("X") the total score of the indicator will be zero.

Table M-7: Criteria to assess each sub-indicator of the indicator P_7

Sub-indicators	Level	Definition	Score
P_{71}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{72}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X
P_{73}	Excellent	Outstanding compared to the other companies	1.00
	Good	Equal or greater than the definition performed by the other companies	0.66
	Moderate	Well-defined, but improvements are needed	0.33
	Poor	The definition is poor and need major improvements	0.00
	None	None shown	X

Note:

- P_{71}: Traffic management plan during the construction works. This must consider the following:
  - Construction materials delivery.
  - Construction waste removals.
  - Construction lift or crane locations, set-up and operations.
  - Coordination between pedestrian access and construction traffic.
  - Requirements for construction traffic control measures such as temporary barriers, temporary signage, flagmen, etc.
- P_{72}: Control measures to put in place in order to minimize noise, dust and pollution during the construction works.
- P_{73}: Measures to improve users' safety during construction works.

APPENDIX U: ASSESSMENT OF SOCIAL COMMITMENT OF EACH OFFEROR IN THE PROJECT

This Appendix gathers the Form to assess the social commitment of each offeror in the project. The results of the indicators assessment form (see Appendix T) and the weights established in bidding specifications are needed to assess the social commitment through the composite indicator defined in the form.

Social commitment assessment form

P_i	Offeror 1	Offeror 2	Offeror j	W_i	Value
P_1				W_1	
P_2				W_2	
P_3				W_3	
P_4				W_4	
P_5				W_5	
P_6				W_6	
P_7				W_7	
Social commitment assessment $CI_{G3\ \text{off j}} = \sum_{i=1}^{i} P_{i\ \text{off j}} \cdot W_i$	**Offeror 1**	**Offeror 2**	**Offeror j**		

APPENDIX V: WEIGHTS FOR NON-EUROPEAN COUNTRIES IN CORPORATE SOCIAL RESPONSIBILITY GROUP

This appendix describes the method that has been performed to define the weights in the composite indicator to assess the corporate social responsibility of the construction companies in the procurement procedure. For a complete description of the methodology definition, the full text can be found in chapter 5.

The methodology to assess the corporate social responsibility of the construction companies in the procurement procedure is based on the definition of a composite indicator (equation 6-2) taking into account the following two principles:

- Company indicators need to be quantitative, reliable and verifiable to guarantee the robustness of the methodology.
- Weighting system has to be addressed to minimize the social weaknesses of each country over time.

The company indicators have been defined in Appendix H and can be used in any country. However, the weights need to be calculated if the method wants to be applied to non-European countries. Thus, the method to calculate the weights is explained as follows.

Weighting Method

The weighting method developed in methodology of the corporate social responsibility group is based on the DEA-BOD approach based on the pessimistic version. This method seeks to minimize the efficiency, assigning the maximum weights to the worst social performance indicators in a country; being in line with the principle established for this group of criteria. The model to obtain the weights is defined as follows.

$$CI_c = \min_{w_{ic}} \sum_{i=1}^{n} y_{ic} \cdot w_{ic} \qquad \text{(V-1)}$$

subject to

$$\sum_{i=1}^{n} y_{ij} \cdot w_{ic} \geq 1 \qquad \text{(V-2)}$$

$$w_{ic} \geq 0 \tag{V-3}$$

$$\sum_{i=1}^{n} w_{ic} = 1 \tag{V-4}$$

$$\alpha_j \leq \frac{y_{ij} \cdot w_{ij}}{\sum_{i=1}^{n} y_{ij} \cdot w_{ij}} \leq \beta_j \quad ; 0 \leq \alpha_j < \beta_j \leq 1 \tag{V-5}$$

CI_c is the result of the composite indicator and it shows the social performance of the country 'c'. y_{ic} is the value for country 'c' on the indicator 'i', w_{ic} is the weight assigned to the indicator 'i' in the country 'c', y_{ij} is the value for the country 'j' on the indicator 'i', 'i' is the number of indicators in the model, 'm' is the number of countries in the sample. The composite indicator for each country is going to be greater than 1 (1 ≤ CI_c), higher values of CI_c indicate better overall performances, or in other words, when a country obtains a CI_c equal to 1 represents that there are probably no or only a few underlying performance indicators on which the evaluated country performs significantly weaker compared to the other countries (Rogge 2012). Additionally, α_j and β_j are the 'proportional share restrictions'. These represent the lower and upper limits for the contribution of the j-th indicator in CI_j. Their inclusion in the model is important to ensure that any indicator is not ignored in the composite indicator.

Process to obtain the weights

To define the weights, basic indicators at a country level need to be used as proxy indicators of the company indicators. These Proxy indicators have to be defined according to the following process:

- Databases. National indices need to be identified in statistical databases such as Eurostat, the Organization for Economic Cooperation and Development, the Sustainable Governance Indicators, etc. Databases that define and collect national indices under a Quality Assurance Framework should be selected.
- Selection Method. National indices have to be selected based on a top-down approach. Subsequently, a three-steps process has to be undertaken:
    - 'Theoretical' assessment to assess the national indices following a set of quality criteria;
    - 'Practical' assessment to choose the national indices to be used as proxy indicators of the company indicators. This process is recommended to be performed by a group of experts.

  - Statistical analysis to avoid possible multicollinearity between proxy indicators.
- Normalization Method. To normalize the proxy indicators, the minimum–maximum normalization method has to be performed. Proxy indicators have to be normalized within a unitless interval scale of 1 and 2 to avoid problems with the model respect to the established 'proportional share restrictions'.

Once the proxy indicators are normalized, these are used to obtain the weights of each indicator in each country by the use of the weighting method based on the pessimistic version of the DEA-BOD approach. During this optimization process, the preferences of the procurer have to be defined with respect to the minimum weight that wants to be ensured to each indicator and the number of company indicators which want to be emphasized in the composite indicator with weights over 10%. These preferences can determine the value of α_j and β_j in the model since α_j controls the minimum weight that should be assigned to each indicator, and β_j manages the number of indicators that want to be emphasized for each country.