DIFFERENCES BETWEEN ARCHITECTURE, CIVIL ENGINEERING AND BUILDING ENGINEERING WORLD WIDE

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Here I finish five years of effort, work, hope and happiness but I wish more of these years henceforth.

ABSTRACT

It is usual to talk about architecture and civil engineering but what about building engineering? Paying attention to the situation of this degree, we realize that it is not internationalised. In this thesis, it is going to be developed this idea by means of comparisons between degrees and countries. In this way, it will be shown how the actual condition of this degree is and how it is possible to standardized and make it uniform. Aspects like salaries, years of training, credits, competencies and denominations are going to be studied.

The results show that it is possible to internationalize building engineering and nowadays it is in the correct way. Even the results of the building engineering work can be improve with this process.

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1. INTRODUCTION

This chapter introduces the background to the research problem with particular respect to the actual situation of Architecture, Civil Engineering and Building Engineering. The aims and objectives of the research along with the scope and limitations of the research are stated. The structure of the paper is also explained.

1.1. Background

Nowadays competencies of architecture and civil engineering are clearly established but when we talk about building engineering, the questions appear. What are the differences between architecture, civil engineering and building engineering around the world?

Observing their definitions:

- Architecture is both the process and product of planning, designing and construction usually of buildings and other physical structures.
- Civil engineering deals with the design, construction, and maintenance of the physical and naturally built environment, including works like roads, bridges, canals, dams, and buildings.
- Building engineering is the application of engineering principles and technology to building design and construction, from the project phase, execution, and maintenance, until the demolition (if it is necessary). (Wikipedia, 2013)

1.2. Motivation

The first reason to develop the research question is to be able to work in every country with the same qualification and competencies.

1.3. Aim and objectives

Against the background earlier outlined, this research project will be undertaken with the aim of differentiate the field of application of these three degrees and become internationalized building engineering.

To achieve this aim, the following objectives will be pursued:

Objective 1- Look for some countries, and investigate the existence of these careers in the chosen countries.

Objective 2- Collect data like salaries, years of training, credits, denominations, and competences.

Objective 3- Analyse the result using graphics.

Objective 4- Compare and draw conclusions.

Objective 5- Propose a way to make standard these three degrees or to do easier to work in every country having the same qualification.

1.4. Scope

The scope will be limited to compare salary, years of training, credits, competencies and denomination of people of these three degrees in some countries around the world, and to establish the basic differences between them. As well as investigate a way to standardized building engineering worldwide.

1.5. Chapter Summary

This first chapter has introduced the background of the need to see the differences between architecture, civil engineering and building engineering. The aims and objectives of the research have been stated and the scope and limitations of the research given. The structure of the report has also been explained with the objectives and later it will be increased with the methodology.

The chapter has demonstrated that there is a clear need to established differences and internationalized these three degrees; especially building engineering because is the least widespread.

The next chapter will critique the extant literature.

2. LITERATURE REVIEW

This chapter presents the literature in the extant body of knowledge.

2.1. Overview

The found literature has been scarce therefore it has been required to look for more and new data, to create foundation for this research. Between the found information are:

- A publication in the Journal of Engineering Design “Modeling the Design Process in Engineering and in Architecture” (Nigel Cross & Norbert Roozenburg, 1992)
- A study of the access profiles of new students to engineering and architecture (Vicerrectorado de Ordenación Académica y Planificación Estratégica, 2008)

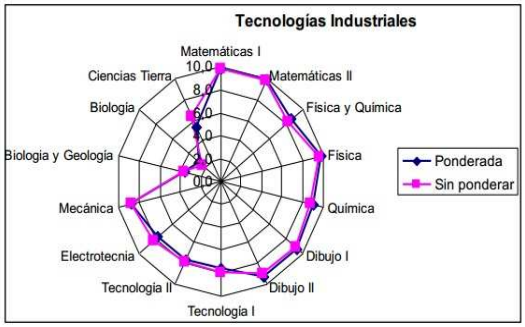
2.2. Analysis and Adaptation

In the publication in the Journal of Engineering Design “Modeling the Design Process in Engineering and in Architecture” (Nigel Cross & Norbert Roozenburg, 1992), the information is not actual so updating is necessary.

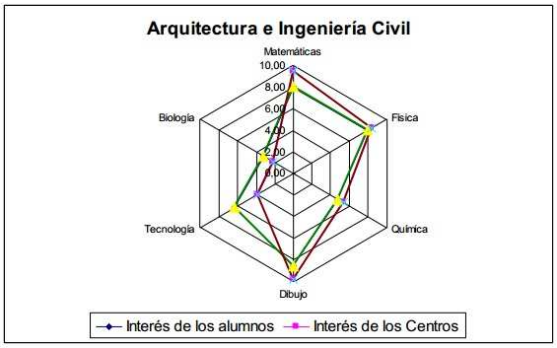
They suggest that attempts should be made to reintegrate architecture and engineering to improve common features of design education and practice across the disciplines. This paper is concerned with the differences that have arisen between models of the design process in different disciplines, especially between engineering and architecture. They find these differences both interesting and informative, especially since early models of the design process in these disciplines had common origins and substantial similarities. They propose in this paper to analyse the differences that have emerged and to suggest the need to reintegrate the models. (CROSS,N. & ROOZENBURG,N. ,1992)

The main idea or inspiration to apply this literature in the thesis is the reintegration of Architecture and Engineering to improve in the results, creating or making appear the Building Engineering figure. We can carry out this process and at the same time differentiating between Architecture and Civil Engineering. So it will be followed the idea of putting together Architecture and Engineering to introduce Building Engineering. The weak point is that they suggest reintegrating both models in one, but they don't give the practical solution.

In the study of the access profiles of new students to engineering and architecture (Vicerrectorado de Ordenación Académica y Planificación Estratégica, 2008) the antiquity is less, but here the most important influence has been the way to compare data. The spider graphics give a global view of data collection and it is going to be useful in this research. Also the concepts used, like the subjects can be significant information to develop the analysis.
Here we have some examples of spider graphics of this study, where it is showed the incoming student's profile in Industrial Technology (Picture 1) and the most interesting subjects of new architecture and civil engineering students (Picture 2). From this study is going to be used the way to compare subjects to make the same with subjects in Architecture, Civil Engineering and Building Engineering in some countries and to see differences between them. The weakness in this study is that, they don't arrive to a specific conclusion but on the other hand the analysis of data has been deep.



Picture 1: New student's knowledge profiles in Industrial Technology. (Vicerrectorado de Ordenación Académica y Planificación Estratégica UPM,2008).



Picture 2: Interests of new students of architecture and civil engineering.(Vicerrectorado de Ordenación Académica y Planificación Estratégica UPM,2008).

2.2.1. Current results

In the publication in the Journal of Engineering Design, it has discussed some positive and negative features of both consensus models. The consensus model of engineering design is essentially a concise prescription of the tasks in a design process. […] In contrast, the models that nowadays prevail in architecture reflect design as it is carried out by practitioners. These models are primarily descriptive and, hence, they offer little guidance to those who believe as the authors do that better ways of working than those in practice are possible and worthwhile to develop.

They have argued for the need to make a reintegration of the consensus models of engineering and architecture. Good models will be built upon rationality

adapted to the properties and features of the tasks to be performed, and to the cognitive characteristics of the designer. This calls for an integration of the insights that have been gained from design methodology in both engineering and architecture, if design practice in general is to benefit from these insights. Above all, it is in education that models of the design process are needed that are neither overly prescriptive nor weakly permissive, but are reliable, robust and formative of good design behavior. CROSS,N. & ROOZENBURG,N. (1992) *Modeling the Design Process in Engineering and in Architecture* (London)
In the study of the access profiles of new students to engineering and architecture, the result is that the student profiles are fairly homogeneous between all the engineering. But the most important for us are the comparing graphics, the way to contrast the information.

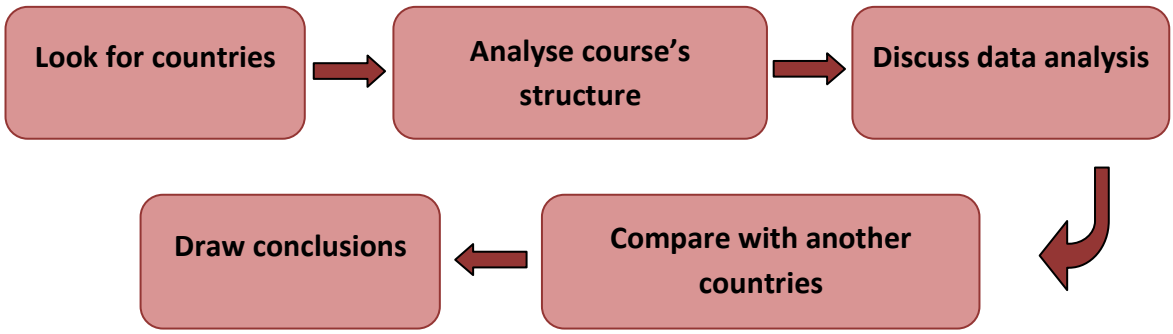
2.3. Chapter Summary

This chapter has developed the main sources of inspiration for this research. It is a very limited literature review, for that reason the following research has been extensive. From here we use the idea of reintegrate architecture and engineering to improve in the outcome. And at the same time, to standardize the building engineering up and to established the main differences between these three degrees.

3. METHODOLOGY

This chapter describes the method adopted and why this method is the suitable one. The proposed research methodology will be an investigation because it's necessary to know the engineering situation in some countries. In order to get more information, due to the almost inexistent study on this topic, it's required to research.

3.1. Methodology Scheme



Like in the founded literature review (A study of the access profiles of new students to engineering and architecture, 2008) subjects and course structure are going to be analysed in three countries and in the three degrees. The selected countries are Spain, United Kingdom and Germany. Here we have an example of the subject's comparison (Picture 3). But in this research the analysis will be deeper. Spider graphics will be used to compare data collection like in Pictures 1 and 2.

	MATEMATICAS		FISICA	DIBUJO	QUIMICA	BIOLOGIA	PROPIAS 1	PROPIAS 2	PROPIAS 3
Arquitecto	Matemáticas 2		Física 1	Dibujo 2			Proyectos 1		
Arquitecto Técnico	Geometría descriptiva	Fundamentos Matemáticos	Fundamentos Físicos	Dibujo Arquitectónico			Materiales de Construcción I		Estructura Edific. I
Ing. de Caminos, Canales y P.	Álgebra Lineal	Cálculo Infinit	Física	Dibujo Técnico	Química				
Ing.Téc. de Obras Públicas	Álgebra Lineal	Cálculo Infinitesimal	Física General	Dibujo	Química		Mecánica		
Ing.Téc. en Topografía.	Matemáticas I		Física				Topografía I	Geometría métrica y descriptiva	Fotogrametría I
Ing. Geólogo	Fund. Matemáticos		Física Básica		Fund. Químicos		Petrología	Topografía	Cristalografía y Mineralogía
Ing. Agrónomo	Matemáticas		Física		Química	Biología	Análisis Matemático	Análisis Instrumental	Química Inorgánica
Ing.Téc. Agrícola: Explotaciones Agropec.	Matemáticas II				Química Agrícola		Botánica	Topografía, Fotog. y Cart	Bases de Prod. Animal
Ing.Téc. Agrícola: Hortofruticultura y Jardín.	Matemáticas II				Química Agrícola		Botánica	Topografía, Fotog. y Cartog	Fitotecnia
Ing.Téc. Agrícola: Industrias Agrarias y Alim.	Matemáticas II		Física II				Ecología	Topografía, Fotog. y Cartog	Bioquímica
Ing.Téc. Agrícola: Mecan. y Construcc. Rurales	Matemáticas II		Física II				Ecología	Fitotecnia	Bases de Prod. Animal
Ing. de Montes	Álgebra Lineal	Cálculo Infinit	Física	Dibujo Técnico	Química				
Ing.Téc. Forestal	Matemáticas		Física	Dibujo y Sist Repre	Química		Estadística	Anatomía y Fisiología Vegental	
Ing. Aeronáutico	Cálculo Infinitesimal		Física Gral II		Química		Aeronaves y Vehículos Esp	Sistemas y Técnicas de Represe	
Ing. Téc. Aeronáutico: Aeromotores	Cálculo I I		Física II	Expresión Gráfica			Mecánica I	Técnicas Experimentales	
Ing. Téc. Aeronáutico: Aeronavegación	Cálculo II		Física II	Expresión Gráfica			Mecánica	Técnicas Experimentales	
Ing.Téc. Aeronáutico: Aeronaves	Cálculo II		Física II	Expres Grafica			Mecánica I	Técnicas Experimentales	
Ing.Téc. Aeronáutico: Aeropuertos	Cálculo II		Física II	Expres Grafica			Mecánica II	Técnicas Experimentales	
Ing.Téc. Aeronáutico: Equip. Mat. Aeroespaciales	Cálculo II		Física II	Expres Grafica			Mecánica I	Técnicas Experimentales	

Picture 3: Subject's comparison between degrees in the first semester. (Vicerrectorado de Ordenación Académica y Planificación Estratégica UPM,2008).

With the analysis done, the results will be discussed. And then following the idea of reintegrate Architecture and Engineering (CROSS,N. & ROOZENBURG,N. ,1992) , more countries will be analyse to carry out the internationalization of Building Engineering.

The subsequent data collection will be salaries, years of training, credits and denominations of each degree in each country. This data will be taken from different university web pages and it will be useful to draw conclusions.

Once all the data is collected, we analyse the results using graphics.

Finally propose a way to make standard these three degrees, especially building engineering and to do easier to work in every country having the same title.

3.2. Sources

The main source has been internet.

Besides the literature review, university pages of the chosen countries, national organizations, engineer's institutions and salary surveys have been useful. And all this sources are referenced, in the chapter references.

3.3. Resources

The resources required have been no material. Therefore this research is exempt of costs.

3.4. Chapter Summary

In brief, the methodology to follow is look for some countries and look into the existence of Architecture, Civil Engineering and Building Engineering there and the course's structure.

Watching the differences in Europe, the research is going to be widened to draw conclusions collecting data like salaries, years of training, credits and denomination. Trying to suggest some method to internationalize Building Engineering without problems to study and perform it anywhere in the world.

4. DATA PRESENTATION AND ANALYSIS

4.1. Data presentation

4.1.1. Selected countries

The countries selected to make the investigation in this research have been: Canada, Brazil, South Africa, Spain, France, United Kingdom, Italy, Germany, Czech Republic, Russia, United Arab Emirates, India, Hong Kong (China), Malaysia and Australia.

At least it is choose one country of each continent.

Picture 4:World's map. From Pérez Bes, P. (2011) Source: www.territoriocreativo.es

In the next table, we can see in which of the chosen countries are the selected degrees officially established. How we are considering along this thesis, building engineering is not an international career. In some countries can exist similar studies to work like a Building Engineering, but in this analysis the word "Engineering" is important and this similar studies have not this term. Between all these countries, only Spain, United Kingdom and Germany are going to be analysed more seriously for more accurate information.

ENGINEERING APPLICATION COUNTRIES

	Canada	Brazil	S.Africa	Spain	France	U.K.	Germany	Italy	Czech Republic	Russia	UAE	India	China	Malaysia	Australia
Arch	X	X	X	**X**	X	**X**	**X**	X	X	X	X	X	X	X	X
C.Eng	X	X	X	**X**	X	**X**	**X**	X	X	X	X	X	X	X	X
B.Eng	X		X	**X**	X			X		X			X		X

Table 1: Engineering application countries (2013)

4.1.2 Subjects and course structure

The next tables show the course structure of Building Engineering, Civil Engineering and Architecture in Spain, Germany and United Kingdom. It has been done a subject analysis, so it is possible to see the similarities and differences between degrees and countries. In Spain exists the possibility to study these three degrees, but in Germany and United Kingdom, Building Engineering is not established and it's necessary to study a Master to complete the formation and to be able to work. Master option is included in these tables. Furthermore credits are included in these tables to do easier the analysis.

The structure of the courses is divided in semesters. There is an aspect to highlight in case of Civil Engineering in United Kingdom, because there are a range of foundation year options if you do not hold the correct qualifications for undergraduate study. (University of Birmingham)

So in United Kingdom is included this option, to show the previous necessary formation to study Engineering.

The first data corresponds to Spain.

BUILDING ENGINEERING (Spain)

1 Sem.	2 Sem.	3 Sem.	4 Sem.	5 Sem.	6 Sem.	7 Sem.	8 Sem.
Math. I 4,5 ECTS	Math. II 6 ECTS	Buil.Serv. I 6 ECTS	Buil.Serv. II 6 ECTS	Hist.build. 4,5 ECTS	Prev.& safe I 4,5 ECTS	Prev.& safe II 4,5 ECTS	External placement 6 ECTS
Economy 7,5 ECTS	Physics 4,5 ECTS	Arch.draw.II 4,5 ECTS	Topography. 6 ECTS	Structure II 6 ECTS	Budget man. 6 ECTS	Build. organiz 6 ECTS	Intens area 12 ECTS
Material.I 6 ECTS	Materi. II 4,5 ECTS	Legislation 6 ECTS	Urb. manag. 4,5 ECTS	Qual. Cont. 6 ECTS	Build.Project I 4,5 ECTS	Build.Project II 4,5 ECTS	Bachelor final project 12 ECTS
Descriptive Geometry 9 ECTS		Mec.struct. 4,5 ECTS	Structure I 6 ECTS	Optional 6 ECTS	Build.Proj.Exec. 6 ECTS	Build. Inspec. and valuation 4,5 ECTS	
Construction I 9 ECTS		Construct. II 4,5 ECTS	Construct. III 4,5 ECTS	Constru. IV 4,5 ECTS	Constru.V 6 ECTS	Const. VI 4,5 ECTS	
Architect. draw I 9 ECTS		Materials III 9 ECTS			Const. Equipment 6 ECTS	Project management 6 ECTS	

Table 2: Building engineering course structure in Spain. Universidad Politécnica de Valencia (2013)

CIVIL ENGINEERING (Spain)

1 Sem.	2 Sem.	3 Sem.	4 Sem.	5 Sem.	6 Sem.	7 Sem.	8 Sem.
Math 7,5 ECTS	Math 6 ECTS	Maths amp. 6 ECTS	Geology 6 ECTS	Structural steel I 6 ECTS	Roads and airports 6 ECTS	Business management 4,5 ECTS	Bachelor final project 12 ECTS
Drawing 6 ECTS	Programming & numerical methods 6 ECTS	Physics ampli 6 ECTS	Electrotechnics 4,5 ECTS	Structural concrete 6 ECTS	Railways 4,5 ECTS	Marine constructions 6 ECTS	
Physics 6 ECTS	Basic statistics 4,5 ECTS	Topography 4,5 ECTS	Materials 6 ECTS	Geotechnics & foundations 6 ECTS	Industrialized construction 4,5 ECTS	Techniques and methods of land engineering 6 ECTS	
Economics, law and business managment 4,5 ECTS	Representations systems 6 ECTS	Construction procedure I 4,5 ECTS	Construction procedure II 4,5 ECTS	Hydraulics & hydrology 7,5 ECTS	Hydraulic infrastructure 6 ECTS	Optional 4,5 ECTS	
Chemistry 6 ECTS	Mechanics 7,5 ECTS	Deformable solid mechan. 4,5 ECTS	Structure analysis 4,5 ECTS	Prevention of occupational risks and organization 4,5 ECTS	Edification 4,5 ECTS		
		Science and environmental impact 4,5 ECTS	Transport and land 4,5 ECTS		Projects 4,5 ECTS		

Table 3: Civil engineering course structure in Spain. Universidad Politécnica de Valencia (2013)

ARQUITECTURE (Spain)

1 Sem.	2 Sem.	3 Sem.	4 Sem.	5 Sem.	6 Sem.	7 Sem.	8 Sem.	9 Sem.	10 Sem.
Math I 7 ECTS	Math II 7 ECTS	Physics I 7 ECTS	Physics II 6 ECTS	Economy and profession 4,5 ECTS	Arch. theory 5 ECTS	Composition 4,5 ECTS	Architect. Restoration 4,5 ECTS	Urban legislation, valuation 6 ECTS	Integral workshop 12 ECTS
Architect. Forms analysis 12 ECTS		Projects I 14 ECTS		Projects II 14 ECTS		Projects III 14 ECTS		Projects IV 7 ECTS	Optional 4,5 ECTS
Architectural drawing 10 ECTS		Arts history 4,5 ECTS	History I 4,5 ECTS	History II 4,5 ECTS	Electrical facilities 5 ECTS	Hydraulic facilities 5 ECTS	Energy facilities 5 ECTS	Soil & foundation mechanic 4,5 ECTS	Integral final workshop 30 ECTS
Descriptive Geometry 9 ECTS		Urban planning I 9 ECTS		Urban planning II 9 ECTS		Urban planning III 9 ECTS		Structure III 4,5 ECTS	
Architect. Intro. 4,5 ECTS	Project initiation 6 ECTS	Materials 9 ECTS		Construction I 9 ECTS		Construction II 9 ECTS		Const. III 8 ECTS	
Construct. Intro 4,5 ECTS			Optional 4,5 ECTS	Structures I 9 ECTS		Structures II 9 ECTS			

Table 4: Architecture course structure in Spain. Universidad Politécnica de Valencia (2013)

The following data corresponds to Germany.

CIVIL ENGINEERING (Germany)

BACHELOR						
1 Sem.	**2 Sem.**	**3 Sem.**	**4 Sem.**	**5 Sem.**	**6 Sem.**	**7 Sem.**
Math I 5 ECTS	Math II 5 ECTS	Construction managem. I 5 ECTS	Foreign construction 5 ECTS	English for academic purposes 6 ECTS	Integrated Design Project 16 ECTS	Praxisproject 30 ECTS
Tech. Mech I 5 ECTS	Tech. MechII 5 ECTS	Statical analysis I 5 ECTS	Statical analysis II 5 ECTS	Construction Project II 6 ECTS		
Physics I/ Chemistry 5 ECTS	Physics II 5 ECTS	Solid building I 5 ECTS	Solid building II 5 ECTS	Structural eng. II 6 ECTS	Bachelorarbeit 14 ECTS	
Material I 5 ECTS	Transport I 5 ECTS	Transport II 5 ECTS	Steel construction 5 ECTS	Hydraulic eng. II 6 ECTS		
Technical drawing 5 ECTS	Hydraulic I 5 ECTS	Water and waste management 5 ECTS	Sanitary Eng, Water Quality and Waste Management 5 ECTS	Geotechnical eng. II 6 ECTS		
Construct. I 5 ECTS	Topography 5 ECTS	Geotechnic I 5 ECTS	GeotechnicII 5 ECTS			

Table 5: Civil engineering course structure in Germany. Bachelor. Fachhochschule Mainz (2013)

MASTER		
8 Sem.	**9 Sem.**	**10 Sem.**
Higher Maths. 6 ECTS	5 Mandatory elective modules 30 ECTS	Interdisciplinary project 12 ECTS
Geotechnical Eng. 6 ECTS		
Elective modules 18 ECTS		Master's thesis 18 ECTS

Table 6: Civil engineering course structure in Germany. Master. Fachhochschule Mainz (2013)

ARCHITECTURE (Germany)

BACHELOR							
1 Sem.	**2 Sem.**	**3 Sem.**	**4 Sem.**	**5 Sem.**	**6 Sem.**	**7 Sem.**	**8 Sem.**
Design I 5 ECTS	Design II 10 ECTS	Design III 5 ECTS	Design IV 10 ECTS	Design V 5 ECTS	Design VI 10 ECTS	Design VII 10 ECTS	Design VIII 5 ECTS
Const. I 10 ECTS	Const. II 10 ECTS	Const. III 10 ECTS	Const. IV 5 ECTS	Const. V 5 ECTS	Const. VI 5 ECTS	Const. VII 5 ECTS	Thesis 15 ECTS
Materials I 5 ECTS	History II 5 ECTS	Building services I and physics 5 ECTS	Building services II 5 ECTS	Energy strategy 5 ECTS	Building services III 5 ECTS	Interior design 5 ECTS	Praxis II 5 ECTS
History I 5 ECTS	Perspective and free drawing 5 ECTS	Measurement and free drawing 5 ECTS	Urban planning I 5 ECTS	History III 5 ECTS	Urban planning II 5 ECTS	Optional 5 ECTS	Optional 5 ECTS
Geometry 5 ECTS		Optional 5 ECTS	Management I 5 ECTS	Praxis I 10 ECTS	Management II 5 ECTS	Free modul 5 ECTS	

Table 7: Architecture course structure in Germany. Bachelor. Fachhochschule Mainz (2013)

MASTER	
9 Sem.	**10 Sem.**
Project 18 ECTS	
Development 10 ECTS	
Company 8 ECTS	
Economy 8 ECTS	
Thesis 16 ECTS	

Table 8: Architecture course structure in Germany. Master. Fachhochschule Mainz (2013)

The following data corresponds to United Kingdom.

CIVIL ENGINEERING (United Kingdom)

BACHELOR						
Foundation year		**1 Sem.**	**2 Sem.**	**3 Sem.**	**4 Sem.**	**5 Sem.**	**6 Sem.**
Maths I 10 ECTS	Maths II 10 ECTS	Materials 5 ECTS	Electrical, electronic & computer syst. 5 ECTS	Structural Engineering 10 ECTS		Civil Engineering Design project 20 ECTS	
Intro. to mechanics 10 ECTS		Modelling concepts and tools 10 ECTS		Floods and River Systems 10 ECTS		Civil Engineering Project and Guided Study 5 ECTS	
Chemical eng. 10 ECTS		Fluid flow, thermodynamics and heat transfer 10 ECTS		Soil Mechanics and Geotechnical Engineering 10 ECTS		Structural Eng. Design 5 ECTS	Structural Eng. Analysis 5 ECTS
Properties of Matter 5 ECTS		Statics and Mechanics 10 ECTS		Const. practice and management 10 ECTS		Water Supply and treatment 5 ECTS	Geotechnical Eng. Applic. 5 ECTS
Waves 5 ECTS		Construction design & prof. Skills 10 ECTS		Engineering Design 10 ECTS		Foundation eng. 5 ECTS	
Eng. Studies 10 ECTS		Other Engineering modules 10 ECTS		Other Engineering modules 10 ECTS		Optional 10 ECTS	

Table 9: Civil Engineering course structure in UK .Bachelor University of Birmingham (2013)

MASTER	
7 Sem.	**8 Sem.**
60 ECTS in modules like: Finance and Core Skills Sustainable construction Engineering structural dynamics Advanced structures and design	Research project 30 ECTS

Table 10: Civil Engineering course structure in UK. Master. University of Birmingham (2013)

ARCHITECTURE (United Kingdom)

BACHELOR					
1 Sem.	**2 Sem.**	**3 Sem.**	**4 Sem.**	**5 Sem.**	**6 Sem.**
Form finding 7,5 ECTS	Building design 7,5 ECTS	Architecture and landscape 15 ECTS	Collective Dwelling 15 ECTS	Modular 15 ECTS	
Modern house 7,5 ECTS	Ancient and medieval arch. 7,5 ECTS	Renaissance to Neoclassicism 7,5 ECTS	Form and structure 7,5 ECTS	Dissertation 15 ECTS	Urban 22,5 ECTS
Light and structure 7,5 ECTS	Building construction 7,5 ECTS	Climate 7,5 ECTS	Nineteenth-Century Arch. 7,5 ECTS		Modernisms 7,5 ECTS
Architectural representation 15 ECTS					

Table 11: Architecture course structure in United Kingdom. University of Kent (2013)

MASTER			
7 Sem.	**8 Sem.**	**9 Sem.**	**10 Sem.**
Design I 15 ECTS	Design II 15 ECTS	Design III 15 ECTS	Design IV 15 ECTS
Technology I 15 ECTS			Technology II 7,5 ECTS
Culture I 7,5 ECTS		Culture II 7,5 ECTS	
Dissertation I 7,5 ECTS		Dissertation II 7,5 ECTS	
			Employability 7,5 ECTS

Table 12: Architecture course structure in United Kingdom. Master. University of Kent (2013)

4.1.3. Salaries

	SALARY PER YEAR IN 2010 (€)		
	Building Eng.	**Architecture**	**Civil Eng.**
Spain	37.067	41.186	49.414
United Kingdom	33.000	33.000	32.000
France	38.713	39.567	39.567
Germany	95.496	37.500	95.496
Italy	33.156	32.741	36.839
Czech Republic	29.748	29.748	29.748
Canada	65.845,45	33.854,54	56.232
Brazil	40.764	30.514,8	2286,94
Australia	55.278	50.396	61.781
Malaysia	22.910,88	25.278	24.642
India	10.263	12.074	9.663
China	40.394	48.473	40.394
UAE	49.931,88	73.141,2	41.317,32
Russia	55.815,12	50.039,76	61.690,32
South Africa	30.529,08	21.298	26.193,96

Table 13: Salaries per year in 2010 (2013)

Salary table has been elaborate from salary surveys and universities pages, referenced in the reference chapter. The amounts of money are expressed per year in Euros. In the countries where building engineering doesn't exist, the salary is from a similar work position.

4.1.4. Years of training

	YEARS OF TRAINING		
	Building Eng.	**Architecture**	**Civil Eng.**
Spain	4	5	4
United Kingdom	-	3+2M	3+M
France	5	5	5
Germany	-	4+M	3,5+1,5M
Italy	3	5	3
Czech Republic	-	3+2M	4
Canada	4	4+M	4
Brazil	-	5	5
Australia	4	3	3
Malaysia	-	2	4
India	-	5	4
China	4	4	4
UAE	-	5	4
Russia	4	5	4
South Africa	3	4	3

Table 14: Years of training (2013)

Years of training are the duration of the formation period, to have the final qualification. It has been extracted from universities web pages, referenced in the reference chapter. The first number is the bachelor period and the number with the “M” is the master term. Not in every country is an obligation to do the master so the data are going to be very variable. The experience period is not contemplated, but in some countries this period is included in the bachelor term. In the case of Spain, Germany and United Kingdom this information is extended is chapter 4.1.2.

4.1.5. Credits

	CREDITS (hours)		
	Building Eng.	**Architecture**	**Civil Eng.**
Spain	7200	9900	7200
United Kingdom		4800	4800
France	9000	9000	9000
Germany	9000	7200	6300
Italy	6750	11250	6750
Czech Republic		9000	7200
Canada	2832	2832	2832
Brazil		5880	4155
Australia	1080	1080	1080
Malaysia		2100	3976
India		2880	2304
China	2160	2160	2160
UAE		2560	2048
Russia	2048	2560	2048
South Africa	1824	2432	1824

Table 15: Credits (2013)

This information has been extract from universities web pages. Credits are in hours. The most of them are in ECTS (European Credit Transfer System) system, where 1 year is 60 ECTS, and 1 ECTS is 25/30 hours of working, so to uniform them is better to make the comparison in the same units, in this case in hours. In countries where the equivalence of credits in hours is an interval, it has been taken the highest one. Despite in Europe is used the ECTS system, there are differences between countries. Then the credits equivalence is showed:

Czech Republic → 1 credit: 25/30 hours

France → 1 credit: 25/30 hours

Germany → 1 credit: 30 hours

Italy → 1 credit: 25 hours

Portugal → 1 credit: 25/28 hours

Spain → 1 credit: 25/30 hours

United Kingdom → 1 credit: 20 hours *(*ECTS Users' Guide. 2009*)*

Whereas outside Europe there are other credits measures, 1 ECTS credit could be considered equivalent to 0,5 US semester credit hours or 26–28 hours of effective work (total classroom contact hours plus time spent outside of class on course assignments and research), but this standard should be applied with flexibility (ISEP). Next terms are examples to measure credits in different countries:

FCE (Full Course Equivalent) (Calgary university. Canada)

EFTSL (Equivalent Full-Time Student Load) (Australia) 1 EFTSL = 10 hours

HEQF (Higher Education Qualifications Framework) (South Africa)

4.1.6. Denomination

This table is a compilation of some title names of building engineering graduates, including in some case a specialisation. The next analysis can help us, to define what will be the future denomination of building engineering or what can be the guideline to make the distinction in the countries where this one is not established. Showing that there are differences not only between degrees, but also within the same degree.

BUILDING ENGINEERING TITLE		
SPAIN	**Building Engineering**	
UK	**Building Services Engineering**	**Construction management**
FRANCE	**Ingénierie du bâtiment**	
GERMANY	**Ingenieurin für Hochbau**	**Construction management**
ITALY	**Ingenieria edile**	
CANADA	**Building Engineering**	
AUSTRALIA	**Building Engineering**	**Construction management**
CHINA	**Construction Engineering and management**	**Building Services Engineering**
RUSSIA	**Construction management**	**Building Materials Engineering**
S.AFRICA	**Construction Economics & Management**	

Table16: Building Engineering titles (2013)

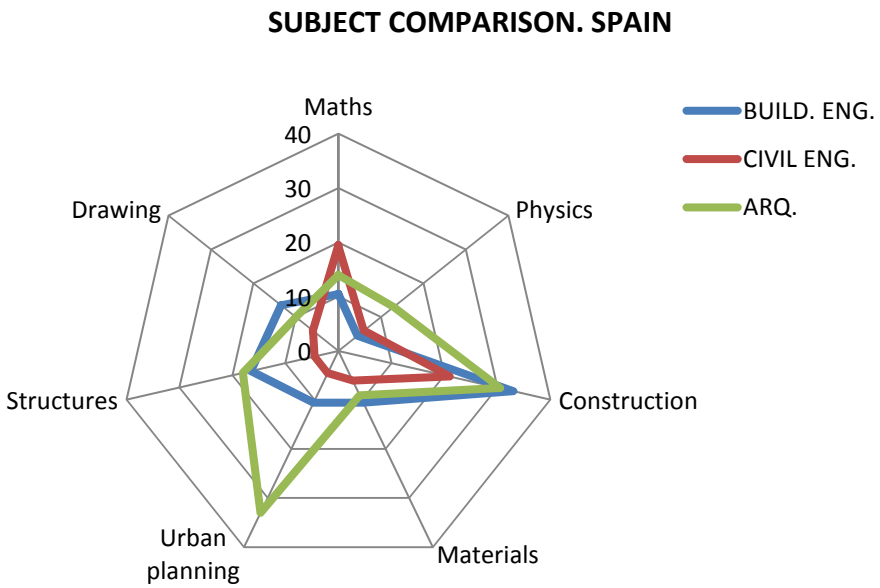
4.2. Analysis

4.2.1. Subjects

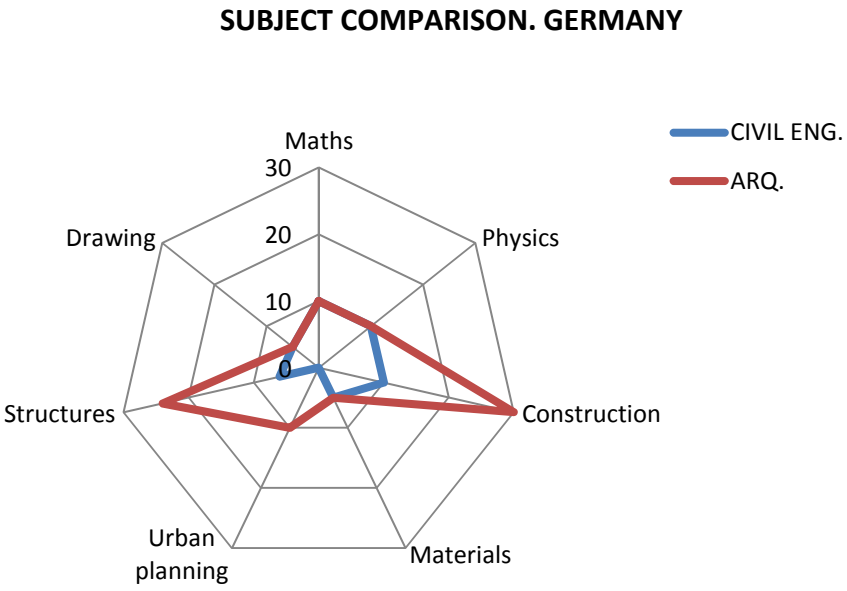
The subject's comparison is going to follow the structure explained in the methodology chapter. For each country it will be a spider graphic to compare degrees. It has been chosen some of the more representative subjects.
To make the comparison has been taken ECTS of each subject and each axis represents each one. In some cases subjects have been adapted:

- Urban planning includes: law, urban planning and legislation.
- Construction includes: construction, steel and concrete.
- Physics includes: physics and mechanics.
- Materials includes: materials and building design.

In some subjects have been assigned 0 ECTS, because in the subject's table do not appear, but in some cases are included in the "Optional" or "Other modules". First it has been compare the degrees within the same country and then the same degrees in the different countries.

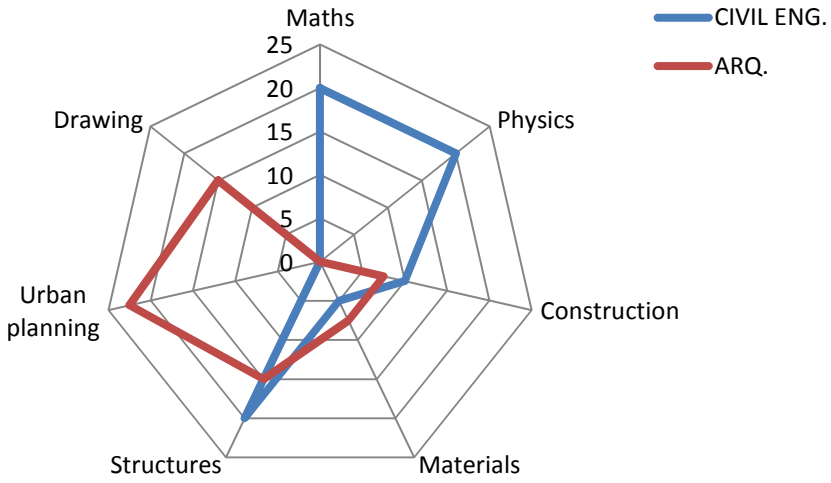


Graphic 1: Subjects comparison in Spain.

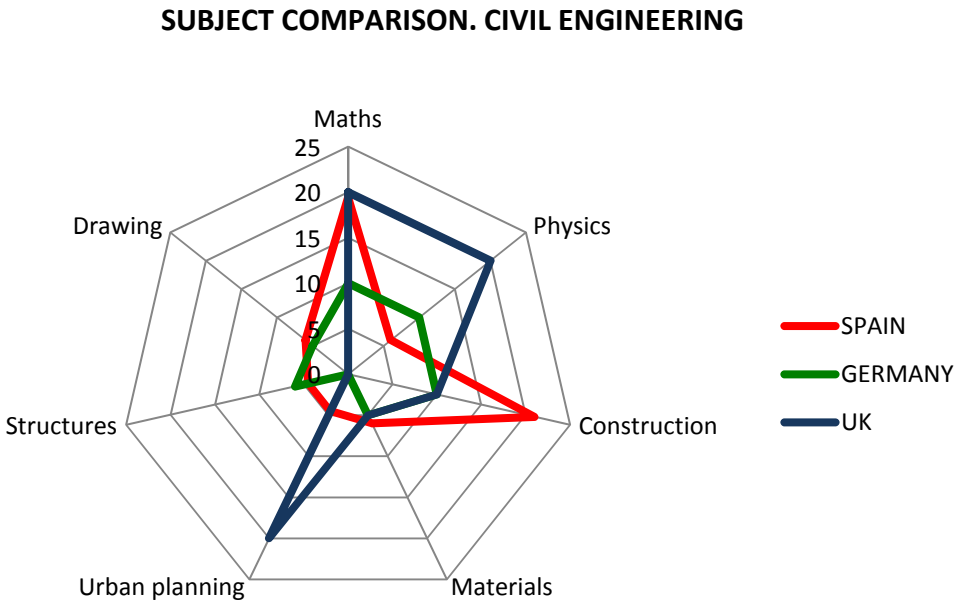


Graphic 2: Subjects comparison in Germany.

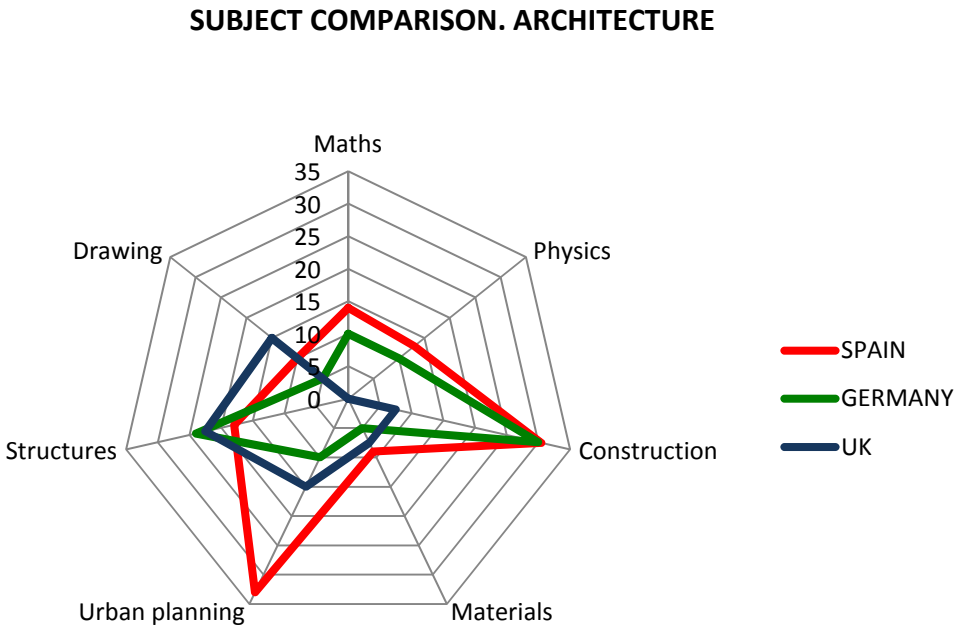
Structures in Germany have been extract from construction, and Maths and Physics from Design.



Graphic 3: Subjects comparison in United Kingdom.



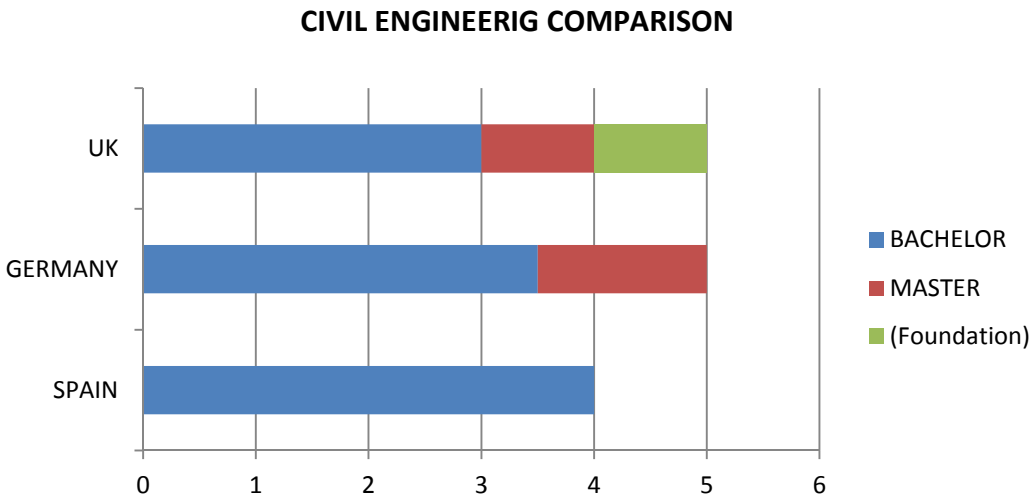
Graphic 4: Subjects comparison in Civil Engineering.



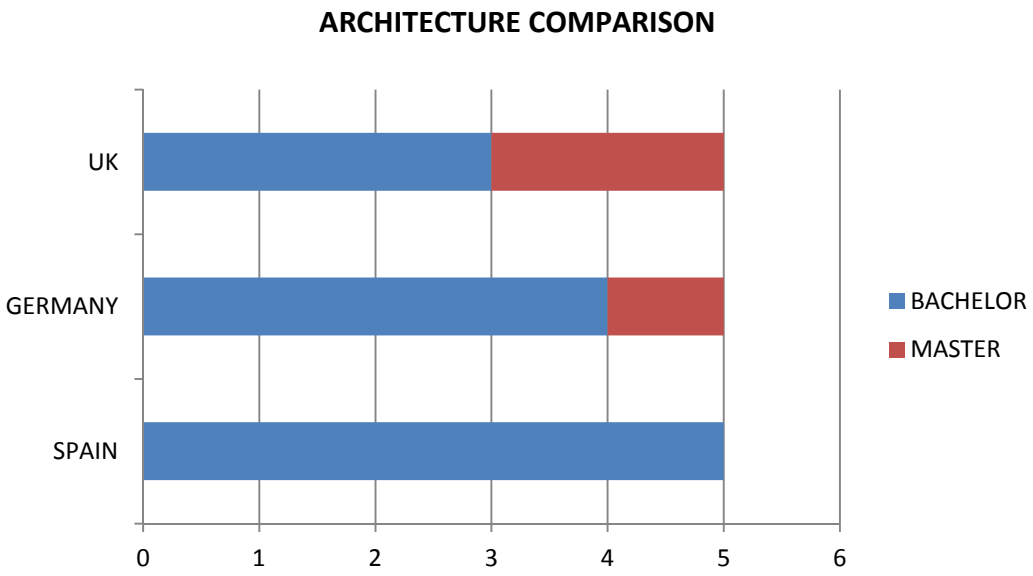
Graphic 5: Subjects comparison in Architecture.

4.2.2. Course structure

With this graphics, it is possible to see a glance the differences between the course structure of Civil Engineering and Architecture, dismissing Building Engineering because of between these countries exists only in Spain.



Graphic 6: Civil Engineering course structure.



Graphic 7: Architecture course structure.

4.3. Chapter Summary

Summarising the concepts to take into account for the conclusions have been developed in this chapter: subjects, course structure, salaries, years of training, amount of credits and the different denominations of building engineering. All of this analysis has a common point, to analyse differences between degrees and see the actual situation of building engineering respect architecture and civil engineering. Knowing that these two degrees are international, and comparing the aspects before mentioned, it is possible to suggest a method to internationalise and standardised building engineering.

5. DISCUSSIONS OF RESULTS

5.1. Discussions of results

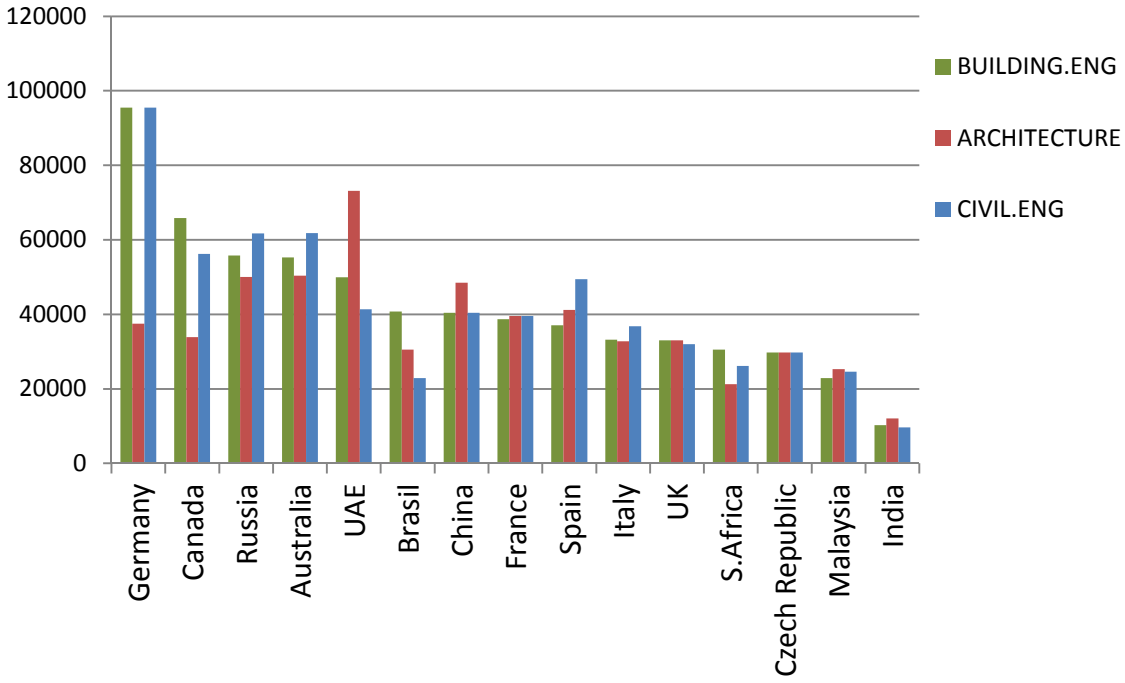
Without forgetting the aim of the research: What are the differences between architecture, civil engineering and building engineering? , along this report it has been more developed the idea of standardised and internationalised building engineering. And at the same time the differences between these three degrees have been showed.

With all of this information, it is possible to reach a conclusion paying attention to the collected and analysed concepts:

- Subjects' comparisons by country (Graphic 1, 2 and 3) show us clearly that there are a lot of differences between degrees. It can be seen in the spider graphics that the different lines don't coincide. In the case of Spain there is a tendency to equalize in construction and mathematics, while in urban planning and structures there is a significant divergence. Paying attention to Germany the similarities are more but the exceptions like structures and construction have a big difference between degrees. Finally United Kingdom is the country with less similarity in its degrees. This proves that these three degrees should coexist because each one has a different approach.
- Making the same kind of comparison but by degree instead by country (Graphic 4 and 5), it's possible to see how uniform is Civil Engineering and Architecture. The common area in Architecture graphic is bigger than in Civil Engineering. So taking into account these three countries, one can say that

Architecture is more standardised. In Civil Engineering for example has more importance urban planning in UK and construction in Spain. Being Mathematics a common important subject. And Germany has the most uniform subject's distribution.

- Course structure analysis is the information with more similarities between degrees, because all are five years of duration, except for Spain in Civil engineering and Building Engineering (4 years). So not only Building Engineering is the exemption, when Civil Engineering in Spain has different duration.
- Salary (€ per year) is compared in the next graphic, where Building Engineering salary is ordered from high to low. Thus, we can see if the influence of the existence of this degree, concern in the earned money.

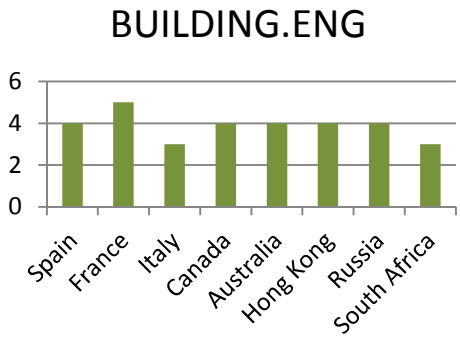


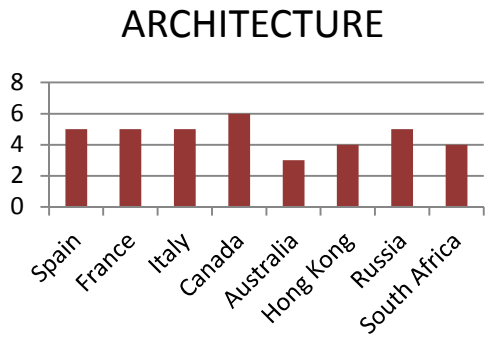
Graphic 8: Salaries comparison (2013)

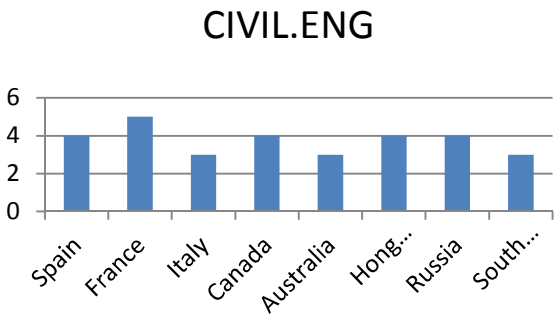
After analyse this graphic, it is clear that the most of countries with building engineering have a higher salary than the others. With the exemption of Germany, UAE and Brazil, where the construction development is now booming. Brazil because of the Olympics and because in the residential construction is expected a growth of 6,2% from 2010 to 2015. (Observatorio de Internacionalización. 2012. Report on the construction sector in Brazil 2012.)

And in UAE has not taxes, all the capital money comes from the natural resources in the energy system so this provides an economic relief.

- Comparing the years of training collected in the table 14, we can see that there is not only in building engineering a variable number of years, in the other two degrees happen the same. So with this evidence it's possible to say that building engineering is not in a wrong way to be standard and international like civil engineering and architecture.

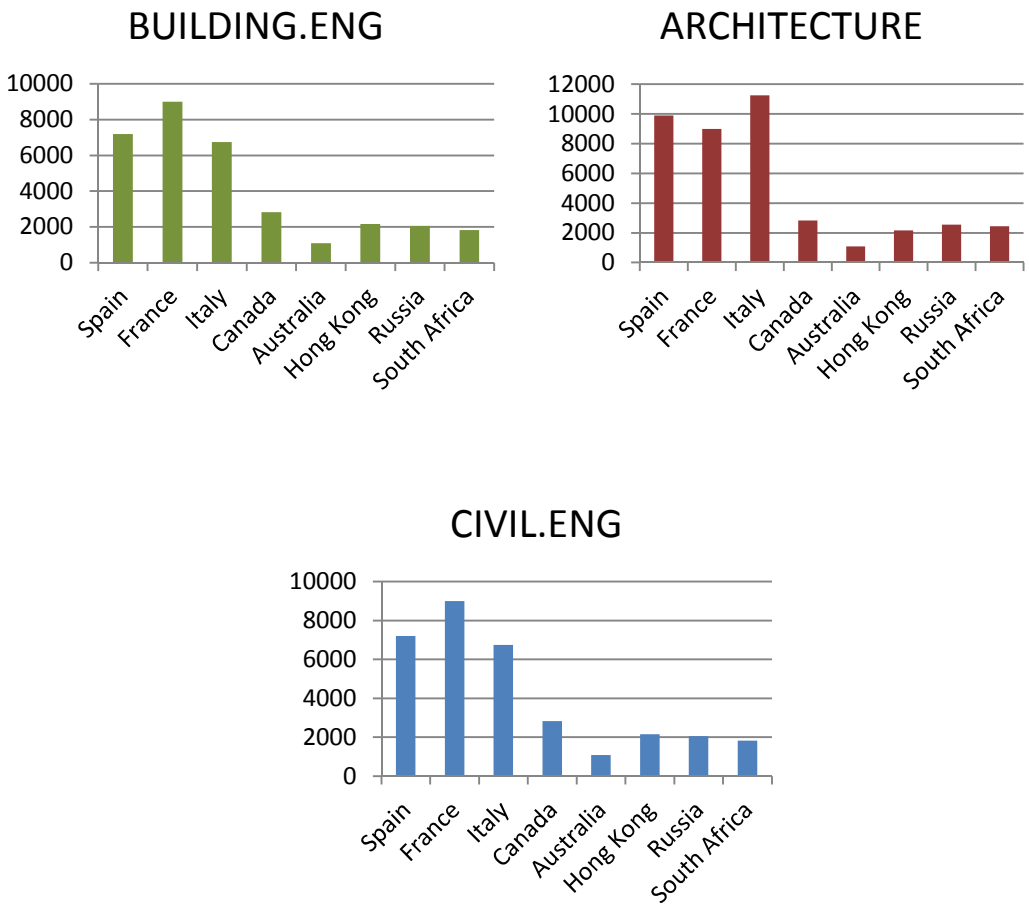






Graphic 9: Degree year's comparison (2013)

- Credit comparison with collected data of table 15, express the same that the degree year's comparison, that the way to internationalise Building Engineering is right. Credits are denominated in hours. And as in the case of the years of training comparison, we obtain a very variable result. And here it is possible to observe that in European countries change considerably the amount of hours per degree. European area is more standardised and adapted. The ECTS system in Europe makes easier the adaptation. And the different systems outside Europe are a barrier to extend the new ways of education. Nowadays it has been published a report in the Institution of Civil Engineers magazine (Anwar A. & Richards D.) where it is discussed the recognition of professional engineering qualifications and the globalisation of accreditation of engineering education by US organisation ABET. Here is said that UK courses are not recognised by Washington Accord (the rules to get the title in US) and who want to be covered by Washington Accord must graduate from an accredited bachelor degree. This situation is what is stopping the standardization of these degrees, for example.



Graphic 10: Credits comparison (hours) (2013)

- Denominations for Building Engineering are very similar in the different places where Building Engineering exists. Being the most common Building Engineering and Construction Management. This aspect guide us, to reaffirm that this degree is not far to become official around the world.

5.2. Limitations of the research

The more difficult thing in this research has been to find the most reliable information because in the same country for the same degree there are a lot of universities that offers different programs.

On the other hand to propose a method or a way to make uniform around the world Building Engineering, as well as Architecture or Civil Engineering, is a hard work, but a good way to get it, is to have the subjects tables of chapter 4.1.2., and try to introduce the same program in every country or make it similar.

5.3. Chapter summary

Summarising Discussion's chapter, analysis and data collection have been put in common, extracting different ideas about the existent differences between these three degrees and the few similarities between them. But despite the differences, the possibility to internationalise Building Engineering opens a way to think about follow the process of Architecture and Civil Engineering. To carry out these works has been discussed topics like subjects, course structure, salaries, credits, years of training and denomination.

6. CONCLUSIONS AND RECOMMENDATIONS

This research about the differences between Architecture, Civil Engineering and Building Engineering worldwide has opened new questions to add to the aim. And these questions are: Why Building Engineering is not in every country? And what can be the way to internationalize it?

In the first research, we realised that not in all the countries Building Engineering is established (Table 1). The establishment of Building Engineering is positive because in the places where it is implanted, salaries and efficiency are higher. And the possible reason why it is not working in some countries is because Architecture and Civil Engineering absorb the competences of Building engineering, as can be seen in the subjects' comparison where every degree has a common area in every country.

Despite that, the differences between degrees are visible just in the subjects' comparison, and this show that the application area of each degree is different and it will better do not absorb competencies (Chapter 4.2.1).

Last incentive is to standardise and internationalise Building Engineering around the world. With the research we can see that is not impossible and it is in the right way to do it. Because comparing years of training and credits (Graphic 9 and 10), we obtain a disparity of numbers. But in Architecture and Civil Engineering happens the same, and they are standard and international degrees. Regarding the title denomination in the different countries, it is being quite defined, and this is an important aspect to make uniform the degree.

Finally the ideal solution is to make uniform Building Engineering, as possible as we can, to work around the world without impediments in the competences. To follow investigating in this research, it will be interesting to find or look for the way to make uniform every degree around the world, taking as an example the homogenisation of other degrees. It should be interesting to see the evolution since this research has been written until the next one regarding the Building Engineering evolution and the standardisation of these three degrees. It is also a interesting idea to observe the evolution along the history of these degrees, watching the formation and diversification of them because maybe in the past happened some similar process and it could be a good idea.

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