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An Information Management Conceptual Approach for the Strategies Alignment Collaborative Process

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Abstract: This paper proposes an information management approach to deal with the strategies alignment collaborative process. Much attention has been given to the information management in collaborative networks (CNs), resulting in a wide variety of information management approaches and frameworks. The treatment, estimation, and collection of data are key issues that still need to be addressed, due to the complexity associated with the information exchange and the need to build trust relationships within the CN. In order to address this literature gap, this paper presents an approach to manage information in the specific collaborative process of strategies alignment. The approach is composed of a methodology, that enables to identify the roles participating in the application of the collaborative process, select the collaborative application context, determine the level of collaboration to be applied, and estimate and gather the data required to feed the strategies alignment process. The proposed information management approach bridges the conceptual model of strategies alignment process, with its application in real-world CNs.

Keywords: strategies alignment; collaborative process; information management; data estimation

1. Introduction

Collaboration and information exchange between companies are considered as key factors to promote and support the establishment of collaborative processes, and to achieve higher levels of business performance derived from the collaborative network (CN) [1–3]. Currently, CN enterprise challenges are related, amongst others, with the information management with regards to the exchange of data required to establish collaborative processes. In this particular paper the authors particularly focus on the strategies alignment collaborative process.

Considering that a CN is constituted by a set of autonomous enterprises, it is logical to state that each CN partner defines the objectives to achieve. In order to fulfil such objectives, every single enterprise formulates its own strategies. The strategies formulated by each CN enterprise are characterized by being heterogeneous leading to the strategies' diversity. This diversity may generate conflicts, since a particular strategy formulated in one CN enterprise could influence in a negative way the achievement of the objectives defined in another enterprise of the same CN. Let us suppose a food distribution CN is composed of two enterprises: E_1 is the supplier and produces single-use plastic containers for ready meals and E_2 is the manufacturer that cooks and distributes the ready meals in supermarkets. On the one hand, E_1 aims to increase its sales by 5%; to do that E_1 formulates an aggressive commercial strategy to reduce the prices of the raw materials (plastic pellets) at the expense of reducing the containers quality. On the other hand, the objective of E_2 is to reduce the carbon footprint by 10%. In order to achieve its objective, E_2 formulates the following strategy, "to substitute single-use plastic containers for those product references that due to their characteristics can be prepared in cardboard containers". At first glance, it can be stated that the strategy formulated by

E_2 negatively influences the objective defined by E_1 , therefore it can be deduced that the strategies formulated to achieve the objectives of each of the enterprises are contradictory, and we can conclude that the strategies are not aligned.

To deal with the strategies' misalignment, Andres and Poler [4] proposed a decision support system (DSS) for the collaborative selection of aligned strategies in a CN, with the aim of modeling, assessing, and solving the strategies alignment process from a collaborative perspective. The proposed DSS is based on the Strategies Alignment–Decision-Making Model (SA-DMM), which enables to quantitatively model the positive and negative influences that are exerted on the objectives, defined by each CN enterprise, when the strategies formulated by each of the collaborative partners are activated. The SA-DMM is modeled on the base of a mathematical programming method that allows to formally model the strategies alignment process. In the proposed SA-DMM, intra- and inter-enterprise influences are modeled. Intra-enterprise influences represent and quantify the impact that the strategies formulated in one enterprise have on the achievement of its own objectives. Inter-enterprise influences represent and quantify the impact that the strategies formulated in one enterprise of the CN can influence the objectives of another enterprise, and vice versa. In this regard, the SA-DMM provides a performance measurement scheme to quantitatively measure the influences between the strategies and the objectives. The objective function of the strategies alignment mathematical model allows identifying the set of aligned strategies to maximize the network performance through the strategies' selection and activation. Moreover, the SA-DMM is solved through the system dynamics (SD) method. SD allows representing causal relationships between the strategies and the objectives achievement, within the complex system formed by the enterprises of a CN. Finally, a simulation tool is used to solve the proposed SD model, assessing and supporting the strategies alignment process.

The current paper takes over from the research carried out by Andres and Poler [4] and Andres [5], and focuses on information management to deal with the strategies alignment collaborative process. Considering that a CN is characterized by uncertainty and incomplete information, gathering all the data in an accurate way is seen as a drawback to feed the SA-DMM. More concretely, the information as regards the values of influence is among the objectives and the strategies. Additionally, the goal is to improve the exchange of information in collaborative networks, and specifically in the strategies' alignment process to support CN enterprises on the implementation of the SA-DMM.

The main objective of this paper is, therefore, to facilitate the process of gathering the required data to feed a SA-DMM and promote collaboration between partners participating in the CN.

Accordingly, the paper is organized as follows, Section 2 proposes the materials and methods used to pose the strategies alignment information management approach. In this regard, a theoretical background on the Strategies Alignment Decision–Making Model (SA-DMM) is presented. The results of the paper are described in Section 3, in which an information management approach is proposed to support the implementation of the SA-DMM within the CN enterprises, consisting of (i) the proper selection and identification of the roles participating in the application of the SA-DMM; (ii) the selection of the SA-DMM application context; (iii) the definition of the collaboration levels, which are characterized by the level of information exchanged among the enterprises of the CN; (iv) the estimation of values of influence $val_{str_{is_k}pi_{ik}}$; and (v) the information gathering in a standardized template. Section 4 discusses the work proposed and focuses on the limitations found for the implementation on the proposed information management approach. Finally, Section 5 concludes the paper and future research lines are proposed.

2. Materials and Methods

2.1. Theoretical Background

The information management approach is built under the basis of the collaborative networks (CNs) discipline. In this regard, a CN is a concept grounded on the work developed by Camarinha-Matos and Afsarmanesh [1] and defines the terms as a network consisting of a variety of autonomous entities,

geographically distributed and heterogeneous in operational terms and objectives, which collaborate to achieve common or compatible goals. In CNs, the network partners can achieve goals that would not be possible, or would be more costly, if organizations worked individually [3].

The symbiotic relationship between collaboration and sustainability has been proven in different works within the scientific literature [6–8].

The approach proposed to deal with the information management in the strategies alignment collaborative process fulfills the Sustainable Development Goal (SDG) defined by the 2030 Agenda for Sustainable Development [9], described as “Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development”. The work developed in the current paper is a transformative approach that supports stakeholder partnerships as aligned with the challenges posed by the SDG Agenda [9]. The information management approach, proposed in this paper, focuses on the exchange of information among enterprises that are willing to align their strategies in the private sector. Nevertheless, the developed approach is posed in a general way for its adaptation and implementation in other different contexts, including collaborative environments in which governments, institutions, agencies, private sector and public organizations, and society interact, across different industries, locations, and levels [10]. The final aim is to achieve intense and effective cooperation regardless of the nature of the partners and actors participating in the collaborative processes. Moreover, the work hereafter developed is lined up with the research developed by Horan [11] that posits the need for transformative approaches and multi-stakeholder partnerships to address the challenges posed by the SDG Agenda.

The main objective of this paper is the facilitation of the process of gathering the required data to feed the Strategies Alignment–Decision-Making Model (SA-DMM) and promote sustainable collaboration between partners participating in the collaborative networks.

2.2. Strategies Alignment–Decision-Making Model (SA-DMM)

The strategies alignment process is fully described and addressed by Andres [5]. The strategies alignment process is based on identifying the strategies, defined by all the CN enterprises, that are aligned, so that the objectives, defined by each of the CN partners, are positively influenced, increasing the values of performance defined for its measurement. In order to measure this achievement, key performance indicators (KPIs) are used. The collaborative process of strategies alignment starts with the definition of the objectives to be achieved by each networked enterprise. Secondly, each enterprise formulates a set of strategies to attain the objectives defined and estimates the cost of activating each strategy. Amongst all the formulated strategies, the enterprises can activate part of them in order to reach the defined objectives, all in all at the minimum cost. To this extent, CN partners’ concern resides in identifying the influence that each activated strategy has in the objectives’ achievement. Accordingly, enterprises with aligned strategies are characterized by carrying out the strategies that contribute to the increase of the objectives performance (KPIs), minimizing the costs of the activated strategies. Thus, when modeling the strategies alignment process, the KPIs increase/decrease is used to identify how the activated strategies influence the objectives achievement. The strategies of an enterprise i can also influence the KPIs of another enterprise j and vice versa; therefore, not only intra-enterprise influences but also inter-enterprise influences exist (Figure 1).

The mathematical programming language is used to model the strategies alignment process [12]. Particularly, mathematical notation allows representing the elements that characterize the alignment in terms of strategies, objectives, and performance indicators, obtaining higher degrees of accuracy and formality. Next the notation and the mathematical model representing the strategies alignment process are depicted. For more information we refer readers to Andres and Poler [4], Andres [5], and Andres and Marcucci [12] (see Table 1).

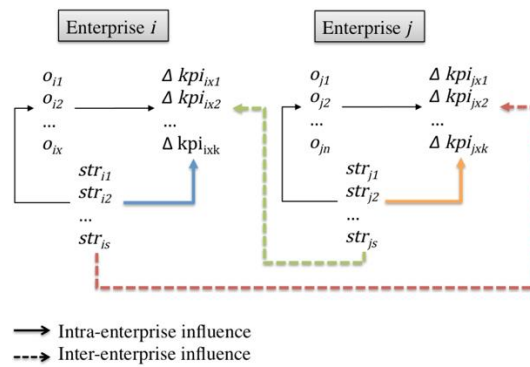


Figure 1. Relationship between the strategies and the key performance indicators (KPIs).

Table 1. Strategies Alignment–Decision-Making Model (SA-DMM): indices, parameters, and decision variables.

Indices	
net	set of networks (net = 1, . . . , N)
i	set of enterprises (i = 1, . . . , I)
x	set of objectives (o = 1, . . . , O)
k	set of key performance indicators (k = 1, . . . , K)
s	set of strategies (s = 1, . . . , S)
Model Parameters	
n	number of enterprises belonging to the network
e _i	enterprise i
o _{ix}	objective x defined in enterprise i (e _i)
b _i	budget owned by the e _i in monetary units (m.u.) to invest in the activation of the strategies
str _{is}	strategy s defined by e _i
kpi _{ixk}	key performance indicator (KPI) k used to measure the objective o _{ix} increase observed in the kpi _{ixk} when the str _{is} are activated. It can be decomposed in:
Δkpi _{ixk}	Δkpi _{ixk} ^{is} increase of the kpi _{ixk} when the str _{is} of the same enterprise i (e _i) is activated Δkpi _{ixk} ^{js} increase of the kpi _{ixk} when the str _{js} of a different enterprise j (e _j) is activated
kpi _{ixk} ^{max}	maximum value of kpi _{ixk} estimated by the e _i (used to homogenize all the KPIs)
w _{ixk}	weight of kpi _{ixk} , determines the relevance that the kpi _{ixk} has for e _i
kpi _i	KPI defined at enterprise e _i level
kpi _{net}	KPI defined at network net level
F _{inf_stris_kpiixk}	function that models the behavior of the kpi _{ixk} when str _{is} is activated, is a time-dependent function f(t)
c _{stris}	cost of activating one unit of strategy str _{is} (m.u.)
str _{is_mu}	monetary units invested in the activation of str _{is} (m.u.)
val _{stris_kpiixk}	numerical value estimated by the enterprise e _i , that registers the increase or decrease of the kpi _{ixk} when one unit of str _{is} is activated
H	horizon, time units (t.u.), period of time in which the set of strategies are to be activated. Normalized to the unit, H = 1.
d _{1_stris}	delay, time period between ti _{stris} and the time when the kpi _{ixk} is started to be influenced by the activated str _{is} (t.u.)
d _{2_stris}	time period between the str _{is} starts to influence the kpi _{ixk} until the maximum level of influence in is achieved (inf _{stris_kpiixk}), (t.u.)
inf _{stris_kpiixk}	maximum level of influence on the kpi _{ixk} when str _{is} is activated
slope _{stris_kpiixk}	slope of the ramp in F _{inf_stris_kpiixk}
d _{3_stris}	time period in which str _{is} is exerting the highest influence (inf _{stris_kpiixk}) on the kpi _{ixk} (t.u.)
d _{4_stris}	total duration of str _{is} (t.u.)
tf _{stris}	unit of time when str _{is} is finished (t.u.)
Threshold _{kpiixk}	value from which the associated kpi _{ixk} is affected by the inf _{stris_kpiixk} . below Threshold _{kpiixk} the influence of str _{is} is not observed, from Threshold _{kpiixk} , the influence exerted by str _{is} is considered
Decision Variables	
u _{stris}	units of strategy (u.s) str _{is} to be activated
ti _{stris}	initial time of activation of str _{is} (t.u.)

The objective function of the SA-DMM (Equation (1)) maximizes the increase of the kpi_{net} according to the units of strategies to be activated, $u_{str_{is}}$, and the time to activate the sustainable resilience strategies $ti_{str_{is}}$.

$$\max. \Delta kpi'_{net} \tag{1}$$

The restrictions of the SA-DMM are posed next in Equations (2)–(20):

$$kpi'_{net} = \frac{\sum_i kpi'_i}{n} \tag{2}$$

$$kpi'_i = \frac{\sum_i \nabla kpi'_{ixk} \cdot w_{ixk}}{\sum_i w_{ixk}} \tag{3}$$

$$\nabla kpi'_{ixk} = \frac{\nabla kpi_{ixk}}{kpi_{ixk}^{max}} \tag{4}$$

$$\nabla kpi_{ixk} = \int_a^b F_{inf_str_{is}_kpi_{ixk}}(t) \cdot dt - \int_a^b Th_{kpi_{ixk}} \cdot dt \tag{5}$$

$$F_{inf_str_{is}_kpi_{ixk}}(a) = Threshold_{kpi_{ixk}} \tag{6}$$

$$F_{inf_str_{is}_kpi_{ixk}}(b) = Threshold_{kpi_{ixk}} / b > a \quad (b = tf_{str_{is}}) \tag{7}$$

$$F_{str_{is}_kpi_{ixk}}(t) = \begin{cases} t \leq ti_{str_{is}} + d'_{1_str_{is}} \rightarrow F_{str_{is}_kpi_{ixk}}(t) = 0 \\ ti_{str_{is}} + d'_{1_str_{is}} < t < ti_{str_{is}} + d'_{1_str_{is}} + d'_{2_str_{is}} \rightarrow F_{str_{is}_kpi_{ixk}}(t) = slope_{str_{is}_kpi_{ixk}} \\ ti_{str_{is}} + d'_{1_str_{is}} + d'_{2_str_{is}} < t < ti_{str_{is}} + d'_{1_str_{is}} + d'_{2_str_{is}} + d'_{3_str_{is}} \rightarrow F_{str_{is}_kpi_{ixk}}(t) = inf_{str_{is}_kpi_{ixk}} \end{cases} \tag{8}$$

$$slope_{str_{is}_kpi_{ixk}} = \frac{val_{str_{is}_kpi_{ixk}}}{d'_{2_str_{is}}} \tag{9}$$

$$inf_{str_{is}_kpi_{ixk}} = val_{str_{is}_kpi_{ixk}} \cdot u_{str_{is}} \tag{10}$$

$$str_{is_mu} = u_{str_{is}} \cdot c_{str_{is}} \tag{11}$$

$$d'_{1_str_{is}} = \frac{d_{1_str_{is}}}{H} \tag{12}$$

$$d'_{2_str_{is}} = \frac{d_{2_str}}{H} \tag{13}$$

$$d'_{4_str_{is}} = \frac{d_{4_str}}{H} \tag{14}$$

$$d'_{3_str_{is}} = d'_{4_str_{is}} - d'_{2_str_{is}} \tag{15}$$

$$H' = \frac{H}{H} = 1 \tag{16}$$

$$t'_{i_str_{is}} = \frac{t'_{i_str_{is}}}{H} \tag{17}$$

$$t'_{f_str_{is}} = \frac{t'_{f_str_{is}}}{H} \tag{18}$$

$$b_i \geq 0, \text{ where } b_i \geq \sum_s str_{is_mu} \quad \forall s \in S \tag{19}$$

$$t'_{f_str_{is}} \leq H = 1 \quad \forall s \in S \tag{20}$$

$$t'_{f_str_{is}} = t'_{i_str_{is}} + d'_{1_str_{is}} + d'_{2_str_{is}} + d'_{3_str_{is}} \tag{21}$$

The output solution of the SA-DMM is the number of strategies to activate and to what extent they are activated ($u_{str_{is}}$), and the initial time in which to activate the strategies ($ti_{str_{is}}$). This results in a sequence of strategies to activate, maximizing the increase of the network performance indicator ($\Delta kpi'_{net}$).

2.3. Strategies Formulation

The strategies are formulated in each enterprise with the main aim of reaching the objectives defined. The set of formulated strategies have potential to be activated in the future. The SA-DMM supports the decision of which strategies to activate, amongst all those formulated, to obtain higher levels of alignment. Each strategy is enumerated according to the notation considered in the SA-DMM for the parameter str_{is} , as the strategy s defined by enterprise i . A short description of the strategies is provided in order to easily understand them. In case the enterprises decide to share the maximum amount of information (Collaborative Scenario 3 or CS3), these strategies will be shortly presented to the rest of the enterprises of the CN. Therefore, a brief, easy, and understandable description must be provided without considering specific terms. This brief description will be exchanged with the other enterprises of the network when considering the CS3. Each formulated strategy, if activated, will have a positive or negative influence in the objective's achievement. After considering the strategies' descriptions, each enterprise belonging to the CN must have a rather clear idea on how the activation of a specific strategy, formulated in another network enterprise, affects the achievement of its defined objectives. This information will be useful when defining the inter-enterprise values of influence.

2.4. Performance Indicators Definition

The objectives of each enterprise are identified, and the data as regards the KPIs used to measure the level of achievement of these objectives are gathered. The objectives are numbered according to the notation described for the parameters in the SA-DMM. In this regard, o_{ix} refers to the objective x defined in enterprise i . In the SA-DMM, the parameter used to design the performance indicators, used to measure the objectives, takes into account the objective that measures. In this regard, kpi_{ixk} refers to the performance indicator k used to measure the objective x of enterprise i . In order to simplify the process of performance indicators' definitions, the performance indicators are numbered consecutively. Therefore, a unique and sequential number for each KPI is defined in each enterprise i . Thus, the KPIs are numbered regardless of the objective they measure, as shown next: kpi_{ik} is key performance indicator k used to measure an objective defined in enterprise i .

An illustrative example is proposed in Table 2 in order to provide better insight regarding the simplification proposed for the strategy's alignment model formulation.

Table 2. Definition of kpi_{ixk} to manage the information in the SA-DMM.

	Objectives Notation	Strategies Notation	KPI Notation	
SA-DMM notation kpi_{ixk}	Enterprise 1	o11: Increase standardization by 5%	s11: Application of standards established in all the enterprise production processes.	$kpi_{11} : \text{increase_standardisation_level} = \frac{\text{standardisation}_t}{\text{standardisation}_{(t-1)}}$
				$kpi_{12} : \text{increase_uniformity_of_production_process} = \frac{\text{uniformity}_t}{\text{uniformity}_{(t-1)}}$
	Enterprise 2	o12: Increase by 25% the exchange of knowledge among partners	s12: Implement a platform to share tacit knowledge and support discussion forums	$kpi_{13} : \text{knowledge_increase} = \frac{\text{knowledge_exchange}_t}{\text{knowledge_exchange}_{(t-1)}}$
				$kpi_{14} : \text{increase_collaborative_webPlatform_investment} = \frac{\text{investment_webPlatform}_t}{\text{investment_webPlatform}_{(t-1)}}$
	Enterprise 2	o21: Increase innovation by 15%	s21: Participate in research European Projects in H2020	$kpi_{21} : \text{increase_innovation} = \frac{\text{innovation}_t}{\text{innovation}_{(t-1)}}$
				$kpi_{22} : \text{increase_application_innovation_processes} = \frac{\text{num_innovation_processes}_t}{\text{num_innovation_processes}_{(t-1)}}$
	o22: Increase uniqueness by 20%	s22: Implement the Engineering to Order Strategy (ETO)	$kpi_{23} : \text{increase_uniqueness} = \frac{\text{uniqueness}_t}{\text{uniqueness}_{(t-1)}}$	
			$kpi_{24} : \text{increase_personalised_products} = \frac{\text{num_personalised_products}_t}{\text{num_personalised_products}_{(t-1)}}$	

3. Results

The information management approach has been developed to support the needs of capture, treatment, and analysis of the information required to address the strategies alignment process, from a collaborative perspective. The description of the five building blocks that form the information management approach for the strategies alignment collaborative process are presented next and described in detail in the following subsections (see Figure 2). Firstly, the CN enterprises have to identify and designate the roles in charge on the application of the strategies alignment process (SA-DMM). Then the enterprises have to determine the application context in which the strategies alignment process is implemented. After that, the enterprises of the CN have to agree on the type of collaboration they are willing to carry out when addressing the strategies alignment process. There are three collaboration levels, each one with different levels of information exchange [13]. Finally, the information is gathered using the proposed standard template.

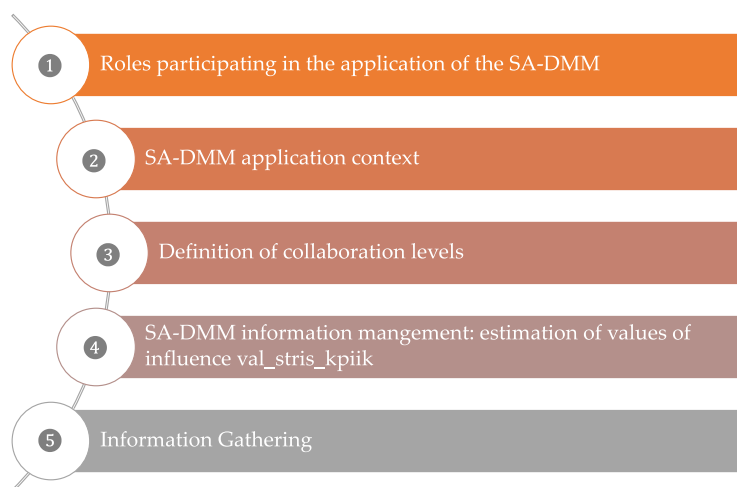


Figure 2. Building blocks for the strategies’ alignment information management.

3.1. Roles Participating in the Application of the SA-DMM

For the identification of the roles participating in the SA-DMM implementation, two levels are considered: enterprise and network level.

- Network level consists of all the enterprises participating in the CN. Aggregated information of each of the enterprises is considered.
- Enterprise level is defined in terms of each individual enterprise. Information is managed by the individual enterprises.

Network Manager. This role is held by a consultant or expert in the CN discipline. The network manager must be an expert on the strategies alignment process. Normally, this role is performed by a participant external to the enterprises conforming the CN. This allows performing the strategies alignment process without aggravating the interests of the partners or benefiting them, in case there exist enterprises more dominant/powerful than others. The network manager works as moderator, so that he/she should be impartial to the issues under discussion, keeping distance from the contents. It is responsible for monitoring the strategies alignment process, pledging to help and encourage the enterprises to collaboratively carry out the decision of which strategies to activate in order to align one another along the CN. This role is in charge of facilitating the exchange of information and supports the CN enterprises on establishing an easy communication. In light of this, it could be stated that the network manager is the orchestrator/moderator [14] of the strategies alignment process. The network manager has clear knowledge on how to implement the SA-DMM proposed to support the strategies alignment process. The network manager is in charge of (i) following all the steps to support the enterprises on carrying out the strategies alignment process; (ii) analyzing the results derived from the application of the SA-DMM and; (iii) supporting the enterprises on negotiation procedure carried out in the strategies alignment process in CN [13]. Different governance modes can be considered by the network manager role in order to properly act as a third-party mediator [15,16].

Enterprise Manager. This role is held by the person responsible for the decision-making related with the activation of strategies in each enterprise. The enterprise manager is in charge of gathering the information required to feed the SA-DMM, regarding the objectives defined and the strategies formulated in each enterprise. The enterprise manager must be involved in introductory sessions (what is called Kick off Meeting) in order to become familiar with the strategies alignment process and have a clear insight about the information required to participate in the strategies' alignment collaborative process.

3.2. SA-DMM Application Context

The type of relationship and the type of decision-making is crucial to identify the application context in which the SA-DMM can be used. With regards to the type of decision-making, enterprises decide which strategies to activate in order to be aligned, from a centralized or decentralized perspective, at the network level [3,17–21]:

- Centralized decision-making: all the enterprises run the same model, that is, only one SA-DMM. The implementation of the SA-DMM provides a single solution for all the network partners. The enterprises also have to decide if the centralized decision-making is (i) intervened by an external actor or (ii) non-intervened, so that there is no external actor that supervises the strategies alignment process. Moreover, in centralized models the enterprises jointly collaborate and apply the SA-DMM.
- Decentralized: the SA-DMM is executed by each of the enterprises of the network. The same model (SA-DMM) is reproduced in all the enterprises: SA-DMM¹ is computed in Enterprise 1, ... , SA-DMMⁱ is computed in Enterprise i, ... , SA-DMM^j is computed in Enterprise j.

Concerning the type of relationship, the network partners can establish non-collaborative or collaborative [3] relationships, when dealing with the strategies' alignment process [22]:

- Non-collaborative: the enterprises do not establish collaborative relationships. There is no-exchange of information. The enterprises operate from an isolated perspective; therefore, the decision-making of the strategies to activate is individually made.
- Collaborative: the enterprises establish collaborative relationships and exchange parts, or all the information of the objectives defined, and/or the strategies formulated. The enterprises operate from a common perspective and the decision of which strategies to activate is made by considering the information of all the network partners. Different levels of collaboration are considered, which depend on the degree of information exchanged, which can be minimum, partial or complete. Different works supporting the development of collaborative processes can be identified in the literature (see [12,13,17]).

In this regard, the enterprises have to decide the context in which the SA-DMM will be applied in order to collaboratively deal with the strategies' alignment process. The current paper supports the information management to deal with the centralized collaborative relationships.

3.3. Definition of Collaboration Levels

Focusing on the collaborative relationship, there are three levels defined for the collaboration in the establishment of the strategies' alignment process, which are characterized by the exchange of information [13].

- Level 1 of collaboration—Collaborative Scenario 1 (CS1)—is characterized by the minimum exchange of information. Only the information regarding the defined objectives is exchanged. The values of influence ($val_str_{is_kpi_{ixk}}$) are estimated by each enterprise considering its own information and the information exchanged about the KPIs, with the other CN enterprises. Enterprise i estimates the impact that its strategies would have in its objectives ($val_str_{is_kpi_{ixk}}$), and the objectives defined by enterprise j ($val_str_{is_kpi_{jxk}}$). In order to determine $val_str_{is_kpi_{jxk}}$, enterprise i needs a minimum exchange of information with enterprise j . This information at the lower level of exchange (level 1) is related with the KPIs or objectives. In the same way, enterprise j estimates the impact that its strategies would have in its objectives ($val_str_{js_kpi_{jxk}}$), and the objectives defined by enterprise i ($val_str_{js_kpi_{ixk}}$). In this case, the network manager (if required) could assess enterprise i on estimating $val_str_{is_kpi_{ixk}}$ and $val_str_{is_kpi_{jx}}$, and enterprise j on estimating $val_str_{js_kpi_{jxk}}$ and $val_str_{js_kpi_{ixk}}$.
- Level 2 of collaboration—Collaborative Scenario 2 (CS2)—is characterized by the medium exchange of information. The information exchanged is limited to:
 - The objectives defined, and therefore the KPIs defined to measure them. This information includes kpi_{ik} , $Threshold_kpi_{ik}$, w_{ik} , Δkpi_{ik_min} , and Δkpi_{ik}^{max} .
 - The data characterize the strategies, including $d1_str_{is}$, c_str_{is} , b_i , $d2_str_{is}$, and $d4_str_{is}$. The strategy definition remains confidential, but the identifier code used to identify the strategies is exchanged. The definition of the strategies itself is not an information to exchange at this level of collaboration.

Each CN enterprise estimates the values of influence that its own strategies have on its own KPIs (enterprise i estimates $val_str_{is_kpi_{ixk}}$ and enterprise j estimates $val_str_{js_kpi_{jxk}}$). Both companies separately estimate the cross-impact of the strategies and KPIs. Enterprise i estimates $val_str_{is_kpi_{jxk}}$ and enterprise j estimates $val_str_{js_kpi_{ixk}}$. At level 2 of collaboration, the network manager (if required) can assess the enterprises on estimating the values of influence. All the values as regards the values of influence estimated by each enterprise are exchanged, besides the parameters defining the KPIs and the strategies are also exchanged.

- Level 3 of collaboration—Collaborative Scenario 3 (CS3)—is characterized by the maximum exchange of information and the joint estimation of all the values of influence ($val_str_{is_kpi_{ixk}}$,

val_stris_kpijxk and val_strjs_kpijxk, val_strjs_kpiiixk). The information exchanged at level 3 includes:

- Performance indicators data, concerning the Δkpi_{ik}^{max} , Threshold_kpi_{ik}, Δkpi_{ik_min} , w_{ik} , and kpi_{ik} .
- Strategies data include $u_{str_{is}}$, $d_{1_str_{is}}$, $c_{str_{is}}$, b_i , $d_{2_str_{is}}$, and $d_{4_str_{is}}$.

The definition of each strategy is information to exchange at this collaboration level.

CN companies jointly estimate the cross-impact of the strategies and KPIs. Enterprise i and enterprise j agree the values of influences of val_stris_kpijxk and val_strjs_kpiiixk. In this case, the network manager (if required) can assess the enterprises on estimating the values of influence.

In the three levels of collaboration defined, the SA-DMM is applied from a collaborative perspective. All the partners of the network are considered in the decision of the strategies to activate so as to be aligned. In this case the SA-DMM is implemented from a common perspective and the enterprises do not only consider their own information, as regards the strategies and KPIs, but also take into account the information of other enterprises of the CN.

In order to have a deeper insight on the different collaboration levels we refer readers to Andres and Blanes [13].

3.4. SA-DMM Information Management: Estimation of Values of Influence val_stris_kpi_{ik}

When a formulated strategy is activated, the objectives defined receive positive or negative influences, increasing or decreasing the values associated to the KPIs. This section provides support to the enterprises in the estimation of the values that define the influences received in the KPIs when one unit of strategy ($u_{str_{is}}$) is activated. In light of this, the SA-DMM proposes the parameter val_stris_kpi_{ik} to determine the influence that the activation of a specific strategy has on a defined KPI. The values related with the parameter val_stris_kpi_{ik} are estimated differently, depending on the collaboration level adopted.

3.4.1. Estimation of Values of Influence in Collaborative Scenario 1 (EVI_CS1)

In this scenario the exchange of information is limited to the performance indicators defined, kpi_{ik} (step 1 in Figure 3). The enterprises only consider the information about the KPIs exchanged in order to estimate the influence that one unit of strategy ($u_{str_{is}}$) has in the KPIs defined by each enterprise. At this level of collaboration, the role of the network manager is crucial because it is the only agent that knows all the information as regards the strategies formulated, ($u_{str_{is}}$) and the KPIs defined (kpi_{ik}) in each of the network enterprises. The limited exchange of information that characterizes this scenario makes the enterprises individually estimate the inter-enterprise influences (val_stris_kpi_{ik} and val_strjs_kpi_{jk}) and intra-enterprise influences (val_stris_kpi_{jk} and val_strjs_kpi_{ik}) by only exchanging information regarding the definition of the KPIs (kpi_{ik}). In order to estimate the values of influence at the inter-enterprise level, the enterprises only have the information of the parameters kpi_{ik} , the questions to ask are proposed next (Figure 3):

- Estimation of values of influence at the intra-enterprise level:
 - Enterprise i: How does the activation of the strategy str_{is} , defined in enterprise i, affect the performance levels of the kpi_{ik} defined in the same enterprise i? → val_stris_kpi_{ik}, used to compute the parameter Δkpi_{ik}^{intra} (increase of the kpi_{ik} when the $u_{str_{is}}$ of the same enterprise i is activated)
 - Enterprise j: How does the activation of the strategy str_{js} , defined in enterprise j, affect the performance levels of the kpi_{jk} defined in the same enterprise j? → val_strjs_kpi_{jk}, used to compute the parameter Δkpi_{jk}^{intra} (increase of the kpi_{jk} when the $u_{str_{js}}$ of the same enterprise j is activated)

- Estimation of values of influence at the inter-enterprise level:
 - Enterprise i only knows the definition of the KPIs formulated in enterprise j (kpi_{jk}): How does the activation of the strategy str_{is} , formulated in enterprise i, affect the performance level of kpi_{jk} defined in enterprise j? $\rightarrow val_str_{is_kpi_{jk}}$, used to compute the parameter Δkpi_{jk}^{inter} (increase of the kpi_{jk} when the u_str_{is} of a different enterprise i is activated)
 - Enterprise j only knows the definition of the KPIs formulated in enterprise i (kpi_{ik}): How does the activation of the strategy str_{js} , formulated in enterprise j, affect the performance level of kpi_{ik} defined in enterprise i? $\rightarrow val_str_{js_kpi_{ik}}$, used to compute the parameter Δkpi_{ik}^{inter} (increase of the kpi_{ik} when the u_str_{js} of a different enterprise j is activated).

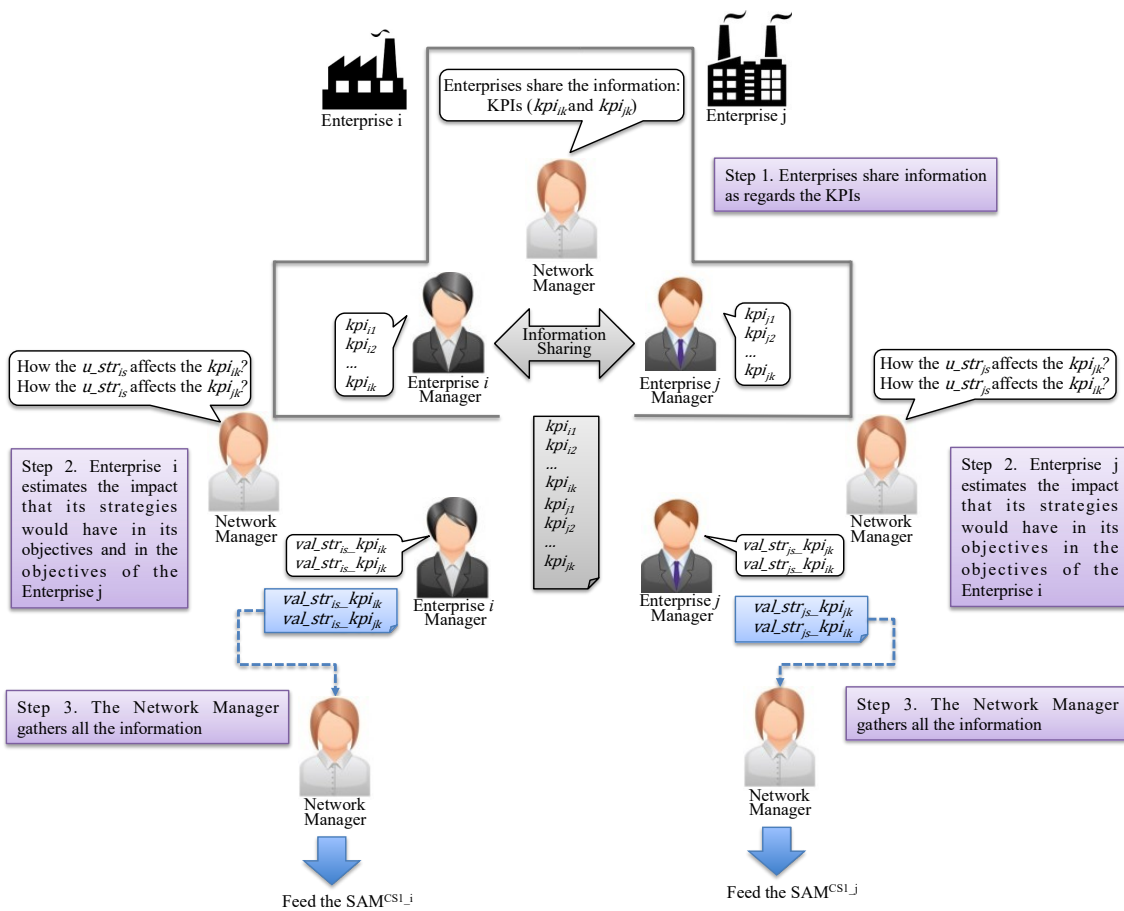


Figure 3. Estimation of the values of influences at the level 1 of collaboration: EVI_CS1.

According to the information that each enterprise manager estimates as regards the values $val_str_{is_kpi_{ik}}$ and $val_str_{js_kpi_{jk}}$, the network manager gathers all the values estimated. The network manager knows all the strategies formulated and the KPIs defined in all the enterprises of the network; therefore, it can help with the estimation of the values of influence, especially in those defined at the inter-enterprise level. Then, the network manager gathers all the information regarding inter- and intra-enterprise values of influence, required to feed the SA-DMM^{CS1} (step 3 in Figure 3).

3.4.2. Estimation of Values of Influence in Collaborative Scenario 2 (EVI_CS2)

This level of collaboration involves the exchange of information about the KPIs defined and the parameters related to the KPIs and the strategies (step 1 in Figure 4). In Level 2 of Collaboration, when estimating $val_str_{is_kpi_{ik}}$, only one enterprise is involved. Enterprise i estimates the influence that the

activation of its own strategies has on its own performance indicators (intra-enterprise influences). The values that refer to the parameters $val_str_{is_kpi_{jk}}$ and $val_str_{js_kpi_{ik}}$ (crossed-influences) are also individually estimated by the enterprises involved in the strategies' alignment process considering the information of the KPIs exchanged. The values estimated for the inter-enterprise influences are exchanged between the network enterprises, enterprises i and j . The set of general questions that can be asked in each enterprise to collect the values of influence are proposed next (Figure 4):

- Estimation of values of influence at the intra-enterprise level (step 2 in Figure 4). Moreover, it can be stated that the network manager can support network enterprises on the decision of estimating the parameters $val_str_{is_kpi_{ik}}$ and $val_str_{js_kpi_{jk}}$
 - Enterprise i : How does the activation of one unit of strategy u_str_{is} , defined in enterprise i , affect the performance levels of the kpi_{ik} defined in the same enterprise i ? → $val_str_{is_kpi_{ik}}$, used to compute the parameter Δkpi_{ik}^{intra} (increase of the kpi_{ik} when the u_str_{is} of the same enterprise i is activated)
 - Enterprise j : How does the activation of one unit of strategy u_str_{js} , defined in enterprise j , affect the performance levels of the kpi_{jk} defined in the same enterprise j ? → $val_str_{js_kpi_{jk}}$, used to compute the parameter Δkpi_{jk}^{intra} (increase of the kpi_{jk} when the u_str_{js} of the same enterprise j is activated)
- Estimation of values of influence at the inter-enterprise level:
 - Enterprise i : knows the KPIs formulated in enterprise j (kpi_{jk}): How does the activation of one unit of strategy u_str_{is} , formulated in enterprise i , affect the performance level of kpi_{jk} defined in enterprise j ? → $val_str_{is_kpi_{jk}}$, used to compute the parameter Δkpi_{jk}^{inter} (increase of the kpi_{jk} when the u_str_{is} of a different enterprise i is activated)
 - Enterprise j : knows the KPIs formulated in enterprise i (kpi_{ik}): How does the activation of one unit of strategy u_str_{js} , formulated in enterprise j , affect the performance level of kpi_{ik} defined in enterprise i ? → $val_str_{js_kpi_{ik}}$, used to compute the parameter Δkpi_{ik}^{inter} (increase of the kpi_{ik} when the u_str_{js} of a different enterprise j is activated).

At the inter-enterprise level, the involved enterprise managers (i and j), having the support of the network manager, separately estimate the values of influence related to the parameters $val_str_{is_kpi_{jk}}$ and $val_str_{js_kpi_{ik}}$. In addition, each enterprise individually estimates the values of influence at the intra-enterprise level ($val_str_{is_kpi_{ik}}$ and $val_str_{js_kpi_{jk}}$). The enterprises exchange the estimated values of influence in order to individually carry out the SA-DMM^{CS2} (step 3 in Figure 4). The network manager gathers all the information regarding the inter- and intra-enterprise values of influence, required to feed the SA-DMM, and provides these values to each of the participating enterprises, so that each enterprise has enough information to separately implement the SA-DMM^{CS2}. In enterprise i the SA-DMM^{CS2-i} is implemented and in enterprise j the SA-DMM^{CS2-j} is implemented considering the values of the parameters exchanged (step 4 in Figure 4).

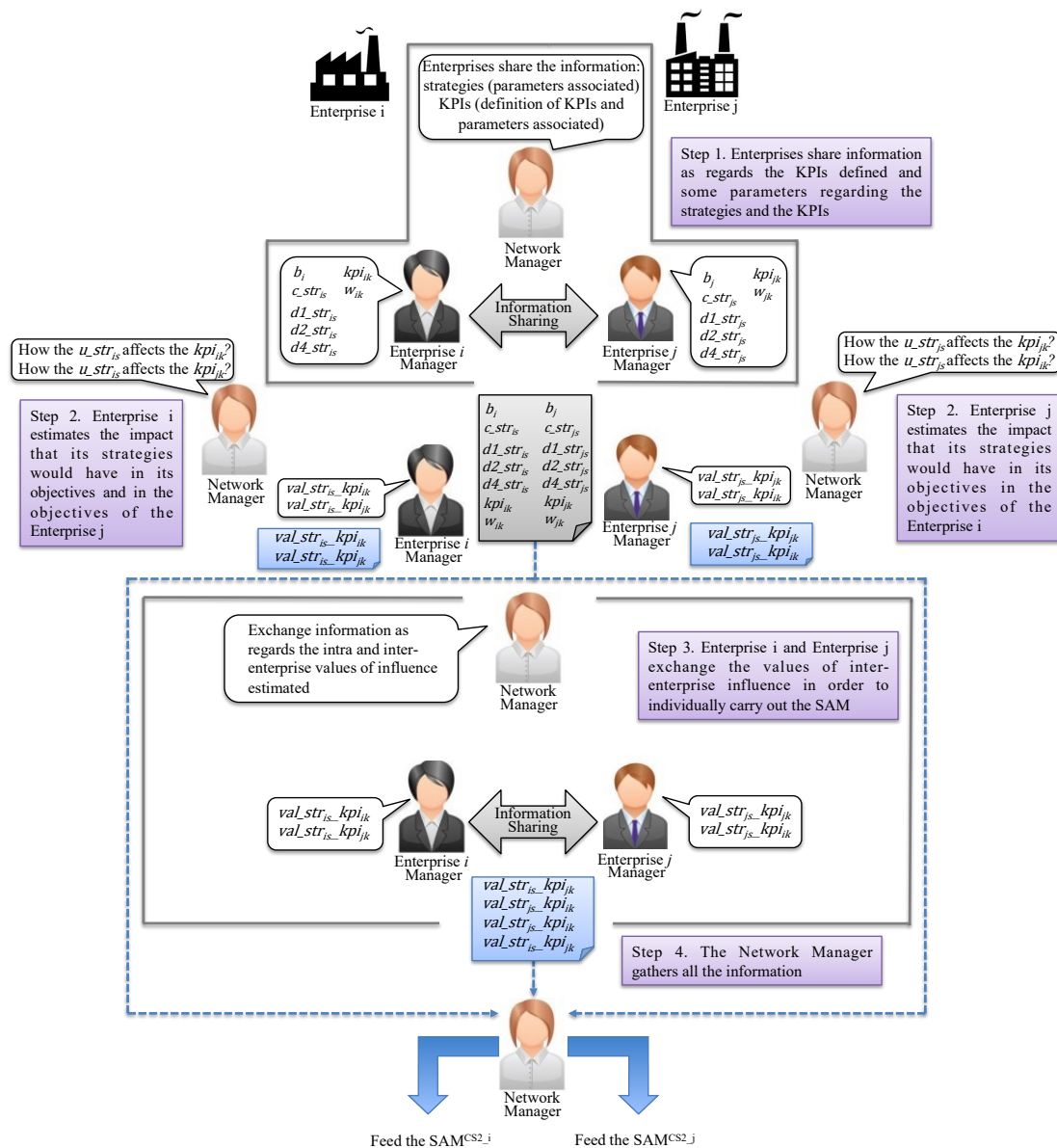


Figure 4. Estimation of the values of influences at the level 2 of collaboration: EVI_CS2.

3.4.3. Estimation of Values of Influence in Collaborative Scenario 3 (EVI_CS3)

This level of collaboration involves a high degree of information exchange about the (i) definition of KPIs and the parameters associated; (ii) definition of the units of strategies, and the parameters associated, such as the costs of the strategies; and (iii) the budget (step 1 in Figure 5). All the enterprises of the network (i and j) are involved in joint estimation of all the values of influence ($val_{str_{is_kpi_{ik}}$, $val_{str_{is_kpi_{jk}}$ and $val_{str_{js_kpi_{jk}}$, $val_{str_{js_kpi_{ik}}$) (step 2 in Figure 5). The set of general questions that can be asked in each enterprise are proposed next (Figure 5):

- Estimation of values of influence at the intra-enterprise level: the enterprises are asked about the intra-enterprise influences of its own strategies and KPIs, but are also asked about the intra-enterprise influences of the strategies and KPIs defined in another network enterprise. Therefore, enterprise i gives an estimation of $val_{str_{is_kpi_{ik}}$ and considering the strategies and KPIs of enterprise j, enterprise i also proposes an estimation of $val_{str_{js_kpi_{jk}}$. Enterprise j proceeds in the same way:
 - Enterprise i:

- How does the activation of one unit of strategy $u_{str_{is}}$, defined in enterprise i , affect the performance levels of the kpi_{ik} defined in the same enterprise i ? $\rightarrow val_{str_{is_kpi_{ik}}}$, used to compute the parameter Δkpi_{ik}^{intra} (increase of the kpi_{ik} when the $u_{str_{is}}$ of the same enterprise i is activated)
 - Knows the strategies and KPIs formulated in enterprise j : How does the activation of one unit of strategy $u_{str_{js}}$, defined in enterprise j , affect the performance levels of the kpi_{jk} defined in the same enterprise j ? $\rightarrow val_{str_{js_kpi_{jk}}}$, used to compute the parameter Δkpi_{jk}^{intra} (increase of the kpi_{jk} when the $u_{str_{js}}$ of the same enterprise j is activated)
- Enterprise j :
- How does the activation of one unit of strategy $u_{str_{js}}$, defined in enterprise j , affect the performance levels of the kpi_{jk} defined in the same enterprise j ? $\rightarrow val_{str_{js_kpi_{jk}}}$, used to compute the parameter Δkpi_{jk}^{intra} (increase of the kpi_{jk} when the $u_{str_{js}}$ of the same enterprise j is activated)
 - Knows the strategies and KPIs formulated in enterprise i : How does the activation of one unit of strategy $u_{str_{is}}$, defined in enterprise i , affect the performance levels of the kpi_{ik} defined in the same enterprise i ? $\rightarrow val_{str_{is_kpi_{ik}}}$, used to compute the parameter Δkpi_{ik}^{intra} (increase of the kpi_{ik} when the $u_{str_{is}}$ of the same enterprise i is activated)

The network manager can support network enterprises on the decision of estimating values at the intra-enterprise, $val_{str_{is_kpi_{ik}}}$, and $val_{str_{js_kpi_{jk}}}$. A process of negotiation will be initiated in order to agree on the values given for the parameters $val_{str_{is_kpi_{ik}}}$ and $val_{str_{js_kpi_{jk}}}$. This negotiation process is defined in Andres and Blanes [13].

- Estimation of values of influence at the inter-enterprise level: enterprise i estimates how the strategies formulated by other enterprises influence in its own KPIs. In addition, enterprise i also estimates how its formulated strategies influence the KPIs of other enterprises. Enterprise j proceeds in the same way:
 - Enterprise i
 - knows the strategies formulated in enterprise j : How does the activation of one unit of strategy $u_{str_{js}}$, formulated in enterprise j , affect the performance levels of the kpi_{ik} defined in enterprise i ? $\rightarrow val_{str_{js_kpi_{ik}}}$, used to compute the parameter Δkpi_{ik}^{inter} (increase of the kpi_{ik} when the $u_{str_{js}}$ of a different enterprise j is activated)
 - knows the KPIs formulated in enterprise j (kpi_{jk}): How does the activation of one unit of strategy $u_{str_{is}}$, formulated in enterprise i , affect the performance level of kpi_{jk} defined in enterprise j ? $\rightarrow val_{str_{is_kpi_{jk}}}$, used to compute the parameter Δkpi_{jk}^{inter} (increase of the kpi_{jk} when the $u_{str_{is}}$ of a different enterprise i is activated)
 - Enterprise j
 - knows the strategies defined in enterprise i : How does the activation of one unit of strategy $u_{str_{is}}$, formulated in enterprise i , affect the performance levels of the kpi_{jk} defined in enterprise j ? $\rightarrow val_{str_{is_kpi_{jk}}}$, used to compute the parameter Δkpi_{jk}^{inter} (increase of the kpi_{jk} when the $u_{str_{is}}$ of a different enterprise i is activated)
 - knows the KPIs formulated in enterprise i (kpi_{ik}): How does the activation of one unit of strategy $u_{str_{js}}$, formulated in enterprise j , affect the performance level of kpi_{ik} defined in enterprise i ? $\rightarrow val_{str_{js_kpi_{ik}}}$, used to compute the parameter Δkpi_{ik}^{inter} (increase of the kpi_{ik} when the $u_{str_{js}}$ of a different enterprise j is activated)

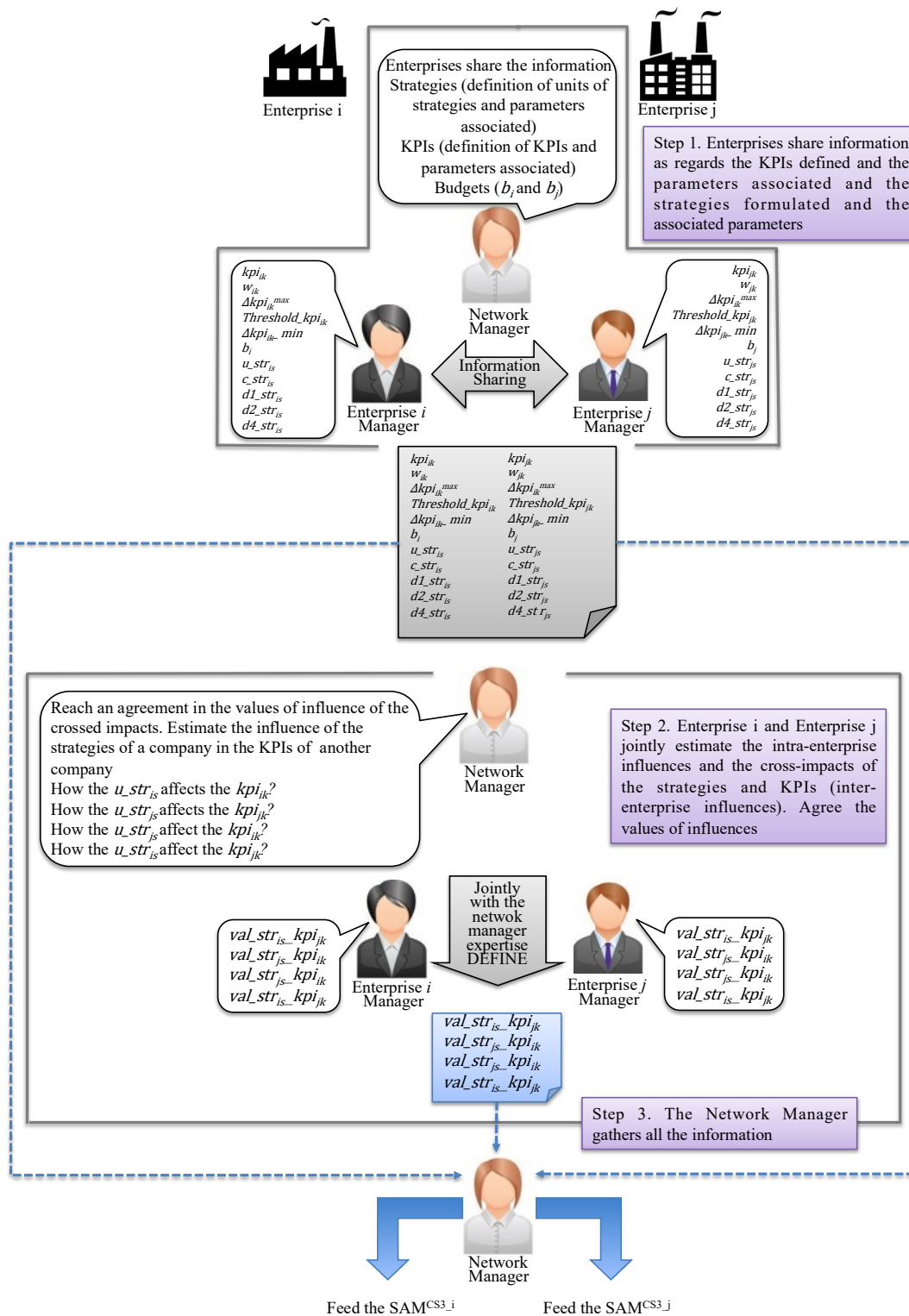


Figure 5. Estimation of $val_str_{is_kpi_{ik}}$ in level 3 of collaboration: EVI_CS3.

At both levels of intra- and inter-enterprise, the involved enterprise managers (i and j), having the support of the network manager, jointly agree and define all the values of influence related to the parameters $val_str_{is_kpi_{ik}}$, $val_str_{js_kpi_{jk}}$, $val_str_{is_kpi_{jk}}$, and $val_str_{js_kpi_{ik}}$. The network manager gathers all the information regarding the inter- and intra-enterprise values of influence, required to feed the SA-DMM and provides these values to each of the participating enterprises, so that each enterprise has enough information to separately implement the SA-DMM^{CS3}. In enterprise i the SA-DMM^{CS3}_i

is implemented and in enterprise i the SA-DMM^{CS3-j} is implemented considering the values of the parameters exchanged (step 3 in Figure 5).

Regardless of the level of collaboration considered, the main drawback appears when the enterprises participating in the strategies' alignment process do not have enough or appropriate information or knowledge as regards the influence that one particular unit of strategy ($u_{str_{is}}$) has on another particular KPI (kpi_{ik}). Therefore, the enterprises have to face the challenge of properly estimating the requested data ($val_{str_{is_kpi_{ik}}}$) to feed the model with the main aim of obtaining accurate solutions.

In this case, the enterprise manager has an important role to accurately estimate the values of the parameter $val_{str_{is_kpi_{ik}}}$. Moreover, the network manager, as an expert in CNs, and being familiar with all the strategies (str_{is}) and KPIs (kpi_{ik}) can also help in the final decision of estimating the best value that defines the parameter $val_{str_{is_kpi_{ik}}}$.

3.5. Information Gathering

In order to gather all the information retrieved a template has been designed (Figure 6). This template will be distributed among the enterprises participating in the strategies alignment process in order to gather all the information required to feed the SA-DMM. When the enterprises define the values for the parameters characterizing the strategies, KPIs, and budget, these data do not necessarily have to be real. Nevertheless, the data must be related to each other. For example, if $c_{str_{is}} = 1$ and the $c_{str_{rs}} = 3$, this means that the real cost of str_{rs} is three times higher than the real cost of str_{is} . The budget will also be defined according to the proportion of values considered by the enterprises. The enterprises have to proceed in the same way, defining proportional values, to define all the information gathered in the proposed template. In the information management template, the information gathered includes:

- Strategy ID
- Strategy definition ($u_{str_{is}}$)
- Strategy cost (m.u) ($c_{str_{is}}$)
- Strategy delay (t.u) ($d1_{str_{is}}$)
- Time that the strategy takes to generate the maximum increase in the KPI (t.u) ($d2_{str_{is}}$)
- Total strategy length (t.u) ($d4_{str_{is}}$)
- KPI ID
- KPI definition (kpi_{ik})
- KPI weight (w_{ik})
- KPI threshold value (Threshold_ kpi_{ik})
- KPI_min (kpi_{ik_min})
- KPI_max (kpi_{ik_max})

						KPIs defined in Enterprise i			KPIs defined in Enterprise j							
KPI ID	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{j1}	kpi _{j2}	...	kpi _{ja}	Definition of kpi _{i1}	Definition of kpi _{i2}	...	Definition of kpi _{ia}	Definition of kpi _{j1}	Definition of kpi _{j2}	...	Definition of kpi _{ja}
KPI Definition	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{j1}	kpi _{j2}	...	kpi _{ja}
kpi_max	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{j1}	kpi _{j2}	...	kpi _{ja}
KPI weight	w _a	w _a	...	w _a	w _a	w _a	...	w _a	w _a	w _a	...	w _a	w _a	w _a	...	w _a
Threshold value	Threshold_kpi _{i1}	Threshold_kpi _{i2}	...	Threshold_kpi _{ia}	Threshold_kpi _{i1}	Threshold_kpi _{i2}	...	Threshold_kpi _{ia}	Threshold_kpi _{i1}	Threshold_kpi _{i2}	...	Threshold_kpi _{ia}	Threshold_kpi _{j1}	Threshold_kpi _{j2}	...	Threshold_kpi _{ja}
kpi_min	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{i1}	kpi _{i2}	...	kpi _{ia}	kpi _{j1}	kpi _{j2}	...	kpi _{ja}
Strategy ID	u_str ₁	Definition of u_str ₁	c_str ₁	d ₁ _str ₁	d ₂ _str ₁	d ₄ _str ₁	val_str ₁ _kpi _{i1}	val_str ₁ _kpi _{i2}	...	val_str ₁ _kpi _{ia}	val_str ₁ _kpi _{j1}	val_str ₁ _kpi _{j2}	...	val_str ₁ _kpi _{ja}		
Strategies defined in the Enterprise i (bi)	u_str ₂	Definition of u_str ₂	c_str ₂	d ₁ _str ₂	d ₂ _str ₂	d ₄ _str ₂	val_str ₂ _kpi _{i1}	val_str ₂ _kpi _{i2}	...	val_str ₂ _kpi _{ia}	val_str ₂ _kpi _{j1}	val_str ₂ _kpi _{j2}	...	val_str ₂ _kpi _{ja}		
...		
u_str _n	Definition of u_str _n	c_str _n	d ₁ _str _n	d ₂ _str _n	d ₄ _str _n	val_str _n _kpi _{i1}	val_str _n _kpi _{i2}	...	val_str _n _kpi _{ia}	val_str _n _kpi _{j1}	val_str _n _kpi _{j2}	...	val_str _n _kpi _{ja}			
Strategies defined in the Enterprise j (bj)	u_str ₁	Definition of u_str ₁	c_str ₁	d ₁ _str ₁	d ₂ _str ₁	d ₄ _str ₁	val_str ₁ _kpi _{i1}	val_str ₁ _kpi _{i2}	...	val_str ₁ _kpi _{ia}	val_str ₁ _kpi _{j1}	val_str ₁ _kpi _{j2}	...	val_str ₁ _kpi _{ja}		
u_str ₂	Definition of u_str ₂	c_str ₂	d ₁ _str ₂	d ₂ _str ₂	d ₄ _str ₂	val_str ₂ _kpi _{i1}	val_str ₂ _kpi _{i2}	...	val_str ₂ _kpi _{ia}	val_str ₂ _kpi _{j1}	val_str ₂ _kpi _{j2}	...	val_str ₂ _kpi _{ja}			
...			
u_str _n	Definition of u_str _n	c_str _n	d ₁ _str _n	d ₂ _str _n	d ₄ _str _n	val_str _n _kpi _{i1}	val_str _n _kpi _{i2}	...	val_str _n _kpi _{ia}	val_str _n _kpi _{j1}	val_str _n _kpi _{j2}	...	val_str _n _kpi _{ja}			

Figure 6. Information management template to gather information for feeding the SA-DMM.

The data recorded in the information management template will represent the curve that models the influence of str_{is} on the kpi_{ixk} (Figure 7).

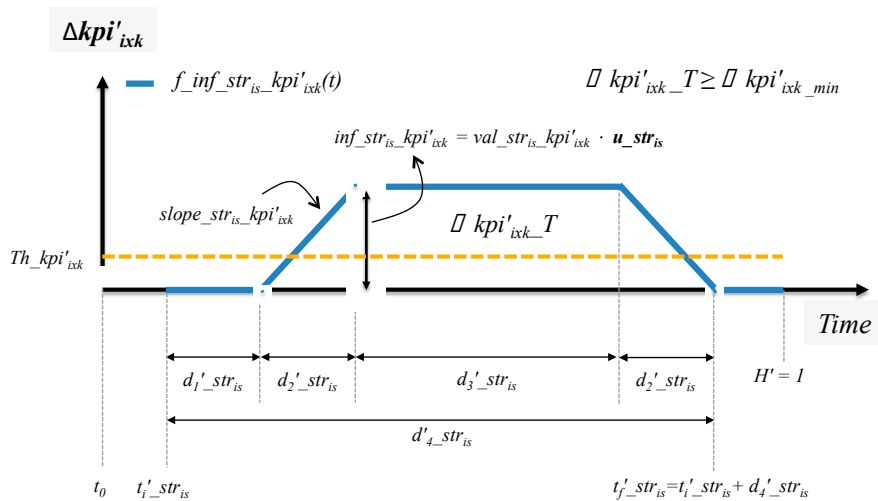


Figure 7. Curve that models the influence of str_{is} on the kpi_{ixk}: f_{inf_str_{is}_kpi_{ixk}}(t).

4. Discussion

Some of the limitations that could appear when estimating val_{str_{is}_kpi_{ik}} are briefly described next. If the strategy u_{str_{is}} has been previously activated, the enterprise manager will have no difficulty in estimating the value associated to the parameter val_{str_{is}_kpi_{ik}}. In this scenario it is more than likely that the enterprise has stored the data as regards the KPI levels (Δkpi_{ik}) in the same moment in which a certain strategy (u_{str_{is}}) was activated. Then, the enterprise only has to retrieve the data and estimate the value of influence val_{str_{is}_kpi_{ik}}. When estimating val_{str_{is}_kpi_{ik}}, this value only considers that one strategy u_{str_{is}} influences one kpi_{ik}. At this point, it is worth to mention that, in real networks, managing this information (val_{str_{is}_kpi_{ik}}) is not as simple as retrieving the data stored of the KPI levels Δkpi_{ik} at previous periods. The values of the KPI levels (Δkpi_{ik}) stored could be influenced not only by one strategy (the strategy for which the influence is studied, u_{str_{is}}) but also by other strategies activated at the same time: in the same enterprise (u_{str_{is}} + u_{str_{ir}}) or in other enterprises of the network (i.e., u_{str_{js}}). Therefore, the increase of the KPI levels (Δkpi_{ik}) could be

influenced by the activation of various strategies (i.e., $u_{str_{is}} + u_{str_{ir}} + u_{str_{js}}$) and not as the result of the activation of a specific strategy. In order to overcome this limitation, the increase of the KPI level (Δkpi_{ik}) should be obtained as a marginal value. Accordingly, if an enterprise wants to estimate $val_{str_{is_kpi_{ik}}}$ when one unit of strategy $u_{str_{is}}$ is activated, the enterprise can consider that the Δkpi_{ik} is the result of computing the sum of the values of influence of all the strategies activated at the same moment ($\sum_s val_{str_{is_kpi_{ik}}} + \sum_s val_{str_{js_kpi_{ik}}}$), which affect the level of the kpi_{ik} . Considering marginal values for the parameter Δkpi_{ik} permits this aggregation.

Real scenarios are even more complex, and situations can arise where the strategy $u_{str_{is}}$ has not been previously activated. In light of this are two main options proposed to define $val_{str_{is_kpi_{ik}}}$: (i) estimate the value considering the experience acquired and the tacit and explicit knowledge or (ii) wait until the strategy str_{is} (str_{js} for other enterprises of the network) is activated, and measure the increase or decrease of the KPIs per one unit of strategy activated ($u_{str_{is}}$). So far, it has been considered that the kpi_{ik} is influenced by only one strategy. Nevertheless, it could happen that one kpi_{ik} is influenced by two or more strategies. In order to estimate the influences of two or more strategies that have not been previously activated, but that are supposed to be activated at the same time (i.e., str_{i1} and str_{i2}), the situation can be modeled considering that the two strategies merge in only one, creating a new strategy (i.e., str_{i3}). Therefore, the numerical value estimated that registers the increase or decrease of the kpi_{ik} when one unit of these two strategies are activated is represented by $val_{str_{i3_kpi_{ik}}}$. This way of modeling the influence of two strategies can be extended to a determined number of strategies.

Considering the above described, the process of managing information and estimating the values of influence is characterized by incomplete and uncertain information. Therefore, the task of estimating a numerical value to the parameter $val_{str_{is_kpi_{ik}}}$ has been associated with uncertainty, as well. This uncertainty must be overcome as much as possible in the SA-DMM. The SA-DMM has a mathematical structure requiring quantitative values. In order to deal with this uncertainty from a quantitative perspective, stochastic methods could be applied, treating the parameter $val_{str_{is_kpi_{ik}}}$ as random. In the literature, there are interesting works to take as a baseline to incorporate fuzzy stochastic methods in the information management approach and consequently in the implementation of the SA-DMM [23–25].

Nevertheless, when there is not enough numeric information available to determine the values of influence that the strategies have on the KPIs, qualitative approaches can be used, substituting the quantitative ones during the process of estimating the values of influence. The enterprises might prefer to give qualitative values, to model the influence of the strategies upon the KPIs, in order not to feel pressured into defining quantitative ones, which should seem to be more accurate. The qualitative values can be transformed into quantitative ones in order to feed the model, because the SA-DMM is mathematically raised and the parameter $val_{str_{is_kpi_{ik}}}$ is introduced as a real number. In order to support the process of estimating the value $val_{str_{is_kpi_{ik}}}$, from a qualitative perspective, a Likert scale on base 10 is proposed. For the definition of the values of influence, proportional values should be used. Working with proportions between KPIs to estimate the values of influence simplifies work for enterprises. In a Likert scale, if there is a lineal proportion between the extreme values and null values, the values of the first row are used. Exponential and logarithmic proportions have also been considered (Table 3). The CN enterprises will be asked if the proportion within the scale is linear logarithmic or exponential. For example, considering a lineal proportion, if $val_{str_{is_kpi_{ik}}} = 5$ and $val_{str_{ir_kpi_{ik}}} = 10$, the influence of str_{ir} is twice the influence of str_{is} upon kpi_{ik} . When using quantitative values for the parameter $val_{str_{is_kpi_{ik}}}$ the enterprises have to also estimate the maximum value that the kpi_{ik} can achieve when a particular strategy str_{is} is activated. This maximum value that the kpi_{ik} acquires allows estimating the parameter $val_{str_{is_kpi_{ik}}}$ in absolute values. The following questions have to be formulated to the CN enterprises:

Table 3. Likert scale for estimating the parameter $val_{str_{is_kpi_{ik}}}$.

	Extreme	Very high	High	High moderate	Moderate	Low moderate	Low	Very Low	Null	Very Low	Low	Low moderate	Moderate	High moderate	High	Very high	Extreme
Linear	-10	-8.75	-7.5	-6.25	-5	-3.75	-2.5	-1.25	0	1.25	2.5	3.75	5	6.25	7.5	8.75	10
Exponential	-10	-9.9	-9.8	-9.6	-9	-7.5	-5	-0.5	0	0.2	0.4	0.6	0.9	1.5	2.5	5	10
Logarithmic	-10	-5	-2.5	-1.5	-0.9	-0.6	-0.4	-0.2	0	0.5	5	7.5	9	9.6	9.8	9.9	10

What is the increase that the kpi_{ik} experiences when the strategy str_{is} is activated?
 What would be the maximum increase that kpi_{ik} gets to experience when the strategy str_{is} is activated?
 What is the proportion used, within the scale, to estimate the values of influence: linear, logarithmic or exponential?
 With the first question the value $val_{str_{is_kpi_{ik}}}$ is estimated but then this number must be considered in absolute value, therefore the second question is raised. Normally, the enterprises will use the lineal scale (see Figure 8).

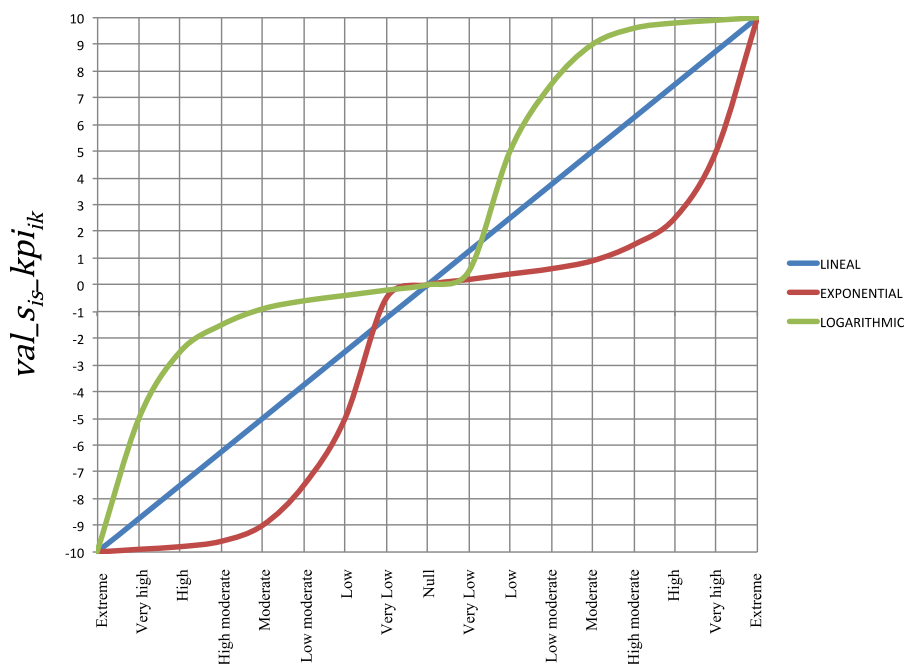


Figure 8. Graphical representation of Likert scale.

In order to estimate the values of influence the methodology proposed by Piedade and colleagues [26] can be used. These authors propose to follow the approach of performance prediction considering the use of predictive measurements to manage the results of inter-organizational processes and performance targets set by the CN. This paradigm of performance prediction allows managing performance proactively using feed forward and feedback control. Therefore, tools that consider performance estimation are used based on a data fusion approach, with a proper combination of leading and lagging measurements, which make it possible to use forecasting methods and tools to achieve good predictions. Predictive performance management represents the ability to control a system based not only on present and past measurements, but also taking into account future performance behaviors. Piedade and colleagues [26] proposed the performance predictive engine (PPE) tool. In the CN context,

the prospective performance measurement can be considered as one of the pioneers in the predictive performance management for CNs.

5. Conclusions

One of the key challenges in collaborative networks is the coordination of autonomous enterprises to achieve common goals. This paper focuses on the specific collaborative process of the strategies' alignment. The strategies alignment process enables to adequately coordinate the network objectives and appropriately identify those strategies that maximize positive impacts and minimize the negative ones, on the objectives defined by all the networked partners, so that the best solution leads to maximize the network performance.

The information management associated with the strategies' alignment process is a complex issue to deal with. Therefore, a rigorous mechanism capable of recognizing and solving the complexity of the information management in the strategies' alignment process is needed.

An information management approach to support the collaborative process of strategies alignment (SA-DMM) is proposed in this paper with the aim of dealing with such operation complexity, in which collaborative partners pursue different goals that are sometimes contradictory. The information management approach proposed to support the implementation of the SA-DMM within the CN enterprises, consists of (i) the proper selection and identification of the roles participating in the application of the SA-DMM; (ii) the selection of the SA-DMM application context; (iii) the definition of the collaboration levels, which are characterized by the level of information exchanged among the enterprises of the CN; (iv) the estimation of values of influence val_stris_kpiik ; and (v) the information gathering in a standardized template.

The current information management approach has been applied in two CNs belonging to the food distribution and automotive sectors. The CN enterprises have determined that the information management approach eases the process of data gathering. Moreover, all the decision makers considered that the estimation of the values of influence was relatively affordable with the help of an expert.

Some limitations have been described in the discussion section. Such limitations have enabled to identify some future research lines, including the application of fuzzy methods to support the estimation of the values of influence, and the consideration of qualitative approaches to support the strategies alignment process. Finally, the authors recognize the application of Industry 4.0 tools, which deal with the process of gathering and analyzing the data required to feed the SA-DMM. Such tools include big data analysis, Internet of Things, machine learning, and artificial intelligence. According to Savastano and colleagues [27] the consideration of Industry 4.0 will enable enterprises, participating in the strategies alignment collaborative process, to evolve and improve in terms of information exchange by using Internet of Things (IoT), cloud and mobile computing, artificial intelligence (AI), data tools, and analytics, involving activities, competences, and stakeholders at all levels.

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