Inter Enterprise Framework for Hierarchical Decisions

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Abstract Due to the condition of the current global environment, organizations have to compete not only with single companies, but also with Supply Chains (SC) or Collaborative Networks (CN). In this sense, companies that make up this kind of organizations have to integrate their processes and must collaborate with each other in order to be competitive. To achieve this goal, companies have to deal with collaborative decision-making processes, which in this context are more complex than in a single organization. Some of these collaborative networks have a hierarchical structure, which means that each level in the structure has a different role in the decision-making process. Enterprise Engineering through Enterprise Architecture (EA) can be used by enterprises to facilitate the integration of all elements and to analyse the complex hierarchical decision processes. Therefore, in order to understand the decision-making process in a hierarchical inter enterprise context using Enterprise Architecture concepts, this paper proposes a framework for inter-enterprise architecture for supporting Hierarchical Decision.

Keywords: Inter-Enterprise Architecture, Collaborative Networks, Extended Enterprise, Hierarchical Decision, Decision Support Systems

1 Introduction

In the current changing business environment, enterprises join forces with their partners in Supply Chains (SC) in order to survive and be competitive. Collabora-

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tive Networks (CN) arise as an evolved form of the SC, which are defined as a net of autonomous organizations that are globally distributed and have a single strategic plan with individual goals, but they collaborate synergistically to achieve better common goals. This jointly generates value for each enterprise, and their interactions normally are supported by new technologies and computer networks (Camarinha-Matos and Afsarmanesh, 2008). An Extend Enterprise (EE) is a manifestation of a CN, where exists a dominant enterprise that increases its boundaries to its network of suppliers imposing stringent contractual conditions, in terms of quality, quantity, delivery times, capacity, technology tools, information systems and methods to be used (Camarinha-Matos et al., 2009). The main goals in these collaborative networks are to achieve efficient workflow, flexibility, effectiveness, agility and coordination between chain links. Thus, every chain link must be provided with sufficient information and appropriate technology and information systems to achieve these goals.

Enterprise Engineering and Enterprise Architecture (EA) can be used as tools that facilitate the design of these collaborative networks. This design might include business processes, systems information, organizational structure and technology infrastructure. In this way, the collaborative networks can be represented in a holistic perspective, in order to achieve joint business objectives and to facilitate its decision-making process. On the other hand, some collaborative networks has a hierarchical structure, as is the case of EE, this means that the decisions have to be made according to a specific hierarchical process. In order to facilitate it, the support of Information Systems (IS) is necessary, specifically regarding Decision Support Systems (DSS). This way, EA can facilitate and support the modelling of DSS in order to overcome the challenges imposed by these new business environments. Thus, we propose an Inter Enterprise Framework for Hierarchical Decisions that will be used as an analysis tool for modelling of a decisions support system in this context.

The paper is structured as follows: Section 2 introduces the field of Enterprise Architecture; Section 3 introduces the field of Decision Support Systems and Hierarchical Production Planning; Section 4 presents the Inter Enterprise Framework for Hierarchical Decisions (IEFHD); finally, Section 5 presents the main conclusions and future steps in this research.

2 Inter-Enterprise Architecture

Enterprise Architecture is a discipline that arises in the field of Enterprises Engineering. Enterprise Architecture provides a set of principles, methods, models and tools used for analysis, design and redesign of a company, thus allowing to represent and document the elements that form the company (such as organizational structure, business processes, systems information and technology infrastructure) and the relations, organization and joints between these elements, allowing the company to be represented in a holistic and integrated perspective, in order to achieve the business objectives and facilitate decision-making processes (Vargas et al., 2011). In recent years, several researchers have proposed enterprise architectures, among which stand out: CIMOSA (Kosanke, 1996), GIM-GRAI (Chen et al., 1997), PERA (Williams and Li, 1998); GERAM (IFIP, 1999), IE-GIP (Ortiz et al., 1999; Cuenca et al., 2011a; Cuenca et al., 2011b); ARDIN (Chalmeta and Grangel, 2003); ARIS (Scheer and Schneider, 2006) and TOGAF-ADM (THE OPEN GROUP, 2011).

The common elements that bind these enterprise architectures are: methodology, framework and language modelling (Vargas et al., 2011). These elements must be provided by enterprise architectures for successful implementation within the enterprise. The definition of a methodology facilitates the implementation of the architecture (Bernard, 2005); the framework allows a graphic and simple structure of the elements that make up the enterprise (Cuenca et al., 2011a) and how these elements are related; furthermore, modelling language allows for modelling, organization and understanding of the relationships between elements of the enterprise (Vargas et al., 2011).

Vargas et al. (2013) propose the concept of Inter-Enterprise Architecture (IEA) looking for applications of the tools and methodologies of EA, which have been developed for the individual enterprise, but adapting them in a collaborative environment between several enterprises that make up supply chains and networks. IEA facilities integrate collaboration processes among enterprises with their information systems and technology systems, supporting joint processes, reducing risks and redundancies and increasing customer service responsiveness. In the context of collaborative networks, it is important to develop an IEA that facilitates the decision-making in a hierarchical environment.

3 Hierarchical Decision

The hierarchical decision associated with the different levels of decision-making in a single organization is extended in hierarchical collaborative networks (HCN) where decisions are extended beyond the boundaries of the main enterprise. The complexity of the decisions and the number of variables to be treated can produce systems that are hardly affordable. In this sense, the analysis of hierarchical decision-making in the area of production has been amply addressed through the Hierarchical Production Planning (HPP) systems. In these systems, the decisions are split into sub-problems. Each sub-problem is referred to a decision-making level in the organizational structure and an optimization model is constructed for solving each sub-problem (Alemany, 2003).

Thus, in order to ensure an effective decision-making process in a HCN, a hierarchical set of decision models can be used, and each participating enterprise can be required to provide the adequate information and to define the aggregation/ disaggregation processes of information between levels.

The decisions that are made at a high level impose restrictions on lower level decisions. In response, the detailed decisions provide the necessary feedback to evaluate the quality of the decision (Boza et al., 2009). Each hierarchical level has its own characteristics, including length of the decision horizon, level of detail of the required information and forecast, scope of the decision, and type of manager in charge of executing the decision (Bitran and Hax, 1977; McKay et al., 1995; Zolghadri et al., 2002). Information Systems are key tools for these hierarchical decision systems, in which the decision system helps to reach the stated objectives in the organizations.

A Decision Support System (DSS) is a computer technology solution that can be used to support complex decision-making (Shim et al., 2002). DSS serves management operations and planning levels of an organization and help make decisions, which may be rapidly changing and not easily specified in advance. Therefore, it is really important for the DSS to be able to provide information in real time.

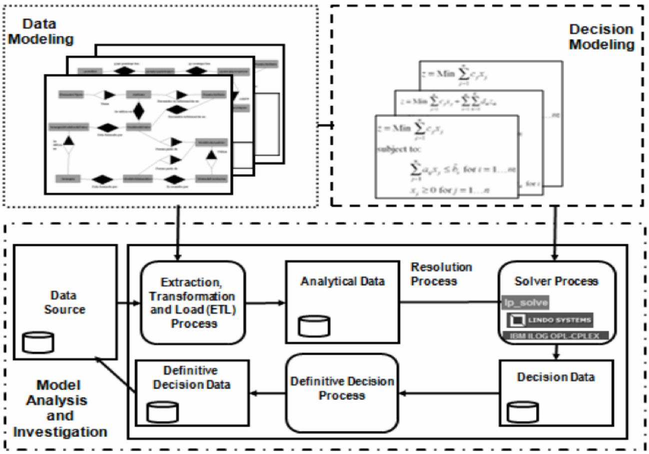

Fig. 1 Framework for a Decision Support System in a Hierarchical Extended Enterprise decision context (Boza et al., 2010)

Boza et al. (2009) propose a framework for a Decision Support System in a Hierarchical Extended Enterprise (FDSSHEE) decision context, see Fig. 1. In this sense, it is possible to use this framework in order to make a flexible DSS that can be used in a variety of settings where a hierarchical approach allows an improvement in the decision-making. Three main components have been identified: Data modelling, Decision Modelling and Model Analysis and Investigation. However, this framework could be extended considering elements from Enterprise Engineering and Enterprise Architecture.

4 Inter Enterprise Frameworks for Hierarchical Decision (IEFHD)

In seeking to propose a useful reference framework for Inter Enterprise Architecture for Hierarchical Decision, we propose the IEFHD, of which the structure and elements are shown in Fig. 2. Previous works on enterprise architecture frameworks referenced in Section 2 and the works of (Boza et al., 2009; Boza et al., 2010) in Hierarchical DSS have been taken into account in this proposal which includes the following perspectives: modelling views, life cycle phases and modelling detail level.

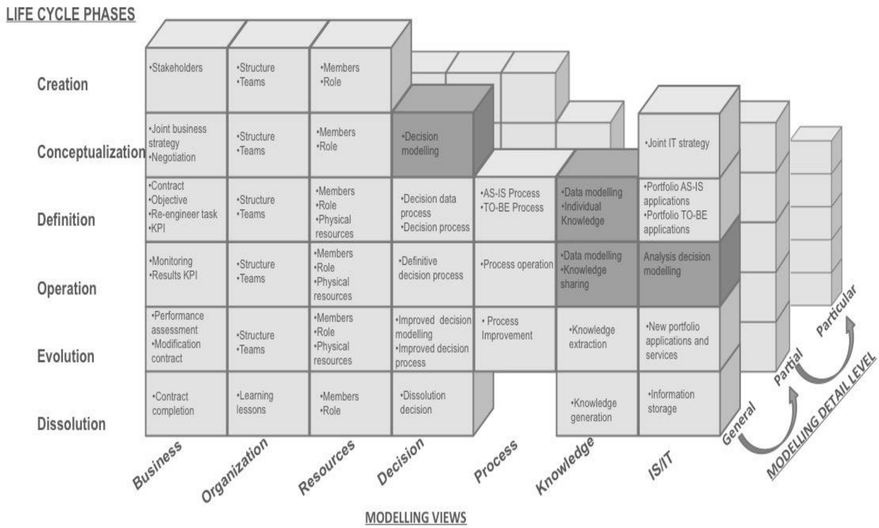

Fig. 2 Inter Enterprise Framework for Hierarchical Decisions

- Modelling views: Seven modelling views have been proposed, in order to assure a complete and integral modelling of the IEFHD. The classical function view (IFIP, 1999) has been split into two different views: business and process, in order to facilitate the modelling, due to the fact that the business view is focused on strategic issues and the process view is focused on tactical and operational aspects. The knowledge view is an evolution of information and data views. The main elements proposed in the FDSSHEE have been taken into account in the IEFHD in the views of Decision, Knowledge and IS/IT, and all of them are related to the process view. These elements have been highlighted in a different colour in the Fig. 2.

– Here is a brief description of each view:
Business: This view represents the strategic aspects that must be taken into account in the EE, including negotiation, contract, objectives, KPI, monitoring, and performance assessment. *Organization*: This view allows the representation and modification of the organizational and hierarchical structure and the teams involved into the HCN and its decision-making (IFIP, 1999). *Resources*: This view represents the capabilities and resources to complete business processes and the roles and responsibilities of individuals and organizational units within the HCN. This view includes physical and human resources (IFIP, 1999). *Decision*: This view refers to the decision-making system that has to be adopted for the business process managers. This view is indispensable to determine how the decisions are taken into the planning process (Chen et al., 1997). It is included in this view the element "Decision modelling" in the conceptualization phase, because this element has to be aligned with the joint business strategy and the organizational structure. *Process*: This view represents HCN processes, functionality, performance, inputs and outputs. This view includes a definition of the AS-IS Process and the TO-BE Process, as well as process operation and process improvement. *Knowledge*: Data is information for organizations. In the continuous learning process where organizations are involved, the information that they handle becomes knowledge. Thus, it is a differentiator asset to the HCN (Boza et al., 2010). It is included in this view the element "Data Modelling" in definition and operation phases, because the Data Modelling has to be designed in the definition phase and it has to work when the process starts. *Information Systems / Information Technology (IS/IT):* This view defines what kind of applications and technology are relevant to the EE and what these applications need to manage data and present information (Cuenca et al., 2011b). It is included in this view "Analysis Decision Modelling" in the operation phase, due the fact that in this phase the decision process is executed taking into account the "Data Modelling" which is linked with the Information Systems.

- Life Cycle Phases: The life cycle phases are a state of development in the life cycle of a HCN. IEFHD considers in its design the proposals of ARCON (Camarinha-Matos and Afsarmanesh, 2008) and GERAM (IFIP, 1999) in this aspect, due the fact that these two architectures are complementary with each other.

– A brief description of each phase for the HCN scope:
Creation: This phase represents the motivation of collaboration from stakeholders and its incubation. In this phase are defined the teams the teams evolved, structure and roles and responsibilities. *Conceptualization:* This

phase represents the strategic definition of the HCN and its implicit negotiation. *Definition:* This phase represents the definition of business process, contract, objectives, Re-engineer tasks, KPIs, individual knowledge, sensor ontology and sensor behaviour system. *Operation:* This phase is surely the most important; it occurs when the HCN operates directly towards achieving its goals. *Evolution:* During the operation of a HCN it may be necessary to make some changes to its membership, process, contract, structural relationships, and roles of its members. *Dissolution:* A HCN will typically dissolve after accomplishing its goal. However, this network could evolve into a new structure where the knowledge acquired could generate collective learning and trust in the collaborative process.

- Modelling detail level: This perspective has to do with the detail level of the modelling, the general modelling being the most neutral that it could be for any kind of HCN, partial modelling occurs when the model is developed for a specific cluster and the particular modelling is developed for a specific EE.

Each cell in the IEFHD represents the intersection of a particular life cycle phase with one modelling view. Not all views include all life cycle phases because the views of process, knowledge and IT do not require the definition of elements in the beginning of the life cycle due to the fact that their core is in the middle of the HCN life cycle.

5 Conclusions

In this paper, we have proposed the IEFHD seeking to use Inter Enterprise Architecture to facilitate the modelling hierarchical decisions in HCN. This framework allows to organizing in a structured way all the elements that represent a HCN through its whole life cycle. This proposal allows for having a big picture of a HCN that will facilitate understanding our current research about decision-making process in hierarchical environments.

For future papers, we are going to continue working in this line of research in order to propose a complete Reference Model for Inter Enterprise Architecture for HCN, defining the Meta-Model of relationship between elements of the IEFHD that allow validation of the correct gear of the framework, proposing a Inter Enterprise Architecture Methodology for hierarchical decisions (IEAMHD) and choosing the modelling language to use it. Also, it is important to validate different HCN in order to propose specific and particular architecture models.

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