A CONCEPTUAL MODEL FOR CONSTRUCTION SUPPLY CHAIN MANAGEMENT IMPLEMENTATION

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During the last two decades, both researchers and governmental studies revealed an increased interest about Construction Supply Chain Management (CSCM), but up to now practitioners are still facing difficulty to improve business performance through such approach. A call for ad-hoc solutions that foster the effective implementation of SCM practices has clearly risen up. This working paper is part of a wider research project which aims to provide academics and practitioners with a valuable support in this direction. We propose an integrated conceptual model to enhance the implementation of CSCM from a contingent view. The research to date includes an extensive and systematic literature review that assesses the main building elements related to SCM introduction. Such elements include: the antecedents, or prerequisites; the approaches, which involve the interrelation of strategies, structure and practices; the benefits related to an effective SCM adoption; and the contextual and environmental variables. Main implications for academics concern the analysis of extant CSCM literature from an innovative and integrated perspective, in order to highlight actual research gaps and future research agenda. At this research stage, other important goals include the advancement of useful and challenging research questions and hypothesis, with the aim to collect relevant feedback about the suitability of both the model and the research strategy.

Keywords: antecedents, conceptual model, contingent approach, supply chain management.

INTRODUCTION

SCM is a concept that originated in the manufacturing industry as "an integrative philosophy to manage the total flows of the entire business process" (Xue *et al.* 2007). During the last two decades, the debate increasingly involved also the project-oriented contexts such as the Construction sector. Despite the successful expectations surrounding SCM in construction, many organizations in the sector have experienced significant difficulties in achieving the planned business goals (Segersted and Olofsson, 2010). These conditions have caused a number of critics, disputes and questions rise up. The traditional SCM models were in fact developed for a process-centric context and their transposition in the construction sector (and more in general to project-oriented contexts) is not immediate and structured yet (O'Brien *et al.* 2002).

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The discontinuity of the information flow and the uniqueness of projects which, for example, jeopardize the management of relationships between the Construction Supply Chain (CSC) members get an undoubted effect on the logic of SCM adoption and the effectiveness of some traditional practices.

Construction sector differs substantially from the stable and continuous supply chains within "goods and service" sectors for a number of specific characteristics, as for example: the high complexity and uncertainty in which the production system operates (Fearne and Fowler, 2006); the transitory site configuration managed by temporary supply chain configuration (Love *et al.* 2002); the high customer influence on the final product (Pesämaa *et al.* 2009); the process fragmentation (Baiden *et al.* 2006); the complex network of stakeholders, which involves multiple organizations and relationships (Xue *et al.* 2007). These peculiarities together with a number of cultural factors (e.g. Love *et al.* 2004) are charged to be the rooting causes of the failure to replicate the positive experiences from other sectors, and the poor results finally achieved. In order to successfully introduce SCM in a project-oriented sector, a context-based approach is essential. This working paper is part of a wider research project which aims to provide academics and practitioners by investigating the building elements that characterize/influence the adoption and implementation of SCM in Construction: antecedents, SCM approaches (strategies, practices and structure), benefits, contextual factors.

From an academic viewpoint, this contribution aims to analyse the state-of-the-art of literature concerning CSCM approaches in order to highlight actual research gaps, and to formalize the conceptual model contributing with useful directions to future research. Nevertheless, the article has also implications for practitioners, providing first insights to support a proper, context-specific SCM implementation, e.g. what are the prerequisites and levers to CSCM adoption (antecedents); what SCM approaches are more suitable (SCM strategy, structure and practices); what target is desirable (SCM related benefits).

RESEARCH DESIGN

Research Strategy and Objectives

The research methodology is showed in Figure 1. It entails two main phases: a literature review and a multiple case analysis. The current status of research can be positioned at the beginning of Step 2: "Design and Preparation".

The literature review allowed uncovering CSCM constructs and variables. Then, case studies will be aimed at exploring and at theory-building patterns or linkages between the proposed constructs and variables. The objective of overall research involves the descriptive and normative study of the CSCM topic, in order to provide explorative and theory-building propositions that regard main SCM elements and their interrelationships. For what concerns the present article, the first research objective consists in reviewing previous research contributions from an integrated perspective, in order to investigate the domain surrounding relevant topics in the construction literature. Such topics concern the main elements that constitute the building blocks of SCM implementation. These include: the antecedents (or prerequisites), the approaches (strategies, practices and structure), the benefits and the contextual factors. The second main objective of the article consists in describing the interactions between such elements through an original conceptual model. We propose a set of Research Questions (RQ) that arises from an extensive literature review. They

represent the basis for future research agenda that we aim to test through empirical investigation.

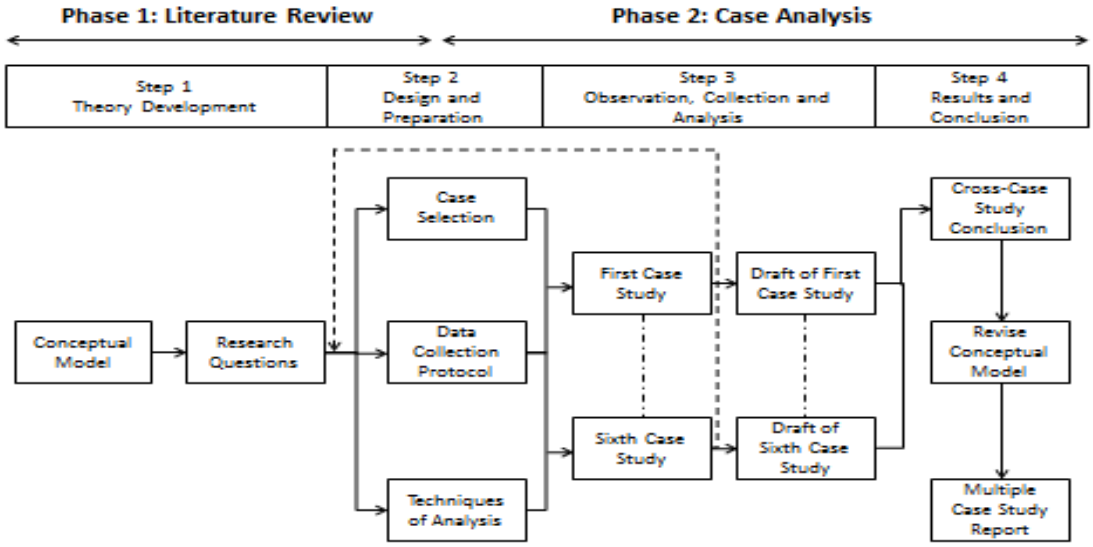

Figure 12 - Main steps of research methodology. Adapted from Yin (1994).

The novel of the proposed framework lies in the different perspective about the elements that characterize CSCM implementation. The rationale of the present research states that a set of antecedents affects SCM adoption/implementation, which in turn affects the achievement of SCM-related benefits. We aim to address several gaps in extant construction literature. In particular, a few building elements have not been introduced yet (e.g. CSCM antecedents), and others require further investigation because at the introductive research level (e.g. CSCM structure and CSCM strategies). At the best of our knowledge, also the relationships between the building elements have not been proposed within the construction literature yet. To analyse such relationships, the contingent approach represents a central tenet of present research. Thus, a set of contextual and environmental variables are included within the framework since they can significantly influence (by mediating or moderating) the relationships and interactions between SCM building elements. Analysing extant CSCM literature, we found a number of useful and valuable contributions. Nevertheless, all these contributions focus on specific aspects of the construction process without addressing an integrated view of the proposed elements that interact in SCM implementation. Without the aim to be exhaustive, we here critically examine some relevant conceptual models. Cox and Ireland (2002), for example, provided a better understanding of how to achieve effective SCM by proposing a model that analyse specific power regimes in buyer/supplier relationships. Love *et al.* (2004) suggested a holistic approach focused on the integration between design and production process following TQM philosophy. Cheng *et al.* (2004) aimed to improve the issue of strategic alliances and examined the purchasing perspective as an organizational change process. Finally, Xue *et al.* (2007) faced the inter-organizational problems in order to enable business process integration and achieve better performance.

Research to date

The Step 1 of research methodology consists in "Theory Development" (see Figure 1). A systematic literature review was performed in order to analyse the issue of CSCM. Main output of this research step consisted in the identification of the building

elements of SCM implementation, which have been included within the conceptual model. The literature review supported also the formulation of the Research Questions for each building element. The review comprehended an initial sample of 176 refereed international articles. This set stem from a search through main scientific electronic databases, namely: Emerald, Scopus, Taylor&Francis, IEEE, JStor. The search contained the combination of the words “supply chain management" and “construction”. Sample selection was limited to papers published in international peer-reviewed journals from 2000 to 2010. This time selection depends on the evolution of procurement approaches in the construction sector (Saad *et al.* 2002), as a perception of a progress in adopting SCM principles was perceptible only in the late 1990s. A selection process was performed in order to exclude book reviews, dissertations, editorials, conference papers, or even articles which key words had different meaning from the chosen one. After the selection process, the final number of papers was 138.

Research proposal

The second phase of research methodology (Step 3 and 4; see Figure 1) is not included within the present article and it will be conducted through a multiple case study analysis. It will be used with the two-fold purpose of exploring and theory-building research propositions and hypothesis related to the proposed model. The case study analysis was considered suitable to obtain in-depth results in a research area that is characterized by limited empirical research as CSCM.

CONCEPTUAL MODEL FOR CSCM

The proposed conceptual framework is showed in Figure 2. It illustrates the relationships between SCM main elements, in order to effectively implement SCM in the construction sector.

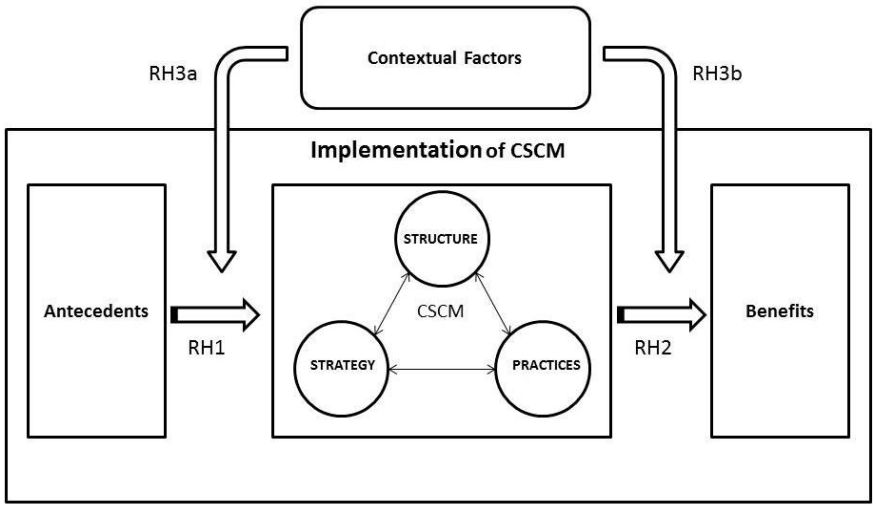

Figure 13 - Conceptual model for CSCM implementation.

The left part of the model includes a number of preconditions. The rationale of present research upholds that a proper understanding of antecedents represents the first pivotal step to properly introduce SCM (Lambert *et al.* 2005). The antecedents are related both to intra- and inter-organizational relationships and their acquisition is required to implement SCM approaches. Such approaches are represented in the middle section of the model. They constitute the core of the SCM concept and show the combination between strategies, structure and practices. They need to be context-specific and to reflect the peculiarities of the construction sector. Hence, the proper deployment of

SCM approaches is unavoidable from a continuous adaptation with a set of contextual factors. Finally, the right side of the model shows the expected SCM-related benefits. Such benefits positively affect the success of final construction projects in both increased efficiency and effectiveness. Also, the identification of SCM-related benefits pull to promote their repartition among SC members, which commitment will be leveraged in turn. All the above-mentioned elements of the framework are further described in the following subsections. Each subsection also proposes a set of Research Questions that will be investigated through the multiple case-study analysis.

CSCM approaches: Strategies, Structure and Practices

CSCM implementation is characterized by the interrelation of strategies, practices and structure. In the proposed conceptual framework, we adapted the core elements of SCM concepts (e.g. Lambert *et al.* 1998), following a project-oriented perspective. Opposing the "one-size-fits-all" paradigm, the present article supports a contingency-based approach for the proper implementation of CSCM. The construction sector requires specific SC solutions (e.g. Cox and Ireland, 2002) and inter-sector differences have to be emphasized in order to catch the peculiar requirements of each supply chain. In the last two decades, many articles contributed to the topic of contingent SCM. They identified a set of strategies, practices and structures that fit the SC characteristics as the context changes. However, these models originally developed within process-centric contexts, where the demand is predictable, volume is high and variability is low (Christopher, 2000). Such contexts face specific criticalities (e.g. high margin of error in forecast) and therefore require specific solutions (e.g. standardization of product components) that may not be translated to the construction sector. A comprehensive definition of ad-hoc SCM approaches is still lacking for the construction sector. Therefore, we analysed both construction and process-centric SCM literature with the objective of investigating how consolidate SCM approaches can be adapted to a project-centric environment. In particular, the following results are showed for each component of SCM approach:

- Strategy. "The concept of project strategy has remained ambiguous in existing studies" (Artto *et al.* 2008). To address this research gap, we selected a number of SCM models from process-centric literature, with the aim to define a strategic profile for the construction sector. The identified models propose different suggestions according to the contingent context of each organization. Such context is described through different contextual variables (e.g. variability, complexity, uniqueness and volume of the final product). The research objective is to investigate the suitability of extant models and the effective applicability of the related strategies among construction companies.
- Structure. As organizations need to adopt new systems to shift to integrated SCM, they inevitably recognized the importance of adopting suitable organizational structures. These vary as the levels of centralization, formalization and hierarchical relationships (Kim, 2007). At this purpose, we identified five different SCM structures through the process-centric SCM literature. The structures are: market oriented (SCM is not recognised as a distinct function and exists as a sub-department of production or marketing); SCM department (SCM department has an equal hierarchical position with existing functional departments); matrix organization (SCM department has an equal hierarchical position with other departments but is focused on coordination and connection); process (SCM department has an higher position than other functional department but plays the role of overall coordinator); and

SCM leadership (SCM department directly controls other functional departments).

- Practice. We identified a set of practices from CSCM literature. They have been divided into three groups in accordance with their impact on the goods flow (e.g. waste reduction, modularity, postponement), the information flow (e.g. co-design, e-procurement, e-collaboration), or the planning and control flow (e.g. supplier scorecarding, time compression, concurrent engineering). The objective of future research is to investigate the modalities and the effective utilization of such practices in the construction sector.

In relation with SCM approaches, the following Research Questions are proposed:
RQ1: What are the suitable strategies, structures and practices to implement CSCM?

RQ2: How construction companies apply the suggested strategies, structure and practices from consolidated models?

Antecedents of CSCM

The importance of preconditions stemmed from traditional SCM literature (Lambert *et al.* 2005, Kotzab *et al.* 2011). In particular, the antecedents are necessary to properly connect the inter-organizational networks (Mentzner *et al.* 2001) in order to enhance the relationship perspective within and among organizations. Extant literature was reviewed to identify the antecedent elements for a successful CSCM implementation. Articles were screened by content (using keywords as "antecedent", "prerequisite", "precondition"), searching for those items that were perceived as relevant to introduce SCM. Results highlighted a total of 20 antecedents to implement SCM in the construction sector. They can be classified in four main groups: management (e.g. suitability of skills, top-management commitment); technology (e.g. IT integration, information sharing); business culture (e.g. trust, sharing of risks and benefits); market (e.g. contractual protection, government regulation). The proposed antecedents shape a heterogeneous set. They impact on different level of SCM implementation, applying to different management areas and requiring different modalities of introduction. We underline that most of identified antecedents are related to the business culture of the Construction sector (8 out of 20). Since the construction has a temporary SC structure, a high and variable number of SC participants, the identification of specific antecedents for this sector assumes considerable importance. The analysis of literature highlighted a major criticality of the elements that are usually easier to implement in more stable contexts as "relational behaviour", "trust" and "focus on the long term". Such difference of focus reflects the late implementation of SCM approaches in the construction sector and requires further research efforts in order to highlight the priorities of intervention that are necessary to adopt CSCM. Most of the antecedents are also related to each other and a certain level of overlap is exhibited. This is a consequence of the heterogeneous usage of definitions surrounding these concepts. However, very scarce information can be found about these mutual relationships and about their priority of introduction. From this viewpoint, the present research represents a first effort to clarify the domain of CSCM elements.

Further research will be addressed to empirically test the following Research Questions:

RQ3: To what extent the identified antecedents are perceived as critical for CSCM implementation?

RQ4: How are antecedents interrelated?

Benefits of CSCM

The measure of project success corresponds to the extent that it satisfies the needs of its intended user. In accordance with Cooke-Davis (2002), the realization of benefits is essential to establish project success. Benefits of effective SCM should be potentially value-enhancing for all the participants within the network. This is especially valid for the construction sector, where the push to implement SCM arises not only from the focal company, as in the process-centric environment, but also from a multitude of participants. Hence, the high recourse to outsourced activities, which count almost 75 per cent of the project value (Gadde and Dubois, 2000), points out a great potential interest for all involved members. The identification of benefits constitutes a first step to leverage the commitment of CSC participants. To identify CSCM benefits, we analysed the selected CSCM literature, searching for the goals and performance improvements related with SCM implementation. Also, we conducted a content analysis for keywords as "benefit", "improvement", "advantage", and "gain". From the literature, we identified a total of 18 benefits that can be related to the implementation of SCM approaches. Such benefits can be represented through a classification between three concentric categories: organizational effectiveness (e.g. coordination among SC members, order cycle times), business performance (e.g. product quality, inventory turnover) and financial performance (e.g. financial liquidity, net profit). Another critical aspect is represented by the different importance that benefits can assume between different supply chain members (Agrawal and Park, 2001), as well as different functional managers (Fawcett *et al.* 2008). The divergence of interests should be minimized, where possible, in the case where it leads to both sub-optimal choices and conflicts.

Our research aims to gain insights about these interesting topics by investigating the following Research Questions:

RQ5: To what extent CSC members perceive as relevant the identified SCM benefits?

RQ6: How CSC members share benefits between each other?

Contextual Factors

In the present article we classified the contextual factors into internal (supply network structure) and external (environmental uncertainty and technical dynamics):

- Supply network structure. Choi and Hong (2002) captured these contextual factors in three main dimensions: formalization of guidelines (rules for enterprises or suppliers that increase work credibility through formalized rules procedures), centralization of decision-making within the supply chain (e.g. the power and size of companies, as the extent to which authority is centralized affects the interaction between enterprises) and complexity of relationships (the product level of complexity, its relevance of speed and its perishability; also it includes the relative importance of linkage costs, the length of the chain and the proximity to final customer).
- Environmental uncertainty. The complex relationships between SC members involve numerous sources of uncertainty. To perform the relationships in an effective manner, a better control of the uncertainty is fundamental and SCM acts as an uncertainty reduction mechanism. Davis (1993) identified three major source of uncertainty: manufacturing (e.g. systems breakdown and human errors); demand (e.g. volatile markets and fluctuating demand); and supply (e.g. natural disaster or shortage of natural resources).

- Technical dynamics. They concern the technological speed of change in relation with the involved materials, as well as the breakthrough in the management of processes and techniques (Hsu and Chen 2004).

Relationships between SCM building elements

The present research also aims to propose a set of Research Hypotheses (RH), in order to investigate how each building element may affect each other. In particular, we aim to gain insights about the following relationships, in accordance with the links represented in Figure 2. The formulation of hypothesis emerged from the result of the literature review and their investigation will be conducted during next research steps.

The first relationship involves the antecedents and the approaches of SCM. The antecedent represents a necessary prerequisite to properly introduce the strategies, the practices and the structure that are best suited to the construction sector. Such relation has been investigated for the process-centric context (see for example Lambert *et al.* 2005; Kotzab *et al.* 2011), but not yet for the construction sector. As emerges from the analysis, scarce information can be found about the impact of the antecedents on CSCM implementation. The peculiarities of the CSC requires further investigation about the relationship between antecedents and SCM approaches in order to determine what antecedents are the most critical to implement specific SCM approaches.

RH1: The acquisition of well-defined antecedents fosters the introduction of SCM approaches (strategies, structure and practices).

The second relationship links the settlement of SCM modalities with the achievement of SCM benefits. Hence, organizations select most suitable strategies, practices and structure in order to achieve such benefits and to strengthen project success. SCM has to be applied consistently among the multitude of companies involved within the construction sector and in a continuous and progressive manner over time. The second research hypothesis aims to investigate what SCM approaches are best suited to achieve different configurations of SCM benefits. The criticality of this relationship is a consequence of the necessary investments required to implement SCM, which represents the most resource-intensive and time-consuming management approach.

RH2: The implementation of proper SCM approaches fosters the achievement of SCM benefits.

The third relationship consists of two sub-hypothesis. Hence, it involves the role of contextual factors, which may affect in turn the settlement of SCM approaches and the achievement of SCM benefits. Firstly, The Research Hypothesis 3a advocates that the settlement of antecedents could not univocally lead to a determined set of SCM approaches. This may be the case when a contextual variable act as a moderator between the antecedent and the approaches of SCM. Hence, in correspondence with the same antecedent configuration, two different companies may require different strategic profiles, or they may need to implement different practices (e.g. the contextual factor "supply uncertainty" may moderate the relationship between the antecedent "relational behaviour" and the practice "e-collaboration"). Another interesting effect that we aim to investigate concerns the mediating role of contextual variables. For example the antecedent "adequate sharing of risks and benefits" may negatively influence the contextual factor "complexity of relationships", which in turn may negatively influence the practice "e-sourcing".

RH3a: Contextual factors affect the relationship between the settlement of antecedents and the implementation of SCM approaches.

Secondly, the Research Hypothesis 3b aims to investigate the moderator/mediator effect of the contextual factors between SCM approaches and SCM benefits. The rationale of this hypothesis assumes that the proper deployment of SCM approaches does not ensure the achievement of full SCM benefits. The success of organizations in achieving SCM benefits depends on the effectiveness of the adaptation with the ever-changing environment (Stonebraker and Afifi, 2004). Thereby contextual factors can limit or foster the amount of each benefit among different SC projects (e.g. "technical dynamics" may act as moderator between the practice "co-design" and the benefit "total cost reduction"). Also, contextual factors can influence the repartition level of benefits between different SC members. In this connection, an interesting example concerns the role of the contextual factor "supply uncertainty" that may moderate the relationship between the "time compression" practice and the benefit "decreased Time-To-Market".

RH3b: Contextual factors affect the relationship between SCM approaches and the achievement of full SCM benefits.

CONCLUSION AND FUTURE DEVELOPMENTS

This paper has to be framed in a wider research project, which aims to provide a support for a more effective, contingency-based implementation of SCM in the construction sector. The objective of this article was to present the results of a CSCM literature review and to propose a conceptual model with the related research agenda. The model was developed from several extant SCM models in the literature, with an intended adaptation for the construction sector in order to enhance its peculiarities. It represents an initial attempt at identifying the various elements to be managed for an effective CSCM implementation. The elements that compose the model have been described and a set of further research questions and hypothesis have been proposed. From an academic perspective, the present article can foster the understanding of CSCM from an innovative perspective. Expected managerial contributions may arise from the further investigation of both the building elements of SCM and their interrelationships (e.g. how antecedents and contextual factors foster SCM implementation, as also, what SCM approaches can lead to higher SCM benefits).

Future developments will be addressed at the empirical investigation of proposed model, through a multiple case analysis.

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