CONSTRUCTION VIRTUAL SUPPLY CHAINS.
A CASE STUDY IN SPAIN
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Abstract
In this paper tendencies in Construction Supply Chains are analyzed. These tendencies are leading to the constitution of Virtual Enterprises, with a customer-oriented policy.

The case of one Spanish construction SME is studied. The characteristics of this enterprise, the advantages to the client as well as the difficulties of their formation, which occur through the necessity of a cultural change from the clients and the suppliers, are analyzed.

This company act as the broker of the VE corresponding to each construction project. The principal problems that have emerged, as well as the processes established to solve them, are studied.

Keywords
Virtual Enterprises, supply chain, construction

1. INTRODUCTION

The construction sector presents a series of peculiarities that make it different from other productive sectors. One of the most important is the fact that the supply chain is configured for each individual construction project.

The actual tendency of companies participating in these supply chains is towards greater specialization, above all when referring to construction processes.

Likewise, some promoter and construction companies are signing contracts with only one supplier, who constitutes a Virtual Enterprise, containing all or part of the members of the supply chain.

This implies notable savings in cost and time and other advantages, such as a better control of the outsourcing processes and the possibility of concentrating the organization’s energy in its core competences.

In this paper a real case of a Spanish Construction Company will be analyzed. This company configured a Virtual Enterprise from the point of view of clients (promoters or property) at the first level of the Supply Chain, acting as a broker.

2. CONSTRUCTION SUPPLY CHAINS

Given the particular characteristics of the sector, the supply chain is different for each construction project. London and Kenley [1] propose a method to describe Construction Supply Chains. The principal criterion to establish the relations and structure is the initial identification of each particular project. The three key factors of the model are: the project, the participants and the relations between them.

Each project involves the demand for an infrastructure or building by the client’s organization. In Figure 1, the structure of a construction Supply Chain is shown, in which the client is considered as the central organization, according to the model of Lambert et al. [2], taking into account that the client may be the promoter or property owner.
According to this model, the client (construction demand organization), as a central organization, is the equivalent to the large assembler in the traditional Supply Chain Models in the automobile sector. This challenges the general assumption of many authors that the main contractor is the equivalent to the assembler.

In figure 1 the horizontal structure tiers are grouped into those that supply to produce the facility/infrastructure (production suppliers), the focal demand organization, and those that supply after project completion (in-use suppliers).

The model can become complicated when there are multiple suppliers for each level and when organizations are located in more than one layer.

On the other hand, the vertical structure of each link reflects a degree of competition between suppliers. At this level, relations between companies become one of the critical parts of the model.

3. SUPPLY CHAIN TRENDS

This paper focuses on current trends in Supply Chains, and, particularly, in the Construction sector. An increasing tendency towards subcontracting is detected; in many cases, this means signing a contract with only one supplier, for all the processes of an organization, satisfying all the client’s necessities.

These suppliers are called Third-Party Logistics Providers (3PL). 3PL become the best allies of Supply Chain optimization. The definition of the necessities and expectations of clients is necessary in order to develop 3PL. It is important to improve relations and exchange information and knowledge, to create added value and high standards of quality in a differentiated service.

In this context a new concept arises [3]; through which companies and suppliers create a new type of alliance, Fourth-Party Logistics (4PL). 4PL represents the evolution of the Supply Chain Management (SCM), combining the capacities of 3PL, of the suppliers of technological services and the business process providers, in order to create valid solutions
for all the company.

4PL is different from the traditional concept of subcontracting in two ways: on the one hand, it offers a global solution and, on the other hand, it offers a measurable value, thanks to its ability to influence the complete SC.

4PL brings the organization to integration, obtaining the benefits that this brings: an increase in profits, reduction of operational costs, less circulating capital, and reduction of fixed assets.

In this sense, new organizational architectures begin to appear, the consequence of the strategic project that the integration into a Supply Chain implies [4]. The potential of the SCM is in the configuration of the Supply Chain, through the integration of its members in the area equivalent to the Enterprise Integration, but not intra, but inter enterprise.

This integration must be understood in the field of Extended / Virtual Enterprise as an extending and improving of external company management, allowing the basic flows (physical and information), with a client orientation.

In the case of construction, subcontracting is getting more and more important. This involves the specialization of the companies, which creates a change in the organizational models of the sector.

In this sense, some companies, mainly promoters, are establishing alliances with only one supplier or manager (who acts as a 4PL), in distinct points of the chain, forming Virtual Enterprises. The saving in costs and time that this creates are notable, together with other advantages as a larger control of the process, and the possibility of the companies to concentrate in its core competences.

4. CASE STUDY

In the concrete case of the Spanish construction industries, these new alliances are being detected, mainly in the sub sectors of residential or industrial construction, constituted by SMEs.

These alliances are constituted as networks of collaborative companies, which act as nodes of a Virtual Enterprise (VE), each of them contributing with the best that it knows (core business). All operate directly with the client (promoter or property) as if it were dealing with a single company.

Each time a market opportunity (construction project) arises, the VE is formed. Thanks to the open systems structures and the use of IT, a rapid communication is established, that produces a real time VE configuration.

4.1. Constitution of the Supply Chain like a VE

In this paper, a representative case is studied, corresponding to the sub sector of industrial construction. A company that functions under a turn key scheme is analyzed. This
The company offers the property an integral service for the construction of industrial plants. In practice, the relevance of a turn key contract is in the fact that it is, in a simplified way, a ready-to-work whole sale contract. That means that all responsibility falls upon a unique legal or physical entity.

If we follow the Supply Chain Model of London and Kenley, corresponding to a construction project, we would now have the situation shown in Figure 2. There we can observe that the entire Supply Chain is perceived by the client as a unique company (Virtual Enterprise).

![Virtual Enterprise configuration for manage a construction project in the industrial construction sub sector](image)

The studied company acts as the VE broker, playing two main roles [5]; looking for new business opportunities, managing their reception, and coordinating the process of selecting the most suitable consortium of enterprises for every opportunity.

The advantages for the client are obvious; he only needs to contact with a single interlocutor, there is a cost reduction, there is more information available to the client and there is a high agility in production and negotiation.

4.2. Problems detected

The construction firm examined has found a series of problems, when constituting the VE. The principal problems are motivated by the culture of Construction SMEs:

- The participants in the construction project are not sure about the benefits they can gain sharing knowledge and experiences.
- Belief that they can lose competitive advantages.
- Dissimilar culture.
- Different objectives.
- Different standards and productive systems.
- Different language (jargon).
• Existence of a relationship among the members of the Supply Chain that present certain rivalry and lack of confidence.
• Problems of communication and information management due to an insufficient coordination.
• The available information is most of the time incorrect or insufficient. This can affect tasks that depend one on another.
• Low quality and failure to comply to terms as a result of lack of understanding among the parts of the chain.
• The arrangement of the companies by departments creates internal barriers. This prevents them from having a clear vision of their own processes and makes them unable to concentrate on their client’s needs and requirements.

4.3. Need of a cultural change

The solution to the problems mentioned above depends mainly on the achievement of a cultural change of the participating companies in each VE.

The analyzed company operates in a well defined geographic area; therefore the participants in each VE are nearly located. This fact and the cooperation among them (most of them repeat in different VE) have contributed to make this cultural change easier. A real business ecosystem [6] has been created between them.

According to this cultural change, the broker company has principally worked on three major facts, shown in [7].

4.3.1. Change of mentality

The most common problem is the rivalry that exists among the members of the chain and a low level of confidence among them. The broker, in order to solve these problems, must coordinate their efforts and try to work together, looking for end client satisfaction.

It starts determining the clients’ needs, transferring them to certain product requirements and finally establishing how the delivery of the final product (industrial plant) to the client must be executed. All this must go through every construction stage.

The broker promotes this relationship among the members of a chain and this will be based on confidence, mutual understanding, knowledge and acceptance of the particular expectations of each one and also on the information exchange.

This is how the product will be delivered on time and with the right levels of quality. This will satisfy the end client and implies high internal levels of satisfaction, very few conflicts, etc.

4.3.2. Orientation to a process management
The construction industry, especially with regards to SMEs, is very inclined to a configuration by departments. This can be a problem because the companies cannot concentrate on the client. This kind of organization is too rigid as all the activities are performed in sequence, going from one department to another, following the hierarchic lines which make taking decisions a slower and more complicated task.

Although the fact that concentrating on the client’s requirements is not a new concept for construction companies, they do not usually pay the attention deserved to the value of the client in their processes.

An orientation by processes will increase the company’s efficiency, the client will be more satisfied, terms will be reduced and high levels of quality achieved.

The main goal must be the end client; therefore we must look for ways which offer him as much value as possible and not only according to price, quality or deadlines. If the whole company is focused on the same goal (satisfying the client) is easier than confronting several departments or sections with different goals.

Once the company is working this way, it will be easier to work together with the rest of the members of the SC.

4.3.3. Exchange of personnel and knowledge

The exchange of personnel among companies is a symptom of a good relationship and an orientation by processes.

This helps to generate confidence between a company and its providers, between a client and other companies. This also shows that the company wants to learn from others and is ready to share knowledge and technology.

The broker promotes the exchange of personnel when a new industrial plant is being developed so that human resources, experience and knowledge can be shared.

Therefore, each company is not only focused on its own processes but it can view the global process of the entire VE working as a unique body as well. They can compete against other VE and satisfy their clients’ needs.

This exchange of personnel allows for personal and physical communication among people of different companies of the chain and a “social net” is created.

We will obtain a high grade of interaction and therefore this tacit knowledge will be transmitted through the companies [8].

4.4. VE life-cycle needs

Following the model of VE life-cycle proposed by Camarhina-Matos and Afsarmanesh [9], the main steps needed for each stage will be studied.

4.4.1. Creation
This stage includes all the previous activities before construction itself is started. It consists of the creation of a team of designers including every professional that must take part in the project. The designer is the most important member of this team.

The contractors, depending on the contract system adopted, should participate actively in the design process.

They must define the specific points and relative calculations concerning their area, starting from the basic lines planned by the designer.

At the same time, the engineers can be integrated into each of the different contractors’ organizations. This fact does not imply enlarging the structures of the contractors and/or providers but it is simply a matter of integrating their own technicians at this stage.

The fact of promoting eagerly the direct hiring by different specialized companies and having them involved in the design phase leads to a more general quality, because those who participate in each part of the project have a deep knowledge of the specific technology utilized.

This methodology improves the construction process, allows a more elaborate planning and better global results are obtained, in view of the fact that each contractor determines which is the most suitable solution in its field.

This effect is not accomplished when the designer or his team imposes on the contractor what he must do. The increasing specialization of this field turns the providers and contractors themselves into the ones who are better acquainted with technology and more specific products.

If the suitable conditions are achieved to increase interaction between the design team and at least the main contractors, their knowledge could be kept and shared and at the same time a new knowledge could be developed and competitive advantages extended.

4.4.2. Operation

This stage should develop all the coordination tasks and the permanent control of time, costs and quality. Each construction company must be able to create an infrastructure that enables its equipment to have access to the organization’s resources, experience and knowledge.

It is necessary to optimize to the highest point the coordination and the knowledge exchange with the rest of the members of each Virtual Supply Chain.

If this objective is achieved, we would be able to slightly reduce the drawbacks that appear in the building process and become significant deviations of the terms, carry out costs of the different units and as a consequence it affects the final performance of the contracts.

The studied company has act in three principal ways in order to achieve the mentioned objective:

- **Organization and people:** One of the goals is to create information channels for those who work on the same kind of jobs or units. In such a way, they can save the effort to solve technical problems that have been already solved by others. Both,
knowledge and experience at the organization should be organized adequately to create a common database from which any member of the VE can have access anywhere and anytime.

- **Processes:** They analyze and design the flow of documental management that takes part in every building project. They are classified by groups (technological, legal, economic, etc). Their characteristic attributes are identified as well as the different stages that each document goes through, the people in charge to take action in relation to them, etc.

- **Technology:** Some technological items help to hold this infrastructure. As an example, they have created a platform based on the web environment that allows the connectivity from any device, mobile or fixed, without the need of additional software to have access to the provided services.

One of the purposes of the above mentioned is to save time when they search for information or documents, as well as a reduction of the number of hours inverted in the rework on specific construction units due to the lack of coordination.

To conclude, it can be affirmed that the management of this stage should achieve a double goal: making easier the learning of experiences and previous errors including a tacit knowledge of the personnel with more experience; and creating a propitious environment for new techniques and ideas.

### 4.4.3. Dissolution

Once the construction process has been finished the broker must try to organized knowledge transference. The main problems concerning this transference are motivated by the discontinuity between the projects and the teams working on them. Everything that has been learned during the performance of a certain project can be simply lost or forgotten when the project is over and the team is dispersed.

There are not many occasions when they can count on the time and space they need to make sure that all has been learned through the project are assumed by the appropriate organization. The programming and the demanding market provoke the immediate reassignment of people to new projects, so their matters of concern automatically change.

In order to solve these problems some mechanisms that promote learning in organizations have been provided. It is worthwhile mentioning the post-project review, which is becoming part of the ordinary processes worked out by the teams. This review is a very useful tool as it maintains the generated knowledge of each project. These three facts must be complied with:

- Problems should be recognized from an impersonal point of view. People should not consider it a witch-hunt or a search for the underachieving staff.

- Videos or journals of the project that help to recall the more relevant facts could be used.

- It must be made sure that actions are identified in the review and are rapidly implemented.
5. CONCLUSIONS

In the present paper, a true case of a Spanish construction company, acting as a Virtual Enterprise broker in the Supply Chain, is studied. The principal problems that have been found are presented, and the solutions proposed are analyzed.

It is necessary to establish a methodology for creating and managing this kind of Virtual Enterprises in a project environment, in order to increase their potential benefits. Towards this goal our research group is working nowadays.

6. REFERENCES


