THE IMPORTANCE OF COMMITMENTS MANAGEMENT TO THE INTEGRATION OF MAKE-TO-ORDER SUPPLY CHAINS IN CONSTRUCTION INDUSTRY

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ABSTRACT

Most causes of the inefficiency in construction supply chains are related to managerial issues, including the poor management of commitments among their members and the lack of integration of managerial processes along the chain. This paper discusses those problems in two case studies carried out in the building elevator and cut and bend rebar supply chains. As in many of construction supply chains, both configurations are characterized by their make-to-order nature, the delivery of customized products to their customers and by having their production based on final design specifications. Focusing on the flow of information along the supply chain, the objective of this paper is to assess how the integration of these make-to-order supply chains' processes is affected by the way commitments among chain members are coordinated. By undertaking a detailed description of both supply chains' processes and analyzing their existing problems, the study shows that a major part of them are related to the poor integration of the information flows. The Language Action Perspective (LAP) was used to provide an additional approach for analysis, emphasizing the commitments involved in the information sharing among supply chain agents. The LAP analysis revealed that the root cause of those problems relies mainly on the poor management of commitments among supply chain members. Moreover, many of the problems could be avoided by explicitly planning the flow of commitments that are made necessary by inter-organizational processes as well as by organization's internal processes. The adoption of the LAP and the focus on the flow of commitments may support the understanding of make-to-order supply chains integration problems as well as suggest actions towards the integration of their processes.

KEYWORDS:

Supply Chain Management, Make-to-order, information flow, Language/Action perspective, commitments management.

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INTRODUCTION

Most causes of the inefficiency in construction supply chains are related to managerial issues, including the lack of integration of managerial processes along the chain and the poor management of commitments among their members. Problems and waste are largely caused by obsolete and myopic control of the construction supply chain, characterized by independent control of each stage of the chain (Vrijhoef and Koskela 2000).

These problems are very similar to the ones cited in previous studies of make-to-order supply chains (e.g. Luhtala et al. 1994). Typical problems of make-to-order supply chains include the inaccurate communication among companies, lack of production planning and control and lack of information regarding the supply chain performance (Luhtala el al. 1994). To achieve overall performance improvements in this kind of supply chain it is necessary to improve the information flow of internal processes as well as information exchange among organizations.

In this context, supply chain management (SCM) has been identified as an adequate conceptual framework for improving the performance of the construction sector (O'Brien, 1999). SCM suggests an alternative approach to control supply chains which focuses on the total flow of production (Koskela and Vrijhoef 2000). Beyond just-in-time and Lean Production concepts SCM theoretical framework also includes a set of concepts related to relationship and collaboration between organizations. According to Christopher (1999), trust, commitment and willingness to share information among the supply chain companies are all fundamental for the functioning of the supply chain as a set of interconnected processes.

This paper discusses two case studies in the building elevator and cut and bend rebar supply chains. Like many construction supply chains, both configurations are characterized by their make-to-order nature, the delivery of customized products to their customers, and have their production based on final design specifications. Moreover, the design, procurement and installation processes need to be coordinated not only inside the companies but also across the supply chain. This coordination demands a substantial managerial attention.

Focusing on the information flow issue, the objective of this paper is to assess how the integration of these make-to-order supply chains' processes is affected by the way commitments among chain members are coordinated. The Language Action Perspective (LAP) is used to provide an additional approach for analysis, emphasizing the commitments involved in the information sharing among supply chain agents.

INFORMATION FLOW AND COMMITMENTS: THE LANGUAGE/ACTION PERSPECTIVE

Supply Chain Coordination Through The Management Commitments

The integration of supply chains has been frequently associated with the flow of information among their members. Some authors as Hong-Minh et al (2001) view the flow of information as a managerial process, in which the information plays the role of the subject of the work. According to this view, improvements in the flow of information can be achieved in the same way as in production processes, for example by reducing the share of non-value activities in the process or by increasing productivity of value-added activities.

Other supply chain researchers adopt a distinct view, considering the information flow as a means to integrate the supply chain by improving cooperation and collaboration. From this perspective, improvements of information flow are made through the design and implementation of mechanisms that ease the transparency and information sharing among the members of the supply chain about the benefits of cooperation (Ballou et al. 2000).

In 1979, Fernando Flores has proposed a new way to approach the problems of information flow in organizations. According to him (and, after, Winograd and Flores 1986) the descriptive nature of the language represents just part of its role in the organization. Based on previous work of Jürgen Habermas[5], they have suggested that the language could also be intended to create a mutual orientation among different actors, in a kind of 'social action' which, in turn, results in changes in the real world. This new perspective – called 'Language/Action Perspective' (LAP) – made it possible to join elements of both the process and the collaboration views in a single one, offering a comprehensive approach to understand and coordinate the work among people and organizations.

According to Flores (1979), the breakdowns experienced by organizations are a direct consequence of the input-output interpretation of work. He has claimed that effective coordination of action is the same as effective management of commitments, and that the progress of work can be traced by watching speech acts in the communications of those coordinating (Flores 1979).

In the past years, the application of LAP to supply chains in construction has been the subject of investigation by a number of researchers. Vrijhoef, Koskela and Howell (2001) have suggested the use of the LAP as an alternative way to understand construction supply chains. Other researchers have pointed out the potential of use of LAP with other theoretical approaches in order propose theoretical models aimed to comprehensively describe supply chains in construction (Vrijhoef, Koskela and Howell 2001, Vrijhoef, Koskela and Voordjik 2003, Isatto, 2005). However, the application of LAP modelling techniques to real situations in construction supply chains have received little attention from researchers, and its real potential in this context has not yet been established.

Commitments As Closed Loops

The LAP gave rise to a number of distinct methodologies to business processes description and (re)design, among them the one proposed by Denning and Medina-Mora (1995)[6]. Based on Winograd and Flores, those authors have suggested that commitments could be viewed as work-flow loops and that every organization is a network of commitments. Thus, an organization could be depicted as a map of interconnected commitment loops, which could be used as a guide to design work processes and their supporting information technologies, manage commitments to completion with customer satisfaction, and measure productivity (Denning and Medina-Mora 1995).

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[5] See J. Habermas, The Theory of Communicative Action: Reason and Rationalization of Society. Polity Press, Cambridge, 1984.

[6] Some other methodologies are described in van Reijswoud, V.E. and Dietz, J.L.: DEMO Modelling Handbook, Delft University of Technology, Department of Information Systems, 1999 and in Lind, M. and Goldkuhl, G.: “Generic Layered Patterns for Business Modelling”, Sixth International Workshop on the Language-Action Perspective on Communication Modelling (LAP2001), Proceedings. Montreal, 2001 (p.109-128).

According to Denning and Medina-Mora (1995), the basic element of a coordination process is a closed loop that connects two parties. One of them (the 'performer') promises to satisfy a request of the other (the 'customer'). As shown in Figure 1, the loop consists of four stages separated by four speech acts (Denning and Medina-Mora 1995):

- **Request:** The customer makes a request to the performer (or accepts an offer made by the performer) ("I request");
- **Negotiation:** They negotiate on the conditions that will satisfy the customer, culminating in the performer's promise (implied contract) to fulfil those conditions ("I promise");
- **Performance:** The performer does the work and ends by declaring that it is done ("I am done");
- **Satisfaction:** The customer accepts the work and declares satisfaction. Satisfaction means that the implied contract has been fulfilled; it means neither gratification nor a psychological report about the customer ("I am satisfied").

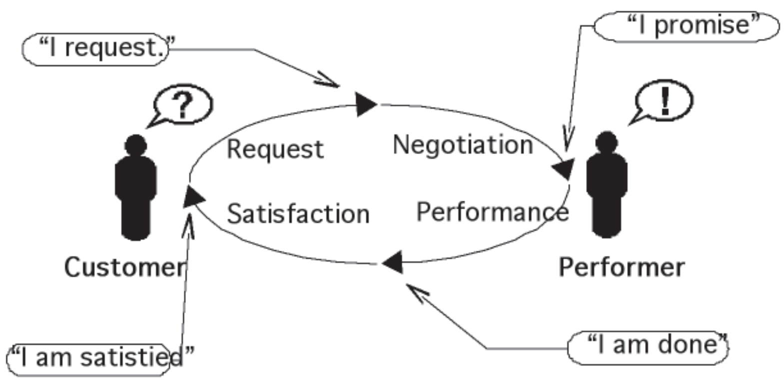


Figure 1: The commitment loop (Denning and Medina-Mora, 1995)

The methodology proposed by Denning and Medina-Mora (1995) stresses the importance of the completion of commitment loops in order to achieve effective coordination of work. They have argued that many of the breakdowns that organizations experience are related with incomplete loops, thus the completeness of commitment loops must be an explicit concert during business processes and information systems design.

CUT AND BENT REBAR SUPPLY CHAIN ANALYSIS

Research Method

The research of the cut and bent supply chain was undertaken in two phases. This procedure has allowed a better understanding of material and information flows, the main problems and their root causes as well as the typical configuration of the supply chain.

Phase 1

The researchers selected the agents which have high influence in the supply chain. The final choice was made after discussions with the Rebar manufacturer. Six (6) General Contractors' managers, six (6) engineers, six (6) structural designers and four (4) design coordinators were then identified and invited to participate in the study.

Once the agents were selected, exploratory interviews were undertaken in order to obtain a general picture of the supply chain processes, their problems and causes. Additional interviews (3) were conducted with the rebar manufacturer managers (operations, technical support).

Phase 2 Case Study

The case study research was conducted in Porto Alegre (south of Brazil). The main sources of evidence analyzed were the following:

- **Direct observation in construction sites:** the goal was to observe the material flow on the job site. Special attention was paid to handling and internal transportation processes, and storage of rebar. The visits to the sites also permitted the researcher to evaluate the assembly of structural elements and formwork activities.

- **Technical support Follow-up:** the researcher accompanied the professionals (Rebar Manufacturer employees) responsible for technical support in their visits to construction sites. During these visits, engineers and assemblers reported information related to their main doubts and difficulties regarding the rebar assembly process. The rebar delivery/unloading processes were also evaluated.

- **Document analysis:** the document analysis sought after data related to design standardization and level of detailing as well as information regarding material delivery scheduling. Documents such as structural designs and production orders provided additional information which complemented the interviews and site visits.

- **Focused Interviews:** in order to detail and delineate the main supply chain problems, root causes and their potential effects, structured interviews were undertaken with twenty-eight (28) General Contractors and (19) structural designers.

General View Of The Cut And Bent Supply Chain

Figure 2 shows a typical configuration of the cut and bent rebar supply chain in Brazil. The rebar configuration differs according to each country. In USA, for example, the rebar manufacturer is also responsible for the rebar detailing. Other alternative configurations can be found in Polat and Ballard (2003).

The main processes and material and information flows are represented as they were perceived by the interviewees in Figure 2. Due to the large number of agents involved and possible different relation links among them, the map only illustrates the main supply chain agents for the sake of the transparency of the analysis. Problems related to communication errors and lack of integration which usually occurs in the interfaces between agents is also illustrated.

The design process in the rebar supply chain starts before the selection of the rebar manufacturer. It is characterized by a long lead time which is primarily caused by the interference among diverse sub-systems designs. Architectural, plumbing and electrical, HVAC and elevator designs directly affect the rebar detailed design. Those designers are not shown in the Figure 2, however the information originated from them are important to the conclusion of the structural design.

The design process starts with the structural typology definition (activity 2) which is defined according to the project features such as type of materials and constructability aspects previously established by the General Contractor and the Architect. Then, the Structural designer carries out the structural analysis (activity 3), the form design (activity 4) and the rebar detailing (activity 6). Before detailing the rebar, the form design is evaluated and must be approved by the General Contractor (activity 5) to check possible changes. The design lead time ranges from 90 to 120 days and is the process with the longest lead time in the supply chain.

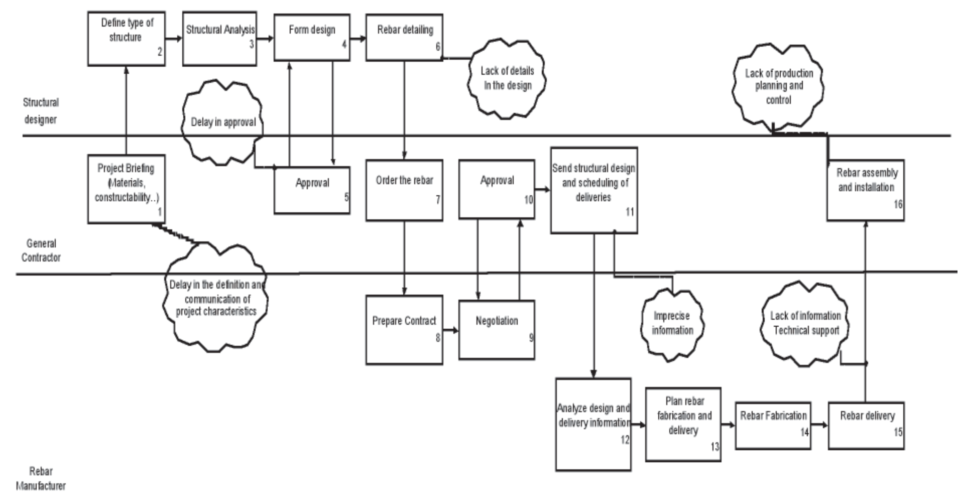


Figure 2 – Current State Map of Cut and Bent rebar's supply chain

After the completion of the structural design and the estimation of the amount of rebar that will be consumed, the General Contractor contacts the rebar manufacturer to request a proposal. Initially, it is communicated as an order (activity 7) informing the most likely purchase quantity. The manufacturer assesses the order and then prepares the contract (activity 8) which is approved after negotiation between the companies (activities 9 and 10). The General Contractor then sends the structural design and the rebar delivery scheduling (activity 11) to the manufacturer. It is paramount that the design and scheduling information (includes the delivery date, job site conditions, production batches) are precise as the cut and bent rebar manufacturing is based on this information.

The manufacturer checks the information received (activity 12) and contacts with either the structural designer or the General Contractor may be necessary to clarify some doubtful information. The next step is the preparation of a spreadsheet and scheduling (activity 13) which consists of inputting data into a computational software that automatically organizes the manufacturing and delivery operations. Finally, the rebar is produced (activity 14) and delivered (activity 15). Normally, the rebar production cycle lasts seven (7) days of the supply chain total lead time.

With the materials in hands, the General contractor is responsible for the final assembly of the structural elements and the installation of them inside the forms (activity 16). Even using just-in-time delivery, the materials still remains in the job site stockyard for 15 days (average) before their installation. This fact points out to either a lack or inefficiency of production planning and control process at construction job sites.

Rebar Supply Chain Problems

The table below presents the main problems associated with the information flow in the rebar supply chain. The agent who identified the problem as well as their possible effects in other agent/processes is also provided.

Table 1: Information flow problems in the Cut and Bent supply chain

Supply Chain Problems			Consequences	
Problem	**Description**	**Identified by**	**Possible effect**	**Agent affected**
R1- Design information flow is not defined	Client needs are not clear; information changes are not transferred to all agents	GC; Architect; Structural designer; Manufacturer	Production of unnecessary rebar pieces; rebar assembly errors	Rebar Manufacturer; Job site
R2- Lack of design integration	Greater design integration is needed to assure information reliability and speed	Structural designer; Design coordinator	Increase in design lead time Rework in design phase	Structural designer
R3- Lack of information for structural design	Information from other designers are inaccurate or delayed	Structural designer	Increase in design lead time Rework in design phase	Structural designer; Design coordinator
R4- Delay in design definitions and approval	Delay in definition of project characteristics (constructability aspects, materials, etc) as well as approval process	Structural designer; Design coordinator	Increase in design lead time Rework in design phase	Structural design
R5- No feedback	No Feedback regarding structural designs	Structural designer	Lack of feedback keeps designers doing the same mistakes	Manufacturer
R6- Design changes	Changes in architectural and structural designs	Structural designer; Design coordinator	Changes in other subsystems designs and design rework; increase in design lead time; unnecessary rebar are produced	Structural designer; Manufacturer

Supply Chain Problems			Consequences	
Problem	**Description**	**Identified by**	**Possible effect**	**Agent affected**
R7- Structural design quality	Lack of information or confusing information presented in the structural design. Information about steel quantity does not match the design details. Structural designs need more details.	Manufacturer; Job site	Contact with structural designers/job site is needed for clarification; insufficient information for rebar fabrication; difficulties in assembly process on site	Manufacturer; Job site
R8- Interaction between structural designer and job site	Structural design is not shown to or checked by the site engineer before construction	GC; Job site	Complex designs with fewer details; difficulties to assembly process on site	Job site
R9- Lack of technical support information	The information provided to engineers is not transmitted to assemblers	Manufacturer	Inspection problems and incorrect use of materials; additional visits to correct problems	Job site; Manufacturer
R10- Imprecise Orders	Lack of information or imprecise information related to scheduling of deliveries/quantities	Manufacturer	Contact with GC/job site is needed for clarification; insufficient information for rebar fabrication; unnecessary rebar are produced	Manufacturer; Job site
R11- Lack of production planning and control	Delay in transmission of information to the designer or the manufacturer. Difficulties in defining the exact time to order the materials. Short lead time provided to design solutions.	Manufacturer; Job site	Increase of rebar inventory; random ordering process; indefinite delivery scheduling (dates, which pieces…); delay in assembly and installation processes	Job site; Manufacturer; Structural designer

ELEVATOR SUPPLY CHAIN ANALYSIS RESEARCH METHOD

This research study encompassed two main stages:

Exploratory Interviews

Initially, the processes were analyzed in general terms, based on interviews with six architects, six engineers and five experts in construction management (academics and consultants). The relationships among designers, construction companies, and elevator manufacturers were investigated from the point of view of these construction professionals. The main problems that resulted from the lack of supply chain integration were identified.

Case Study

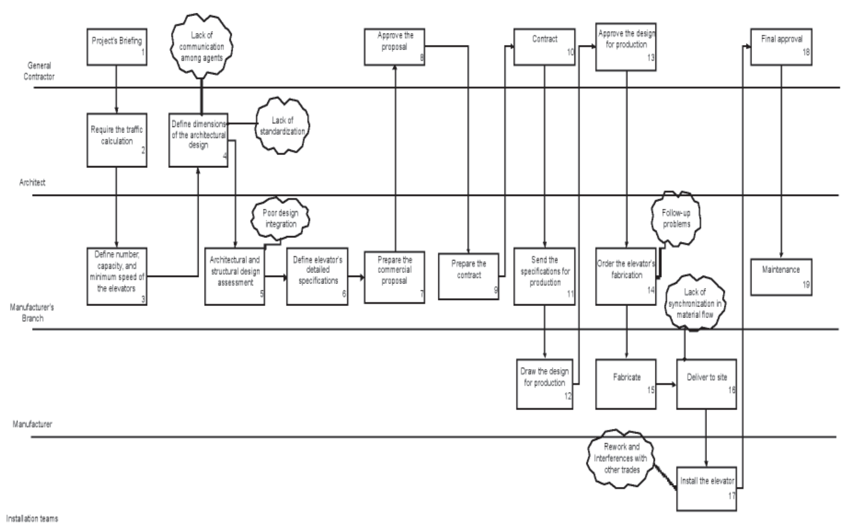
A case study on the elevator supply chain in Porto Alegre was carried out. In this stage, some additional sources of evidence were used: focused interviews, direct observation, document analysis and a survey with a sample of end users.

- The focused interviews provided a counterpoint to the previous interviews. Fifteen people from the supply side were interviewed: nine managers from manufacturing companies, four of them responsible for the installation of elevators, three from the sales department and two branch managers; and six managers from outsourced companies who were responsible for the assembly of elevators on site.
- Direct observation was undertaken through visits to ten building sites. During these visits the pre-installation and installation processes were observed, mapped and documented by using photographs.
- Complementing the information from the building sites and from the interviews, several documents were analyzed: technical specifications, check lists used to evaluate site conditions, production drawings (provided by the producers), technical catalogs, and purchase contracts.

Process Overview

The simplified current state map shown in figure 3 is based on the exploratory interviews that were conducted with architects, building companies and elevator's manufacturers, as well as on direct observation. The main stages of the process are design, procurement, fabrication, installation and maintenance. The process steps on the map do not represent a specific project, but rather a typical industry practice. Figure 3 represents the sequence of activities involved in the process, and the main problems identified in the study.

Figure 3: Current State Map of elevator's supply chain



The conception of the elevator subsystem (activities 1 to 4) starts by calculating its traffic, based on existing standards (ABNT, 1983). Traffic calculation (activity 3) determines the number of elevators, the elevator capacity (number of passengers) and its minimum speed, so that the system meets the building demand. Based on these parameters, the architect can define the dimensions of the component in the architectural design, using criteria established in the catalogs that are provided by manufacturers.

The procurement process (activities 5 to 10) normally starts in the early phase of the project execution due to the long time (usually 5 to 8 months). Also, the elevator is a very expensive item in a residential building project and General Contractors pays for it in instalments, so that its cost is fully financed before it is manufactured.

The establishment of partnerships involving elevator producers and construction companies is not common practice - it usually happens only when either the owners or the GC is fairly large and several units are purchased per year. For that reason, the procurement process is characterized by intense negotiations in which the buyer tries to reduce the acquisition price. Once the manufacturer has been selected, a complex process of detailing and approval of technical specifications (activities 6, 7 and 8) are undertaken. The technical specifications are based on the architectural design and the manufacturer's catalogs information. The definition of contractual issues and milestones (activities 9 and 10) complete the procurement process.

Excessive bargaining allied to the complexities that are inherent to the elevator design and installation often makes the procurement process relatively long (up to 1 month in some cases) and costly for the GCs.

The pre-installation process (activities 11 to 14) encompasses activities ranging from commissioning the elevator to its delivery to the job site. It includes the execution and approval of production drawings (activities 12 and 13) as well as the definition of fabrication and delivery dates (activity 14). These dates are established according to the pre-installation team evaluation of job site conditions to receive and install the elevator. A standard checklist is the main tool used to inform the job sites about the basic requirements for the installation of elevator and warn them what activities still need to be executed. Guidance about storage and installation process is also provided during the pre-installation period. Hence, the pre-installation is characterized by the constant exchange of documents and information among the manufacturer, the manufacturer branch (sales and installation employees) and GCs. The pre-installation plays a crucial role in coordinating the elevator manufacturing activities and the job site installation. Besides, this process should assure that accurate and timely information is transmitted to start the elevator fabrication. Making sure that job sites are in perfect conditions to receive the material and installation will run smoothly with the minimum interruptions is fundamental.

After the fabrication (activity 15) and material delivery (activity 16), the elevator parts are inspected on site by the installation team before the starting of the installation process.

The installation process has a high level of interference with other ongoing processes in the building site (structure, electrical services, finishes). Therefore, the installation lead-time depends fundamentally on the effectiveness of coordination among installers and the site management. During the case study, reported installation lead times varied from fourteen to ninety days. On some sites, elevator parts stayed stored on site for fairly long periods, waiting for installation teams.

ELEVATOR SUPPLY CHAIN PROBLEMS

Table 2 below presents the main problems associated with the information flow in the elevator supply chain.

Table 2: Information flow problems in the elevator supply chain

Supply Chain Problems			Consequences	
Problem	**Description**	**Identified by**	**Possible effect**	**Agent affected**
E1- Lack of information about design requirements	Needed information about the elevator is not shown to structural and electrical designers	GC; Architect; Structural designer	Rework in the design phase; rework in construction phase (execution of the slab of engine room)	Job site; Structural and Electrical designers
E2- Incomplete or incorrect orders sent to the manufacturer	Sales department does not define all product specifications with GCs and forwards incomplete/incorrect orders to the factory	Manufacturer	Delay in the delivery of the production drawings to job site; increase in the total lead time; rework on the job site	Manufacturer; Job site
E3- Design or specifications change during construction are not communicated	Elevator manufacturer is not informed about changes in either dimensions or product specifications during the construction	Manufacturer	Cost increase (specification changes) for GC; Rework on the job site; increase in the installation lead time GC;	Job site; Manufacturer
E4- No production drawings on the job site	GCs execute the construction tasks without analyzing the production drawings	Manufacturer; Job site	Delay in starting installation (no ideal conditions); rework on the job site; Interference with other trades (finishing and painting)	Job site; Manufacturer
E5- Production drawings quality	Information presented is not clear; excess of regulation data; not enough details (mainly electrical)	Job site; Manufacturer	Delay in starting installation (no ideal conditions); rework on the job site;	Job site; Manufacturer
E6- Follow-up and guidance during pre-installation	Information regarding job site conditions is not communicated to the factory. Lack of follow-up doesn't allow anticipation of the potential problems in installation	Job site; Manufacturer	Errors in Fabrication and delivery; rework on the job site; Cost increase (specification changes) for GC; increase in the installation lead time	Job site; Manufacturer; GC
E7- Problems during delivery	Job site is not prepared to receive the elevator due to lack of information regarding delivery date	Job site	Job site labors needed to unload the elevator; decrease in job site productivity due to interruption in production	Job site
E8- Storage problems	Storage locations usually do not achieve the minimum requirements established in the contract	Manufacturer	Damages to Elevator parts; Cost increase for GC; Delay in starting installation	Job site; GC; Manufacturer

DISCUSSION

In the previous section, two cases studies that were conducted in elevators and cut and bend rebar supply chains have revealed a number of information flow related problems. In this section, those problems are discussed from the Language-Action Perspective, in association with different kinds of failures modes that are possible to happen in terms of the completeness of commitment loops and their connectivity.

FAILURES IN THE COMPLETENESS OF COMMITMENT LOOPS

Four classes of failures have been identified regarding the lack of completeness in commitment loops and regarding the presence of all of the four phases presented previously.

Lack, error or lateness in request formulation by the customer

This kind of failure is related with the conversational act in which the customer makes a request to the performer. Three distinct failure sub-classes where identified: the absence of an explicit request from the customer (problems R2, R8, R10, E1 and E4), lack of comprehension about what was really requested (problems R7 and E5) or the lateness of the request to the customer, thus not providing enough time for task completion (problems R4 and R11). A variant of this kind of failure is related with changes request because they are (in general) not expected by the performer. Thus, when they occur, this not rarely represents a break in previous commitments, and throw both parts into a new negotiation phase (problems R6 and E3).

Lack of explicit declaration of commitment by the performer

In such situations, the performer does not make an explicit promise to fulfil the request that was issued by the customer. That promise must at least include what is to be delivered and when it is expected to happen, and its absence or incompleteness may suggest that customer and performer have not yet reached a consensus about the matter, or that its terms were not equally understood by both of them. This failure was identified in problem E7, where the absence of the declaration about the moment when product is expected to be delivered to the site may result in inadequate conditions for the storage of components, interruptions in the installation process of the elevator or interferences in other processes being executed on the site.

Lack of explicit declaration of it conclusion by the performer

In the inter-subject world, a task can only be considered as concluded when the customer is notified by the performer about this fact. However, from the performer's point of view it could be acceptable that his commitment is fulfilled when he completes the execution of the task (i.e., taking into consideration only the material, objective world). In the customer's perspective, when the conclusion time is reached and no notice is available, three possibilities arise: the performer finished task execution and forgets (or does not want) to notify the fact, he is late or he decides to give up. In the situation described in E8, in spite of the fact that space availability for the storage of elevator components is under General contractor's responsibility, no explicit declaration about such availability is given to the elevator manufacturer about the availability of storage space. When the manufacturer delivers the components he may discover that there is no such availability and components must then be stored according the possibilities, which may result in bad storage conditions and quality problems during elevators installation and use.

Lack, error or lateness in declaration of customer's satisfaction

The commitment loops only closes when the customer expresses his satisfaction with the result of performer's work. When this declaration does not occur, the performer is tempted to assume that customer is completely satisfied with his work and no stimulus to performance improvement is given. This kind of situation is illustrated in problem R5. In other situations, the customer identifies problems but does no give any warning to the performer. This happens in situation R4, with problems flowing along the chain without any upstream warning or feedback.

Failures With The Connectivity Of Commitment Loops

Two classes of failures were identified regarding the lack of or poor connectivity among commitment loops. In those situations, loops are complete but the linkages among them are limited to the role of information exchange and do not have the ability of chaining commitments among involved actors.

In the same organization

Commitments are assumed, kept and honoured by firms through their people. Usually, inter-firm commitments demands a number of intra-firm ones, and it is not rare that a person that enters into a commitment with the representative of other firm is not the one that is responsible for its fulfilment. This favours two kinds of problems: the chain of commitments inside the firm is broken and commitments are not fulfilled, or the person that assumes the commitment delegates his work but not the commitment itself (the next performer is committed with him but not with the original one). In situations R9, R10, E2 and E6, failures occur basically because the chain of commitments is broken somewhere inside the firm, or because the quality of the information needed to fulfil the original commitment is eroded along such chain.

Between different organizations

This is similar to the previous one but with the additional difficulty that is imposed by the economic nature of the firms. Such situation usually involves a triangular arrangement in which one firm assumes the commitment of performing some task to other firm, then subcontracts another one to perform part or all the task and asks it to deliver the result directly to the first. In problem R3, there were identified some situations where the structural designer have sent the drawings directly to the rebar manufacturer without warning the contractor about this fact. While this procedure may reduce total lead-time, it breaks the chain of commitments and makes more difficult the control of the overall process.

CONCLUSIONS

Both case studies have shown that the perspective of commitment flows provides means to understand the nature of the information flow problems in make-to-order supply chains in construction. A richer picture of such problems has been obtained, devising novel explanations for breakdowns that elevators and cut and bend rebar supply chains have in common.

The findings of this study suggest that a great part of the information flow problems that happen among make-to-order supply chains can be traced back to the way that commitments among people and firms are managed along such chains. They also suggest that the kinds of failure in managing those commitments can be associated with a small number of classes, which are result of the incompleteness or poor connectivity among commitment loops.

All the information flow problems that were identified in both case studies have shown some relationship with the existence of failures regarding the lack of completeness or poor connectivity of commitment loops both between and inside individual firms.

As the nature of the identified problems has shown, their possible solutions are not expensive in their nature, indicating that some of them could be avoided by making supply chain members aware of the importance of the management of commitments both in the intra and inter-firm spheres of make-to-order supply chains.

Finally, it important to note that this study has been focused only on the information flow breakdown situations found in elevators and cut and bend rebar supply chains. Thus it has not covered all the range of problems that are expected to occur in make-to-order supply chains in construction. Besides, further research addressing the discussion and evaluation of the LAP relative strengths and weaknesses in the context of supply chain case studies is still needed and might contribute to the improvement of construction supply chains performance in the near future.

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