Interface Management and its Effect on Project Complexity in Construction Management

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Abstract - *Recently, formal approaches to interface management (IM) have been adopted in several large-scale engineering and construction (E & C) projects. However, understanding the role and performance of IM practices in E & C projects is quite limited at present. Given this circumstance, this document attempts to understand the effectiveness of IM practices in E & C projects from the perspective of addressing the complexity of the project. The current formal MI practices employed in E & C projects are effective in mitigating the adverse impact of project complexity caused by uncertainty in outreach and communication and a large number of stakeholders; however, they are not as effective in dealing with the complexity of the project that originates from a large number of designed elements.*

Keywords— Interface Management, Project Complexity, construction management, civil engineering

1. INTRODUCTION

This paper reviews various journal papers published on interface management in construction management and its current state. This review paper focuses on construction management engineering field. Many construction projects are increasingly complex and large scale due to advances in technology and operations. These projects involve many stakeholders, with different geographic locations and work cultures, collaborating with each other throughout the life cycle of the project. Industry leaders believe that interface management systems can be created to improve alignment among stakeholders and reduce project problems and conflicts. However, the identification of interfaces and monitoring interface states are important challenges that create a continuous struggle for owners. Interfaces are generally considered as links between different building elements, stakeholders and project areas. Mismanagement of interfaces can result in deficiencies in the cost, time and quality of the project during the execution of the project life cycle, or may lead to failures after the project delivery. Therefore, having a systematic interface management to effectively manage the interfaces throughout the life cycle of the project is critical to the performance of the project. In this document, a process-based approach is proposed for the management of the mega capital project interface, beginning with the definition and taxonomy of the interfaces. Then, the main steps to implement an Interface

Management System (IMS) are presented: (1) interface identification, (2) documentation, (3) issuance, (4) communication and (5) closure. Capital projects in asset intensive industries are becoming increasingly complex. Effectiveness and efficiency considerations of project delivery prompt involvement of multiple specialized stakeholders from different geographic locations and variable scope packages that allow corporate owners to adjust project objectives according to the changing business environment (Yun et al., 2012).

Today, many engineering and construction (E & C) projects are characterized by sophisticated large-scale technology, long duration, large numbers of participants and stakeholders in the project, worldwide dispersed locations of project execution, high levels of uncertainty and high schedule and cost. Pressures in competitive and volatile economic environments. In short, today's E & C projects are more complex than ever. In addition, as technological advances and socio-economic environments become more complicated, the complexity of E & C projects will continue to grow. To better address the higher levels of complexity of the project, some new management approaches have been introduced and have gained increasing popularity among professionals in the E & C industry over the last decade. Among the approaches is interface management (IM).

2. INTERFACE MANAGEMENT

"The peculiarities of building construction — poorly controlled building environment, complexity of construction, temporary multi-organization, and subcontracting and interdisciplinary nature — increase the number and types of interfaces in a project, and cause various interface issues" (Chen et al., 2006). IM is claimed to be "an effective tool in proactive avoidance or mitigation of any project issues, including design conflicts, installation clashes, new technology application, regulatory challenges, and contract claims, and would enhance the successful delivery of megaprojects" (Nooteboom, 2004, INTEC engineering report).

"Interfaces are defined as the contact point between relatively autonomous organizations which are interdependent and interacting to achieve some larger system objectives" (Wren, 1967). In general, interfaces are

considered either internal (within a single contract or scope of work) or external (between)

However, there is a significant amount of interaction between each party directly involved in the project and the other independent entities outside the project, including the government, local infrastructure systems, local and international organizations. To address all types of interfaces, the project interfaces are analysed in three levels (Collins et al., 2010):

• Interface between projects: interfaces between different parties directly involved in the planning and execution of the project.
• Interface within the project: interfaces within the organization of each independent party, involved in a project.
• Extra-project interface: interfaces between project parties and other parties / organizations that are not directly involved in the execution of the project. (for example, government permits or environmental organizations).

As the scale of the project increases, the number of interfaces to manage increases exponentially and its management becomes increasingly difficult. Considering the importance of instant messaging, and in response to the increasing difficulty of managing interfaces, formal IM approaches are formal procedures for interacting with each other, the formal positions of the interface manager / coordinator, the Information systems designed for interface management and so on, have been adopted in a series of large-scale E & C projects. However, the understanding of the role and performance of IM practices in E & C projects is quite limited, and for this reason, IM practices are selected or designed, largely based on speculation about their effectiveness. Given this circumstance, this work tries to get rid of some light on the effectiveness of IM practices in E & C projects from the perspective of the complexity of the project, using an empirical approach. In other words, this paper attempts to empirically understand the usefulness of IM practices in E & C projects in terms of reducing the adverse impacts of project complexity.

The rest of this article is organized as follows. In the next section, we present the theoretical and empirical background of this study, focused on the complexity of the project and the management of the interface. In the following section, the empirical research methodology used in this study is described in detail (variables, method of data collection, methods of data analysis). Next, the results of the data analysis are explained and, finally, the discussions and conclusions are presented.

2.1 Theoretical and empirical background

This study is based on previous theoretical and empirical work on the complexity of the project and the management of the interface. These two issues are often not discussed together, so their theoretical and empirical background is reviewed separately. It highlights a work that directly analysed the relationship between the complexity of the project and the management of the interface.

3. PROJECT COMPLEXITY

Although it is not uncommon to hear people say: "The project is complex" or "Project complexity is high" in industry and academia, the definition of project complexity is not yet fully established in any of these domains. In fact, the concept of complexity has also been a subject of debate in many other disciplines. There have been numerous efforts to technically define system complexity in physics, mathematics, computer science, biology, and sociology, yet a unified definition is still missing (Mitchell 2009). The history of explicit discussions of project complexity is relatively short (Geraldi and Adlbrecht 2007). Baccarini (1996) was one of the first scholars who attempted to define project complexity, which he did by borrowing the idea of integration and differentiation in organizations originally proposed by Lawrence and Lorsch (1967). Since then, many scholars have strived to define and measure project complexity, but an agreed-on, unambiguous definition is still not available (Bosch-Rekveldt et al. 2011) Nonetheless, the project management literature offers a number of definitions of project complexity, each slightly different from the others, a few of which are listed in Table 1. Because of its lack of clarity, project complexity is often understood only intuitively in E&C projects despite its great potential impacts on project management (Bosch-Rekveldt et al. 2011).

Although their definitions offer slightly different ways of looking at the complexity of the project, the common notion seems to be that the complexity of the project is inherent and related to the multiplicity of parts, processes, parts, systems and interrelated technologies of a project, and that is It correlates strongly with the difficulty of managing a project and of predicting the results of the project. For this reason, it is often argued that complex projects require a more structured approach to project conceptualization and planning (Gransberg et al. 2013). In some cases, researchers focused on the subjectivity of project complexity, which implies that complexity can only be defined in terms of its effect on human cognition—such as the cognitive effort exerted by decision makers to make sense of a decision problem (Fioretti and Visser 2006; Remington et al. 2009), and that therefore project complexity might be perceived differently by different

individuals (Jaafari 2003). As discussed here, the complexity of the project is based on an integral notion of its nature. This broad approach is adequate in the context of this study, given that a concept of complexity may not be sufficient to explain complexity. aspects of complexity are helpful in appropriately appraising it (Geraldi and Adlbrecht 2007).

In addition to the different definitions of complexity of the project, numerous and diverse factors / sources of project complexity have been suggested in the literature, including the multiplicity of interdependent disciplines / processes; multiplicity of stakeholders; technological newness and uncertainty; cultural diversity among project participants; risks; and unclear goals, scope, roles and responsibilities (Baccarini 1996; Williams 1999, 2002; Tatikonda and Rosenthal 2000; Geraldi and Adlbrecht 2007; Vidal and Marle 2008; Bosch-Rekveldt et al. 2011). In addition, some researchers have indicated that schedule and cost pressures exacerbate project complexity (Morris 1988; Geraldi and Adlbrecht 2007; Williams 1999; Kardes et al. 2013), thus serving as complexity factors or contributors.

The researchers have tried to place the factors / sources of complexity of the project in several categories. These categories are sometimes called dimensions of or patterns. Because the projects are configured with a unique combination of complexity factors. "not all projects are complex in the same way" (Remington et al. 2009, p. 5). Based on notions of subjectivity and multidimensionality of project complexity, Geraldi and Adlbrecht (2007) claimed that the comprehensive set of characteristics impacting or forming complexity cannot be determined prior to a project's outset but is potentially determinable only subjectively or after the project has been completed. However, it may still be possible to assess the overall level, and pattern, of complexity before a project begins (Geraldi and Adlbrecht 2007)

4.RELATIONSHIP BETWEEN INTERFACE MANAGEMENT AND PROJECT COMPLEXITY.

Several researchers have recognized that the IM and the complexity of the project are interrelated. One of the first accounts of this interrelation in E & C is a book chapter written by Morris (1988, Chapter 2), which states that the IM is useful especially in large, complex and urgent projects and that, in such project's lines of responsibility and the relationships of authority and interface must be clearly defined and intensely coordinated, and the work must be delegated and explained strictly in accordance with these lines and procedures. These recommendations are aligned with what the formal MI approaches suggest. It was also observed in this work that such a formal IM approach had not been used in the construction industry

despite its great potential for application and utility in large and complex construction projects.

More recently, Vidal and Marle (2008) indicated that approximately 70% of the project complexity factors identified from literacy are organizational, not technical. They stated that the complexity factors of the project related to the interdependencies in a project seem to be the most important for the daily management of the project, and that the management of the interactions is probably the most influential and valuable to address the complexity of the project. Earlier Geraldi and Adlbrecht (2007) had tried to theoretically formulate the relationship between the complexity of the project and the interfaces. They argued that the predominant type of project complexity perceived by project managers is the complexity of the interaction, and that this demonstrates the importance of project coordination. Geraldi (2009) further developed this idea and said that this type of complexity occurs in the interfaces between people or organizations and includes aspects of politics, ambiguity and multiculturalism. This type of complexity is indicated by a large volume of emails, phone calls, meetings and misunderstandings, and is influenced by transparency, multiplicity of references and empathy (Geraldi and Adlbrecht 2007). Geraldi (2009) also observed that such complexities are negotiable and, therefore, managers and companies must actively address the complexity of the project by evaluating and configuring it, taking into account that complexity is not a fact, but is constructed and is modifiable and, sometimes, self-induced.

Based on their definitions, it is thought that the complexity of the project generally increases the difficulty of project management, including instant messaging. Given that IM can be seen as an intentional effort to cope with the complexity of the project (since it is about managing the boundaries between the interrelated parties in a project), it is important to understand the relationship between the complexity factors of the project and the effectiveness of the IM. In addition, given that there is a spectrum of IM practices used in E & C projects, it is thought that the impact of the complexity factors of the project on the effectiveness of the MI in a construction project may differ according to the IM practices that are used. use. In particular, it is conjectured that the IM practices used may have a moderating effect (i.e., the relationship between independent and dependent variables depends on a third variable) in the relationship between the complexity factors of the project and the effectiveness of the MI. In simpler terms, it is thought that formal MI practices make a project more resistant to some factors of project complexity. On the basis of these notions and conjectures, two exploratory hypotheses were constructed and tested in this study: (1) the complexity factors of the project affect the effectiveness of the MI; and (2) IM practices

moderate the influence of project complexity on the effectiveness of IM in E & C projects.

4.1 Efficiency of IM practices

The methods and units to measure and objectively evaluate the effectiveness of MI practices have not been established. Therefore, in this research a subjective measure of the effectiveness of MI practices was used, that is, the satisfaction of MI. This type of subjective classification has been widely used as a substitute measure of the real effectiveness of a system or practice in organizations (Gatian 1994, Tornow and Wiley 1991, Pothukuchi et al 2002).

5. CONCLUSIONS

Morris (1988) argued that the clear definition of static / dynamic interfaces is a fundamental principle of project management. However, many structured approaches were not attempted to investigate IM in E & C projects until recently. This document is one of the first attempts to investigate the relationship between the complexity factors of the project, the IM practices and the effectiveness of the practice of IM in E & C. To meet the objectives of this study, variables were identified for the complexity of the project, the IM practices and the effectiveness of the IM practice; the data was collected through semi-structured interviews of a total of 45 large-scale E & C projects and analysed using the quantitative methods of PCA and PCR.

The conclusions of the analysis are (1) that complexity implies "lack of clarity / uncertainty in roles and responsibilities, technology and scope, and a multitude of stakeholders" and "multitude of elements designed in relation to the multiplicity of owners / contractors general "to hinder the effective management of interfaces in E & C projects in general; (2) that, particularly in projects without formal MI practices, "lack of clarity / uncertainty in roles and responsibilities, technology and reach, and a multitude of stakeholders "make instant messaging difficult; (3) that, however, in projects with formal IM, only the complexity component" multitude of elements designed in relation to the multiplicity of owners / general contractors "negatively affects the satisfaction of instant messaging, while" the lack of clarity / uncertainty in roles and responsibilities, technology and reach, and a multitude of stakeholders "may not have a significant impact" . From these results, it can be deduced that current formal IM practices are useful to address the complexity factors related to outreach, communication and a large number of interested parties, but show some weakness when dealing with a large number of designed elements

Due to lack of understanding of their role and performance in E & C projects, IM practices were generally selected or designed, based on speculation about their effectiveness in E & C projects. In these circumstances, this document provides empirical evidence of the effectiveness of IM practices used in E & C projects from the perspective of how they help to deal with the complexity of the project. Therefore, this document informs E & C professionals about the specific expected benefits of employing newly developed IM practices. In particular, it clarifies the strengths and limitations of current IM practices in E & C and, therefore, helps E & C project / program managers to make informed decisions regarding the coordination and management of interorganizational interface points. In addition, information on the limitations of current IM practices in the E & C industry will guide professionals in the design and development of more advanced IM tools / practices to better address the complexity of the project in large scale E & C projects.

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