HOW TO IDENTIFY THE CRITICAL STAKEHOLDERS IN AN INTERFACE MANAGEMENT SYSTEM?

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ABSTRACT

The increasing size and complexity of mega construction projects result in having several geographically distributed stakeholders, collaborating with each other to successfully deliver the project. Electronic Product and Process Management Systems (EPPMS) are recently emerging to facilitate the collaboration between stakeholders, reduce the surprises and issues, and improve the project productivity. These are commercially successful but evolving systems. An important component of EPPMS is the Interface Management System, which aims at formalizing and automating the communication channels between stakeholders. An interface is generally considered the link between construction elements, phases, or stakeholders.

An interface Management System (IMS) involves five iterative steps: (1) Interface Identification, (2) Interface Documentation, (3) Interface Transferring, (4) Interface Communication, and (5) Interface Closing. A fundamental part of step 2 is recognizing different roles in dealing with interfaces. Each stakeholder is assigned a different role, such as responsible, accountable, consulted, and informed. In a mega project, several thousands of interfaces exist with complex relationships between stakeholders. Therefore, identifying stakeholders with higher responsible roles has been requested as useful information to the project owner in dealing with some of the project risks.

After the interfaces are determined, and the responsibilities are allocated, the critical stakeholders are identified using the centrality concept in Social Network Analysis. The critical stakeholders can be determined at the highest level, considering all types of interfaces, as well as for each specific type or discipline-related interfaces. The proposed methodology is applied on a hypothetical offshore project with over 500 interfaces. In fact, this project is a simplified representation of a real scale Liquid Natural Gas project. In order to reduce the complexity of calculations and clarity of explanations, the simplified case study is used.

By implementing IMS in mega projects, different parties not only formalize the communication between each other, but also gain better visibility concerning their roles and responsibilities. In addition, the owner benefits from analysing the complex relationships between stakeholders to further identify critical ones, along with other criteria like package cost, stakeholders' experiences, etc.

KEYWORDS

Interface Management, Critical Stakeholders, Centrality Concept

INTRODUCTION

Many construction projects are becoming more complex and larger in scale because of significant improvements in technology and operations, as well as increasing market demand. These projects involve many and various stakeholders, with different geographical locations and working cultures, but also collaborating with one another throughout the project life cycle. Oil sands, off-shore and nuclear are examples of this class of projects. In response to this new project delivery paradigm, "electronic product and process management systems (EPPMS) have emerged to facilitate execution of mega projects by linking project stakeholders over a range of distances via the internet and system servers, formalizing and automating work processes, and automating the document management system" (Shokri et al., 2012). Interface Management System (IMS) has become a growing component of an EPPMS. IMS focuses on formalizing and automating the communication channels between stakeholders to facilitate collaboration, increase alignment, and reduce misunderstanding and conflicts.

Poor management of interfaces typically results in deficiencies in the project cost, time, and quality during the project execution, and may result in failures after the project has been delivered (Shokri et al., 2012). Through a comprehensive IMS, stakeholders get a clear understanding of their roles and responsibilities, and better insight on their objectives. According to the leading construction companies, the IMS is still in its infancy and need more development to reach its maximum benefit to the industry. One of the instant benefits of IMS to an owner is the ability to identify the critical stakeholder(s) in dealing with interfaces. In this paper, a process-based IMS is proposed for the construction industry. Then, by incorporating the Social Network Analysis (SNA) concepts to the IMS, a tool is provided to determine the complex relationships of interfaces in the network of stakeholders, and classify stakeholders according to their responsibilities.

BACKGROUND

Interface Management

The Interface Management (IM) concept is not new. It was first introduced by Wren to understand and analyse the inter-organizational problems within a typical aerospace project and an electric power pool project (Wren, 1967). However, due to lack of advanced technological infrastructure, the IM and its applications were not employed until recent years. IM is referred to as a "an effective tool in proactive avoidance or mitigation of any project issue, including design conflicts, installation clashes, new technology application, regulatory challenges, and contract claims, and would enhance the successful delivery of mega projects" (Nooteboom, 2004, INTEC engineering report).

In a complex project, several interface points are identified, and these points reflect any physical or virtual contact points between every pair of independent organization. Interface points are analysed in two levels: (1) internal interface points, which are within boundaries of a single contract or work package, and (2) external interface points, which reflect the relationship between contacts or scope packages (Chen et al., 2007; Lin, 2009).

Due to the fragmented nature of construction projects, IM was used to increase alignment between parties by assisting the communication. As an example, IM was implemented to create an effective and timely communication between an MAC (Main Automation Contractor) and an MEC (Main Electrical Contractor) (Calgar and Connolly, 2007). The other examples are improving project safety by transferring the information of hazardous materials between project parties (Kelly and Berger, 2006), defining the communication strategies in agile project management (Chen et al., 2007), and creating an error-free communication infrastructure between architecture, mechanical and electronic engineering, and air conditioning system engineering (Siao et al., 2011).

Social Network Analysis

The Social Network Analysis (SNA) concept was introduced by Moreno (Moreno, 1960) to capture and visualize the social relationship between children (Scott, 2012). "A social network consists of a finite set or sets of actors and the relation or relations defined on them" (Wassermann and Faust, 1994; Pryke, 2012). Since then, it has been used as a quantitative tool to represent and formulate the interactions between several groups and entities. In the SNA studies, graphs are used to represent the inter-relationships between individuals or organizations in a group. In a graph, or sociogram, a node or actor represents an individual, organizations, entity or collective social unit (Wassermann and Faust, 1994; Pryke, 2012). The links or edges illustrate the relation between the actors, and the relation is defined as "the collection of ties of a specific kind among members of a group" (Wassermann and Faust, 1994; Pryke, 2012). If the relationship is two-sided, a simple line is drawn between two nodes. A directed edge is used for one-sided relationship. The relation can address the information transfer, responsibilities of entities, collaborations, etc.

Several concepts of graph theory are adopted by SNA to formalize and analyse the relations between actors in a network, including:

- Density: it indicates the actual amount of interaction (edges) between entities in a network. (Pryke, 2012; Wassermann and Faust, 1994, Chinowsky et al., 2008)
- Centrality: this is related to the distribution of relations between nodes in a network. It shows how involved an actor is in relationship with other actors. (Pryke, 2012; Wassermann and Faust, 1994, Chinowsky et al., 2008)

SNA concepts are used in the construction industry during the past two decades in different fields of project performance assessment and supply chain management. Integrating social networks and traditional project management concepts illustrates that the information sharing and knowledge exchange is a foundation of achieving high performance teams and project outcomes (Chinowsky et al., 2008; Chinowsky et al., 2010; Ruan et al., 2012). The construction project coalition in the supply chains is also modeled to enable the identification and classification of construction procurement methods (Pryke, 2004). One of the outcomes of studying construction projects using social network concepts was that roles of the project actors and the relationship between them are not clearly defined (Pryke, 2012). In this study social network concepts are employed to visualize and analyse the network of interface points between stakeholders in a project.

METHODS

Process Approach for Interface Management System

To identify the key stakeholders in a network of interfaces, a systematic IMS should be designed and implemented. A process-based IMS involves five steps: (1) interface identification, (2) Interface documentation, (3) interface transferring, (4) interface communication, and (5) interface closing. (Shokri et al., 2012). These steps are iterative and they should be repeated at different stages of the project. However, the early identification of interfaces gives more visibility on the roles and responsibilities, as well as the areas that may pose some risks to the project. These steps are discussed as follows:

1. Interface Identification: During this step, as many interface points as possible are identified. Major portion of the interfaces are identified during the FEP (Front End Planning) phase. Interface identification is an ongoing process throughout project life cycle and usually is done by a group of experts of the project, by reviewing the design documents, work breakdown structure (WBS), contract documents, project specification, etc (Chua and Godinot, 2006; Shokri et al., 2012).
2. Interface Documentation: Once the interface points are identified, their associated information is gathered and documented. This information includes the interface point characteristics, stakeholders involved in this specific interface point, deliverables, need dates, interface point stage, etc. One of the important tasks at this step is to recognise and record the roles and responsibilities of the involved stakeholders.
3. Interface transferring: The general information of interface points is gathered at the early stages of the project, and prior to contract awards. After the contracts are awarded to different contractors, the owner will transfer all the identified interface points and their information to the awarding party. Therefore, the contractor will know about the interface points related to his package and scope of work, his responsibilities, estimated deadline, and the other parties with which he is interfacing.
4. Interface Communication: After the contracting parties receive their interface points, and approve the accuracy and adequacy of the information, they start to communicate with the

interfacing parties by issuing interface agreements. This step will be executed under the jurisdiction of the Interface Manager and involve all interfacing parties.

5. Interface Closing: "The interface is considered closed if all involved stakeholders agree on the efficiency, accuracy and completion of communicated information/tasks and deliverables" (Shokri et al., 2012). The closing time of an interface point depends on its life cycle. Some interface points are active throughout the whole project; however some of them are only active during the design stage.

The framework of the proposed IMS is represented in Figure 1.

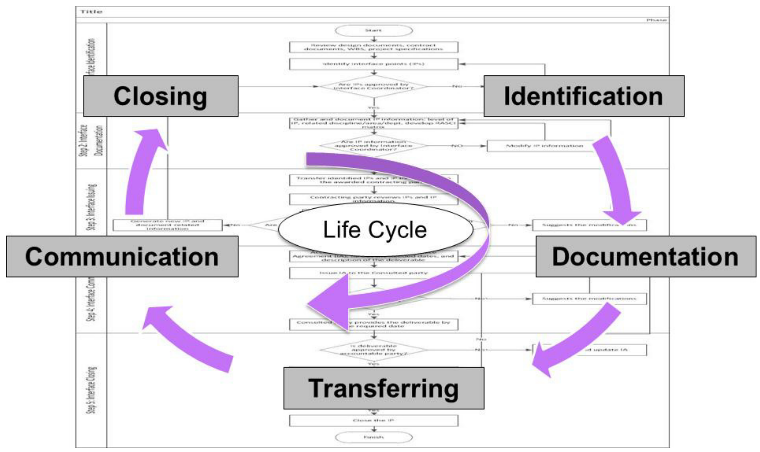

Figure 1– Process-based Interface Management System (IMS) Framework

Social Newark of Interfacing Stakeholders in an Interface Management System

"In the social network model, the underlying hypothesis is that projects need to be managed as social collaborations to achieve results that exceed traditional expectations" (Chinowsky et al., 2008). IMS systems are evolving rapidly in the past few years, and are considered as one of the approaches to address the abovementioned hypothesis. The objectives of the IMS are to facilitate the alignment process between stakeholders by formalizing communication channels between them; increase visibility on the roles and responsibilities of collaborative works, and reduce the potential risks.

In a mega project, there are several stakeholders with thousands of interface relations between them. As a result, monitoring the performance of all stakeholders in dealing with interface issues could be a challenging process. Therefore, there should be a methodology to select key stakeholders in terms of the interface-related interactions.

Social networks are considered as appropriate tools to visualize the relationship between different entities. For the purpose of this study, a social network concept is proposed to capture and analyze the interface interactions between stakeholders. In the proposed Stakeholders Interface Network (SIN), the stakeholders are represented on the nodes, and the edges show the interface points between them. The direction of the edge depends on the roles of stakeholders. For each interface point, two major roles are recognized during the first and second steps of the IMS (interface identification and documentation):

- Leading stakeholder: He has the overall responsibility of the interface point. This stakeholder should make sure that all the requirements of the interface point and associated deliverables are identified, communicated and delivered, at the specified time and with the requested accuracy.
- Interfacing stakeholder: He has to provide the major portion of the information and deliverables within the requested time, and with the required description.

According to these definitions, the direction of each edge starts from the leading stakeholder toward the interfacing one.

To illustrate an example of SIN, a hypothetical offshore example is generated. This example is a simplified but realistic illustration of a full scale offshore Liquid Natural Gas project. The main reason of using a simplified model is to reduce the complexity of explanations and calculations. The general schematic representation of the project is shown in Figure 2. In this project, 6 major EPCs are awarded 6 different scope packages, and they are dealing with several electrical, pipelines, turret, mooring, and well system interface points. Approximately 550 interface points are identified during the FEP stage for this project. Table 1 illustrates the number of interface points for each discipline.

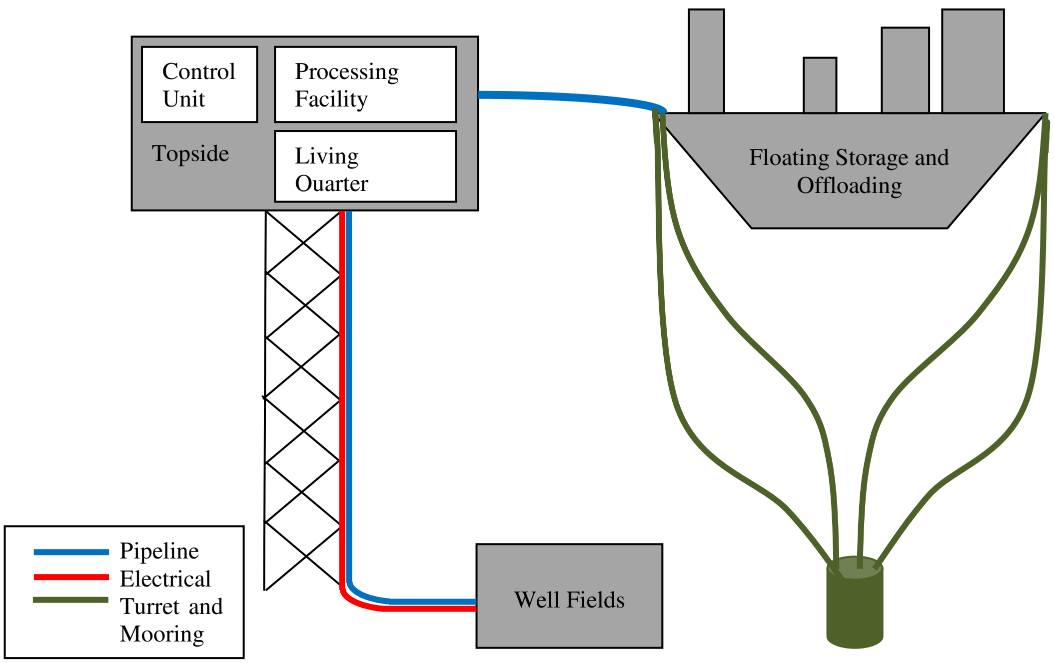

Figure 2 – General Illustration of Hypothetical Offshore Liquid Natural Gas Project

Table 1 – Number of Interface Points for each Discipline

	Electrical	*Pipeline*	*Turret*	*Mooring*	*Well System*
Number of IPs	145	275	20	25	77

The SIN is generated using UCINET (Borgatti et al., 2002). Since the generated network is very complicated and large in scale, Figure 3 illustrates a snapshot of SIN for this offshore project. In this figure, the interface relations are shown between 5 EPC (Engineering, Procurement, and Construction) companies. The interface points are shown on edges and are related to the pipeline, turret, electrical and well system disciplines, which are shown in black, green, red and blue edges, respectively.

Identifying the Central Interfacing Stakeholders

To leverage the size and complexity issue, the weighted network is suggested to represent the interface interactions. In the Weighted Stakeholders Interface Network (WSIN), for each discipline, the number of interface points between every pair of stakeholders are added up to represent the weight of the edge between them. Figure 4 shows the WSIN for the hypothetical offshore project. In this figure, the pipeline, turret, mooring, electrical and well system disciplines are shown by black, green, purple, red and blue edges, respectively.

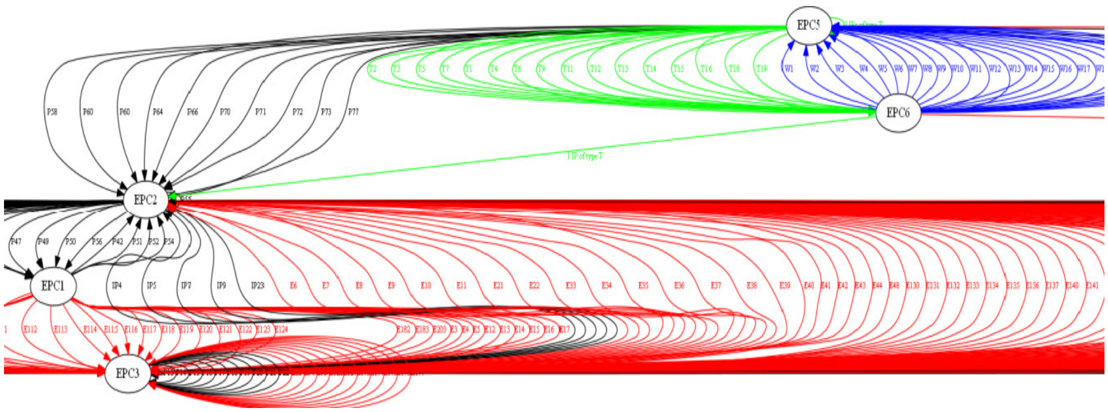

Figure 3– Snapshot of Stakeholders Interface Network (SIN) for Hypothetical Offshore Project

Social networks assist to visually predict the behaviour of the network. The visual analysis of Figure 4 illustrates that the network follows a centralized pattern with EPC 2 and EPC 3 being involved in the major part of interface points, either as a leading or interfacing stakeholder. In other words, most interface points should be either initiated or answered by these two EPCs. It can be concluded that the low performance of the central stakeholders could affect the overall IMS performance, and the owner should make sure that the central parties have an effective IMS within their organization. On the contrary, EPC 1 and EPC 4 are involved only in interface relationship with EPC 2. Therefore, establishing and monitoring the collaboration and communication process between these EPCs are less complex, comparing to EPC 2 and EPC 3.

The other point that can be inferred from the visual analysis of the network is that both of EPC 2 and 3 are dealing with interface points related to three disciplines. It means that their scope packages are more complex, and these organizations must have been specialized in more discipline or they are involved in contract relationships with several specialized subcontractors.

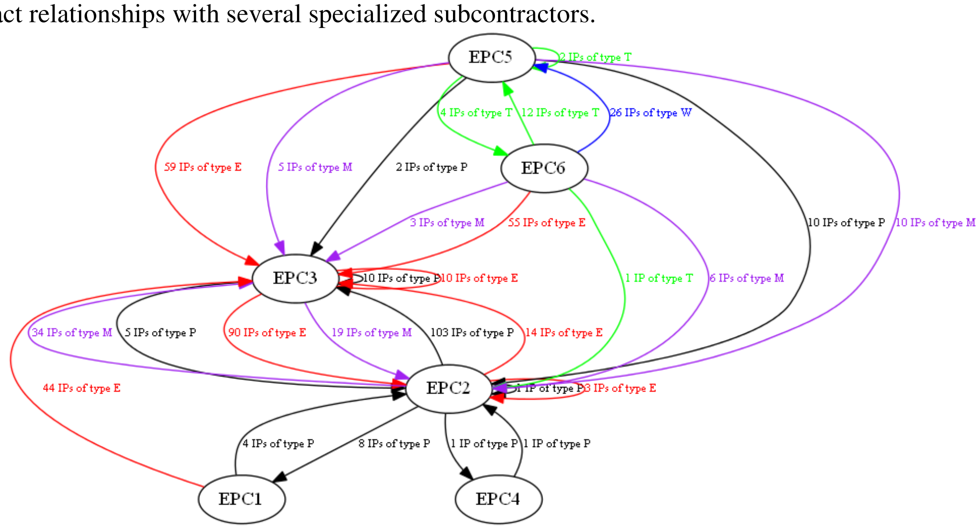

Figure 4– Weighted Stakeholders Interface Network (WSIN) for Hypothetical Offshore Project

In order to mathematically analyse the network, two types of centrality concepts are introduced (Pryke, 2012).

- Influential actors: The ones with large number of out-degree edges.
- Prominent actors: The ones with large number of in-degree edges.

In the WSIN, the influential stakeholders represent the ones that have major leading roles in managing the interface points, and the prominent actors are the ones that have the major portion of interfacing roles. The network shown in Figure 4 is analysed using UCINET (Borgatti et al., 2002), and centrality analysis of the network, considering all types of interface points are shown in Figure 5.

The same analysis is done for all five disciplines and the results are represented in Table 2.

Table 2 – Centrality Analysis for the Hypothetical Offshore Project

	All IPs	*Electrical*	*Pipeline*	*Turret*	*Mooring*	*Well System*
Influential	EPC 2	EPC 3	EPC 2	EPC 6	EPC 2	EPC 6
Prominent	EPC 3	EPC 3	EPC 3	EPC 5	EPC 3	EPC 5

The analysis results are aligned with the visual analysis, and show that EPC 2 and EPC 3 are the central stakeholders in the interface network, with EPC 2 having more leading roles, and EPC 3 being mainly in the interfacing position. In the electrical discipline, EPC 3 seems to have the major responsibilities in handling the interface points. And, EPC 6 is responsible for all the interface points related to the well system.

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
2	EPC2	126.000	111.000	21.538	18.974
3	EPC3	95.000	277.000	16.239	47.350
6	EPC6	94.000	4.000	16.068	0.684
5	EPC5	75.000	38.000	12.821	6.496
1	EPC1	48.000	8.000	8.205	1.368
4	EPC4	1.000	1.000	0.171	0.171

DESCRIPTIVE STATISTICS

		1 OutDegree	2 InDegree	3 NrmOutDeg	4 NrmInDeg
1	Mean	73.167	73.167	12.507	12.507
2	Std Dev	39.889	98.704	6.819	16.872
3	Sum	439.000	439.000	75.043	75.043
4	Variance	1591.139	9742.473	46.494	284.680
5	SSQ	41667.000	90575.000	1217.532	2646.650
6	MCSSQ	9546.833	58454.832	278.964	1708.082
7	Euc Norm	204.125	300.957	34.893	51.446
8	Minimum	1.000	1.000	0.171	0.171
9	Maximum	126.000	277.000	21.538	47.350
10	N of Obs	6.000	6.000	6.000	6.000

Network Centralization (Outdegree) = 13.547%
Network Centralization (Indegree) = 52.265%

Figure 5 – Centrality Analysis of Weighted Stakeholders Interface Network (WSIN) for Hypothetical Offshore Project

DISCUSSION AND CONCLUSION

In this study, social networks are introduced to visualize and analyse the interface relations of multiple stakeholders of a complex project. Social networks are designed to capture the dynamic interconnection of various entities, and since the status of interface points are actively changing within a mega project, social networks are appropriate tools to represent them. By implementing the SNA concepts, the central stakeholders are identified in the complex Stakeholders Interface Network, considering the interface points of all disciplines, or within a specific discipline.

The advantages of the proposed method are to identify the key stakeholders in a complex project, and assess the performance of stakeholders in dealing with interfaces. If implemented during the FEP, it can help the owners in defining the scope packages and selecting contracting strategies. Different scenarios can be simulated to select the scope packages with optimal number of interface points between them, and assign the scope package with multiple types of interface points to an experienced stakeholder with higher technical competency and sound background in interface management and communication management.

It should be noted that at this point, the focus of this research is to identify the bidirectional interface relationships between stakeholders and rank them according to the number of interface points. The weight of interface points is not considered at this model. However, adding the weight for each interface point based on several risk criteria will result in more realistic evaluation of stakeholders. The other limitation of the proposed method with SNA concept is that it is difficult to model the relationships between more than two stakeholders at each interface point. The SNA analysis of stakeholders interface points in conjunction with other analysis methods, such as risk analysis of the interface points, or shared interface points between more than two stakeholders will lead to have a comprehensive decision tool to identify the critical stakeholders in mega projects.

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