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# QUANTIFYING THE IMPACT OF INFORMATION FLOW ON CONSTRUCTION PROJECTS PERFORMANCE AND ITS IMPACT ON CONSTRUCTION SUPPLY CHAIN DISRUPTIONS

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Construction projects are reliant on the cooperation of all construction supply chain partners, i.e., contractor, sub-contractors, architects, and suppliers, thus many factors can influence project performance. The main goal of construction projects is completion on time without experiencing delays and cost overruns; delays are undesirable due to cost and resource implications. Given the plethora of information exchanged between the construction supply chain partners, failure to gather and deal with the correct information on time may cause serious problems and lead to disruption of the project. This paper quantifies the extent of impact of information flow on construction projects' performance through site observations, main survey and development of simulation scenario in order to analyse the extent of impact of the information flow between the contractor, sub-contractors, architects, and suppliers. The results demonstrated that if poorly managed, and excluding other influencers, the information flow can delay projects by 219% of the actual schedule, which is equivalent to 302 days delay and had a probability of occurrence of 13.4%. Analysis of the results revealed that poor and unrealistic project documentation and planning was the main influencer on projects' performance. Other key influencers were Client acceptance of work conducted, Phase review subcontracted information and Quality Assurance information.

Keywords: Supply chain management, Construction information flow, Construction supply chain, Project performance, Project delays, Residential housing construction projects in Jordan

## INTRODUCTION

Nowadays, companies are required to deliver products that meet customer needs at low prices in order to remain competitive in the global aggressive market. To achieve this, companies are forced to look at the end-to-end supply chain rather than internal company processes and functions alone (Barratt, 2011). The number of activities performed by multiple companies and functions results in a complex supply chain

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(Arshinder, 2008) and due to increasing projects' complexity, modern construction project contractors' face significant challenges in successful project delivery (Doloi, 2009). The performance of the construction supply chain is still widely perceived to lag behind other sectors, most notably manufacturing (Harty, 2008; Bankvall, 2010; and Segerstedt, 2010). Many construction processes are inadequate and lack efficiencies due to various problems including, i.e., Time delays, quality, waste, control and budget overrun (Vrijhoef, 2000; Langford, 2012; and Ochieng, 2013).

Within the construction supply chain, all resource flows are impacted by the flow of information and therefore must be managed effectively (Dave, 2010; and Sacks, 2010). Information flow issues can be complex to manage due to the supply chain complexity, fragmented information systems, and the use of traditional communication methods (e-mail, faxes and telephone) to obtain information (Zhai, 2009). By increasing collaboration across the supply chain and working in a more unified manner, supply chain partners may be able to achieve business goals that meet the needs of the customer,in terms of value, through shorter product cycle time, customised products and services, and faster response times (Barlow, 2005; and Zhu, 2010). Many researchers have agreed on the continuous need to improve information sharing within the supply chain (Bowersox, 2000; Lambert, 2008; Yu, 2010; and Barratt, 2011). Recent research has concentrated on the benefits (Li, 2006; Guo, 2006; and Zhou, 2007), rather than quantifying the impact on performance, of information sharing on supply chains.

Iyer (2005) contributed that conflicts among project members have an impact of projects performance. the conflicts include;insufficient level of knowledge and ignorance, existence of poor project specifics and lack of cooperation, climatic condition and hostile socio-economic, reluctance in timely decision, high competition at the stage of tendering and short time to prepare for bids. The same author argues that all project conflicts could manifest through the disruption of the information flow. In addition (Iyer, 2005) determined that the most significant factor to impact project cost performance was coordination amongst project participants.

Table 1 identifies elements impacting supply chain collaboration and thus the flow of information between supply chain partners.

## Problem Statement and Research Objectives

The construction supply chainin Jordan encounters many disruptions that are resulted from several factors. Project delays can result in cost and time overruns. Ineffective communication and problems associated with the information flow in the contractor's company and between the contractor, sub-contractors, architects, and suppliers. Disruptions from the contractor's side have an impact on projects performance. The main aim of this research is to quantify to what extent may information delays from the contractor's side have an impact on construction projects performance in terms of time delays, providing good practices and potential solutions to improve the information flow and therefore more efficient control and management of the construction supply chain. The information flow investigated in this research refers to all information within the project lifecycle excluding client related information.

Table 1: Factors Affecting Collaboration in the Supply Chain

| Elements | Description | References |
|---|---|---|
| Collaborative communication | The process of transitioning information among SC partners in terms of influence strategy, mode, frequency and direction. | (Fynes, 2005) |
| | | (Cao, 2011) |
| | | (Forslund and Jonsson, 2009) |
| Trust | A positive expectation, attitude or belief of a party regarding the possibility that the outcome of another partywill be acceptable. | (Cai, 2010) |
| | | (Chen, 2011) |
| | | (Forslund and Jonsson, 2009) |
| | | (Zacharia, 2009) |
| | | (Nyaga, 2010) |
| Information sharing | Information sharing refers to the exchange of critical, often proprietary, information between supply chain members through media such as face- to-face meetings, telephone, fax, mail, and the Internet to a level were a party shares confidential, relevant and accurate information on the right time with other SC partners. | (Cai, 2010) |
| | | (Cao, 2011) |
| | | (Chen, 2011) |
| | | (Nyaga, 2010) |
| | | (Zacharia, 2009) |
| | | (Zhu, 2010) |
| Information availability | The extent to which relevant information is available to all SC partners equally, beyond the information that is dynamically shared among SC partners. | (Chen, 2011) |
| Information quality | Information quality includes aspects such as the accuracy, understandability, timeliness, credibility, adequacy, ease of use of the information exchanged and reliability. | (Chen, 2011) |
| Commitment | Commitment refers to the willingness of trading partners to exert effort on behalf of the relationship and suggests a future orientation in which firms attempt to build a relationship that can be sustained in the face of unanticipated problems. | (Chen, 2011) |
| | | (Zacharia, 2009) |
| | | (Fynes, 2005) |
| | | (Nyaga, 2010) |
| Enabling technology | Information technology used in supply chain is referred to enabling technology. Example MIS, TPS, DSS, ERP, EIS, etc. | (Lee, 2011) |
| Dependence and interdependence Long term relationship Joint relationship effort | The firm's need to sustain an exchange relationship to accomplishtargeted goals. The structure (relative symmetry and magnitude) of this 'reciprocal' dependency characterizes the interdependence level in the relationship and has relevant consequences for joint effort and interactions such as planning, goal setting, performance measurement, and problem solving, is vital for effective collaborative relationships. | (Fynes, 2005) |
| | | (Nyaga, 2010) |

## RESEARCH DESIGN AND METHODOLOGY

The adopted research tools to finalise this paper incorporated preliminary investigations, main survey and the development of a simulation scenario.

### Preliminary Investigations

During the period of 90 days, sites visits were conducted to 2 medium-sized residential housing projects in Amman, Jordan. observation to the construction process, project meetings and reports helped in identifying delays related to the

information flow between contractors, suppliers and architecture. Problems related to project documentation, plans, phases review, quality and purchase requests were identified as sources of delays in both projects.

### Survey

The survey was conducted to identify sources of delays related to that flow and to help in developing the simulation scenario. The survey was circulated to site engineers, architects, suppliers and CEO's; Figure 1 demonstrates the distribution of responses. The following question was asked to the respondents; do you face any problems receiving timely accurate information regarding the projects activities from the company? If so, please specify the problem, the potential delay it may cause to the whole project in days and the probability of that occurring.

### Simulation Model Development

Development of the simulation model was based on a medium-sized residential buildings construction site's critical path network and the results from the main survey. Tasks associated with the flow of information were isolated from the Critical Path Method (CPM) network. The actual time for task completion was compared against the most pessimistic time required for task completion in order to determine the extent

Figure 1: Survey Respondents

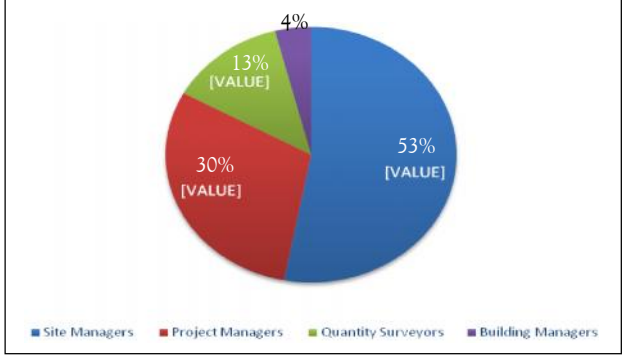
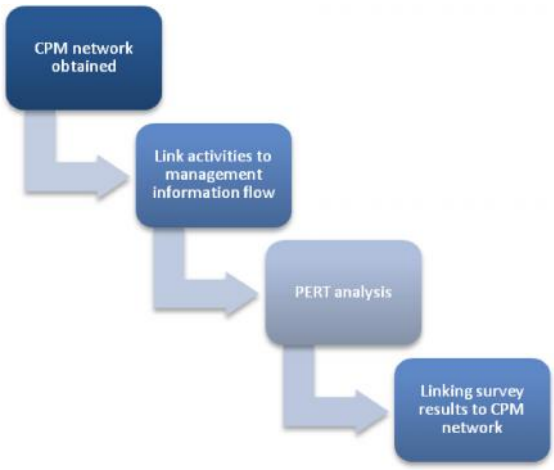



Figure 2: Simulation Scenario Development




of impact of the flow on the project. Moreover, the steps in developing the simulation scenario are illustrated in Figure 2. The following equation clarifies the process of calculating delays in the simulation scenario.

Activities pessimistic duration = Pessimistic duration + Highest pessimistic potential delay from main survey

## RESULTS AND DISCUSSION

According to the simulation results presented in Table 2, information flows within the contractor's company impacted project performance by delaying the project by 219% of the actual project time; equivalent to an additional 302 days. Analysis of the survey results demonstrated that the average probability of information flow delays occurring is 13.4%.

The biggest impact was caused by Project documentation with 24.9% probability of occurrence and 6 days delay on the activity's duration. Other major influencers were Client acceptance documentation, Phase reviews,and Quality Assurance with 20%, 15% and 13.5% probability of delay occurrence, and delays of 0.5,

Table 2: Comparison of Actual vs Information Flow Delays Scenario

| Scenario | Duration in Days | Delay in Days | Delay Percentage |
|---|---|---|---|
| Actual | 138 | 0 | 0 |
| Information Delay | 440 | 302 | 2.19 |

3.5 and 5 days in duration respectively. Activities impacted the least were Objectives reviews and Achievement of Objectives with 5% and 2% probability of delays and both incurring a 1.5-day. Examples of the simulation results are given in Figure 3.

These results indicate the importance of information flow in the construction supply chain (i.e., the contractor, sub-contractors, architect, client and suppliers) regarding exchanging accurate information, at the right time and to the right person.

The results suggest that main contractors encounter some difficulties in managing information flow within their firms. The results also suggest that project documentation and phase reviews have the highest impact in terms of possible delays and probability of occurrence. Monitoring these activities, adopting corrective actions and improving them can help contractors to reduce the risk of having problems with information flow.

The information flow delays can happen for many reasons. Clarkson and Eckert (2010) contributed that some of the major problems that can be resulted from construction firm's failure in transmitting information such as:

1. Team members lack of awareness of the way tasks needs to be done:

   Failing to comply with designer's requirements for each task may results in time delays and additional costs.

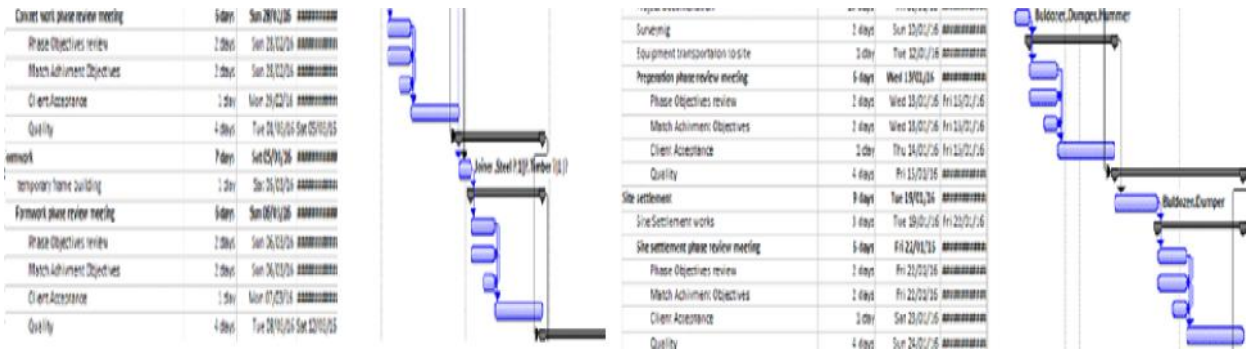
2. Team members lack of awareness of information application process:

   Failure to understand how the overall project relies on all team members' contributions may result in disturbing the information exchange process between team members, designers and management.

3. Lack of awareness of change in design and processes:

   Design changes and tasks rescheduling can happen occasionally in construction projects, any delay in passing the new information to team members may result in additional delays and costs.

Figure 3: Examples from the Simulation Results



4. Expertise of intermediary:

   The lack of technical knowledge from people that needs to pass information within the company may result in a failure in understanding the implications of the information. For example: projects presentations to clients or the board of directors are frequently made by financial experts or mangers with low technical understanding.

Enhancing the communication channels in construction companies' intranets in the Jordanian industry helps in reducing the risk of running behind schedules. According to (Pourrostam and Ismail, 2012), the use of technology in construction projects helps companies to enhance their communication channels and to transmit accurate and timely information that results in getting accurate information regarding the project. The use of information technology can help in facilitating the process of transferring accurate information within the construction supply chain and in particular, the contractor's companies. Electronic Document Management (EDM), web based information systems and Application Service Providers (ASP), are all examples of possible solutions to enhance the information flow in construction companies in site and offices.

## CONCLUSION

As discussed in this paper, information flow within the Jordanian construction supply chain encounters many problems that may disrupt projects and thus severely impact project performance in terms of time delays. Establishing transparent communication channels with the CSC partners can help in managing and mitigating the risks associated with information flow delays which can also aids in increasing the control over construction management parameters which therefore improve the construction industry and processes.

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