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EXAMINING THE ROLE OF EQUIPMENT FLOW WITHIN THE CONSTRUCTION SUPPLY CHAIN AND ITS IMPACT ON PROJECT DELAYS

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Construction projects encounter many disruptions that usually have a negative impact on the project in terms of time delays and cost overruns. Managing the Construction Supply Chain (CSC) aids in mitigating the risks of projects disruptions to occur. This research analyses the extent of impact that the equipment flow has on construction projects performance in terms of time delays in isolation of the other components of the construction supply chain. In doing so, preliminary investigations, survey and simulation were used to finalise the research main aim and objectives. The results of the analysis revealed that the most likely causes for equipment flow delays are: barriers with loaning companies, breakdowns and/or unavailability. The simulation revealed a delay in the duration of the project by 2.2%, equal to 3 days and the probability of the equipment flow delay occurring is 10%. Obtaining equipment is a common problem, hammers with a 11% probability of occurrence and a 12-day delay. This issue affects small to medium-sized construction companies where financing equipment is not an option which forces them to rent equipment or sub-contract the work. This could result in additional costs, have time implications or the equipment may not be available. To overcome this problem and decrease that risk, construction companies should initiate partnerships with lending companies and perform regular machinery maintenance.

Keywords: Construction supply chain, Project management, Supply chain management, Construction project performance, Project delays in Jordan, Asset management

INTRODUCTION

Recently, increasing the productivity of infrastructure and construction projects is one of the main concerns for researchers as the construction is still considered as a low productive industry (Gong *et al.*, 2010; Gao *et al.*, 2013, Nasir *et al.*, 2013; and Dadi *et al.*, 2014).

Moreover, delays and cost overruns are frequent and common phenomena with most construction projects (Abd El– Razek *et al.*, 2008; and Le Hoai *et al.*, 2008). Several authors contributed that improving construction projects productivity is correlated to improving the construction supply chain (Irizarry *et al.*, 2013;

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and Fulford and Standing, 2014). Cox and Ireland (2002), contributed that the construction supply chain consist of the flows described in Figure 1.

The equipment flow is one of the main flows in the construction supply chain (Cox and Ireland, 2002). The criteria for selecting equipment in the construction process includes: safety, cost, site conditions, technology, ease of acquisition and maintenance. Table 1 summarises some factors that influences the process of equipment selection in the construction industry. Moreover, (Waris *et al.*, 2013; and Chinchore, 2014) mentioned that construction equipment effective selection should be focused on availability, financial viability and technical efficiency as these factors mitigate the risk of projects disruptions, delays and cost overruns.

Problem Statement

The Jordanian construction industry contributes 5.8% to the Jordanian gross domestic product (Central Bank of Jordan, 2015). However, the Jordanian construction industry experiences project delays, cost overruns and low productivity. (Odeh and Battaineh, 2002; Sweis *et al.*, 2008; Mattarneh, 2015; and Bekr, 2016). Delays in the CSC have been studied in literature. However, the equipment flow was studied as part of the CSC which opens an opportunity to analyse that flow separately. This research analysed the extent of impact that equipment flow may have onthe Jordanian residential housing construction projects delays in separation to the other elements of the construction supply chain.

RESEARCH DESIGN AND METHODOLOGY

Three research tools were adopted in this research as follows:

Preliminary Investigations

Site observations were conducted to two residential housing projects in Amman, Jordan. The observations were regular in terms of 3 visits a week to each site over 2 months. Delays related to equipment flow were identified as contractors

Figure 1: The Myriad of Construction Supply Chains (Cox and Ireland, 2002)

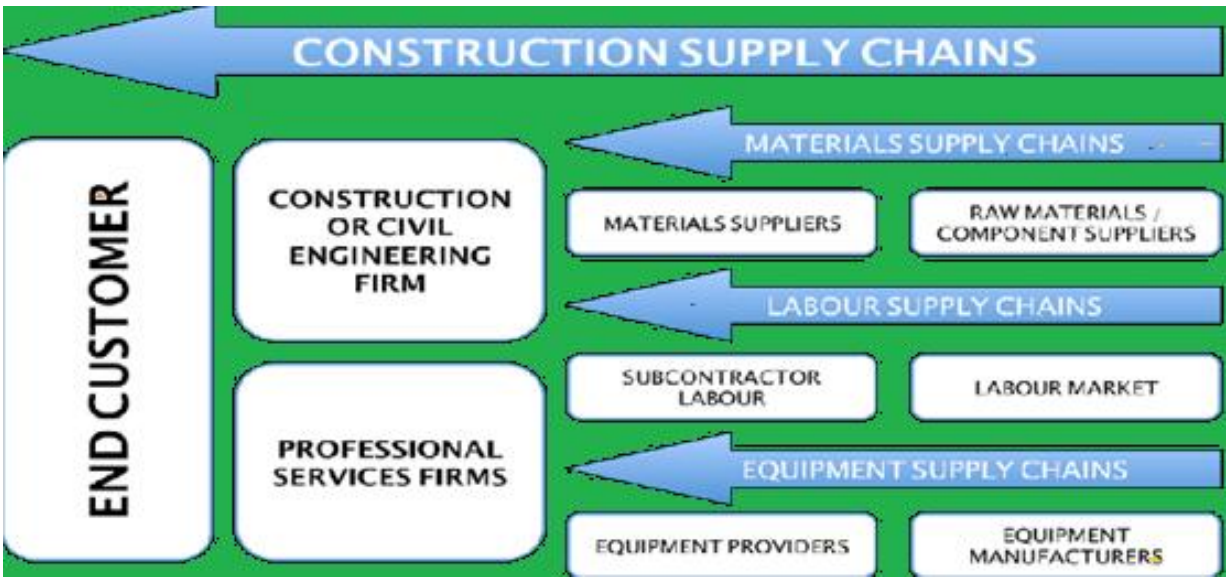


Table 1: Construction Equipment Selection Factors

Factor	Source
Cost	Azhar *et al*. (2008) and Ameh *et al.* (2010)
Safety	Goldenberg and Shapira (2007) and Idoro (2011)
Maintainability	Gransberg *et al.* (2006), Robert *et al.* (2006) and Schexnayder and Hancher (2009)
Parts availability	Prasertrungruang and Hadikusumo (2007) and Waris *et al.* (2014)
Job requirements	Gransberg *et al.* (2006)
Productivity	Chan *et al.* (2001) and Tatari and Skibniewski (2006)
Average life	Goldenberg and Shapira (2007) and Valli and Jeyasehar (2012)
Capacity	Oglesby *et al.* (2005) and Hajji (2013)
Environmental impact	Koo and Ariaratnam (2008), Avetisyan *et al.* (2012) and Hajji (2013)

had some technical difficulties on many occasions and it was challenging to find a substitute on a short notice

Main Survey

The main survey was conducted to gather relevant information about delays related to the equipment flow in construction and to aid in the process of developing the simulation scenario. The survey asked participants to answer the following question: do you experience a shortage of equipment (heavy machinery) during the project? If so, please specify the equipment, the potential delay it may cause to the whole project in days and the probability of that occurring.

Figure 2: Survey Respondents

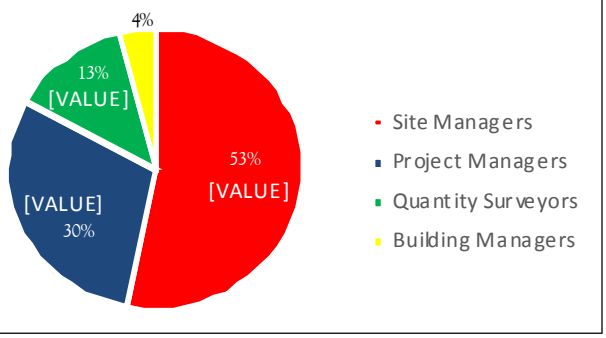


Figure 2 represents the distribution of survey respondents.

Developing the Simulation Model

The delays from the main survey and the critical path method network, obtained from one of the construction projects studied, were amalgamated in order to create the simulation model. The project activities related to equipment were analysed to identify their actual duration. The survey results revealing the pessimistic duration and most pessimistic potential delay were used to calculate the activity's pessimistic duration. To quantify the degree of impact of the Equipment flow on the performance of construction projects, the activity's pessimistic duration was compared against the actual duration. Figure 3 illustrates the process of developing the simulation scenario.

ANALYSIS AND DISCUSSION

A comparison between the simulation results and the actual scenario is displayed in Table 2. The project was delayed by 2.2% of its duration which is equal to 3 days. As was stated earlier, a delay in an activity can lead to delays in other activities. Moreover, the results of the main survey suggest, the average probability of the equipment flow delays occurrence is 10%. The following Table 3 reveals the results of the main survey. The results indicated that hammers and cranes are the most

Figure 3: Simulation Scenario Development

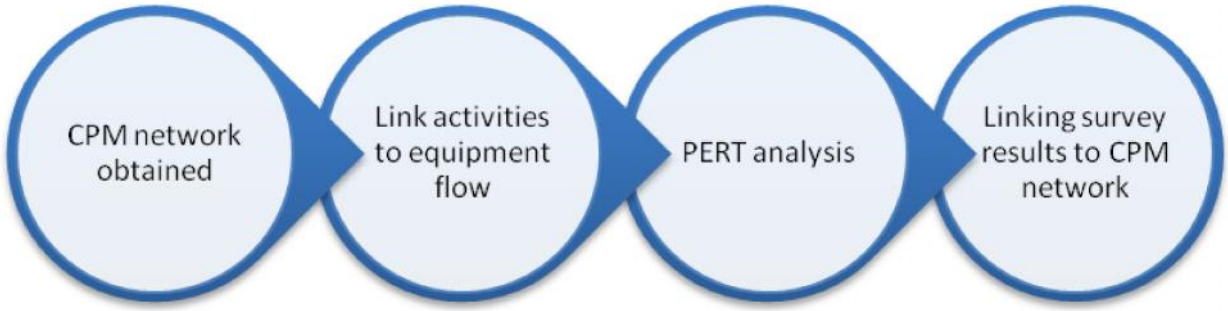


Table 2: Simulation Result vs Actual

Scenario	Duration in Days	Delay in Days	Delay Percentage
Actual	138	0	0
Delay	141	3	0.022

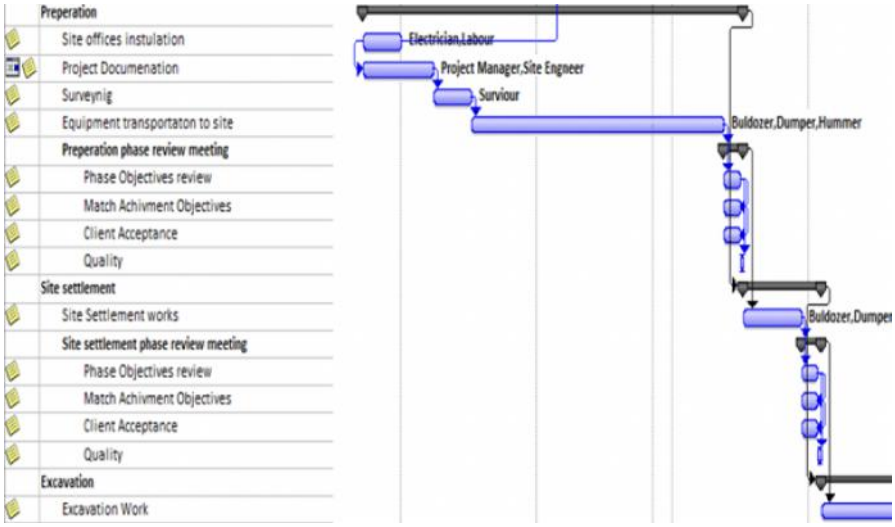
Table 3: Survey Results

Equipment Flow				
Equipment Type	Percentage	Delay in Days		
		Min	Most	Max
Hammer	0.11	2	6	12
Crane	0.09	1	4	6

common equipment that contractors have a problem with in projects.

Equipment's availability impacts on projects performance as demonstrated through the simulation scenario.This can be resultant of the fact that small to medium sized construction companies not having the financial ability to purchase their own equipment. In order to deal with this problem, the majority have to rent equipment or sub-contract the work. Both of these solutions may lead to other problems in regard to cost, availability, quality, control and time. Figure 4 displays some delay examples from the simulation.

Figure 4: Simulation Results Examples



Moreover, Nagpal (2016) contributed, that the equipment flow in the CSC suffers from several problems such as: an undeveloped used equipment market, the lack of renting companies, the lack of qualified equipment handlers and the lack of fixed pricing to both rent or buy equipment.

According to Ross (2013), initiating partnerships with lending companies can be a resolution for this problem as partnering may help contractors in gaining access to equipment when needed and decrease the risk of having any difficulties with equipment.

CONCLUSION

Equipment flow of the construction supply chain, as discussed in this paper, has an impact project performance in terms of time. Equipment flow encounters many problems that may disrupt the project and cause delays that may lead to additional cost. Managing the risk associated with delays in equipment flow can aid in avoiding potential delay sources and improve control over construction management parameters. The Jordanian construction industry should effectively select the right equipment for the construction process, initiate partnerships and/or agreements with the equipment loaning companies, perform regular machinery maintenance and provide equipment handling training programs to mitigate the risk of equipment flow delays.

REFERENCES

1. Abd El-Razek M, Bassioni H and Mobarak A (2008), "Causes of Delay in Building Construction: Projects in Egypt", *Journal of Construction Engineering and Management-ASCE*, Vol. 134, No. 11, pp. 831-841.
2. Ameh O J, Soyingbe A A and Odusami K T (2010), "Significant Factors Causing Cost Overruns in Telecommunication Projects in Nigeria", *Journal of Construction in Developing Countries*, Vol. 15, No. 2, pp. 49-67.
3. Amit Nagpal (2016), "Construction Equipment Industry: Challenges, Trends & Future Roadmap", available at: http://realty.economictimes.indiatimes.com/realty-check/construction-equipment-industry-challenges-trends-future-roadmap/1157 [Accessed 2 December 2016].
4. Avetisyan H G, Miller-Hooks E and Melanta S (2011), "Decision Models to Support Greenhouse Gas Emissions Reduction from Transportation Construction Projects", *Journal of Construction Engineering and Management,* Vol. 138, No. 5, pp. 631-641.
5. Azhar N, Farooqui R U and Ahmed S M (2008 August), "Cost Overrun Factors in Construction Industry of Pakistan", in First International Conference on Construction In Developing Countries (ICCIDC–I), Advancing and Integrating Construction Education, Research & Practice pp. 499-508.
6. Bekr G (2016), "Study of Significant Factors Affecting Labor Productivity at Construction Sites in Jordan: Site Survey", *Journal of Engineering Technology (JET)*, Vol. 4, No. 1, pp. 92-97.
7. Central Bank of Jordan (2015), Annual Report 2014, available from: http://www.cbj.gov.jo/uploads/chapter1.pdf
8. Chan F T S, Ip R W L and Lau H (2001), "Integration of Expert System with Analytic Hierarchy Process for the Design of Material Handling Equipment Selection System",

Journal of Materials Processing Technology, Vol. 116, No. 2, pp. 137-145.

9. Chinchore M N D (2014), "Planning and Selection of Heavy Construction Equipment in Civil Engineering", *International Journal of Engineering Research and Applications*, Vol. 1, No. 4, pp. 29-31.
10. Cox A and Ireland P (2002), "Managing Construction Supply Chains: The Common Sense Approach", *Engineering, Construction and Architectural Management*, Vol. 9, Nos. 5/6, pp. 409-418.
11. Dadi G B, Goodrum P M, Taylor T R and Carswell C M (2014), "Cognitive Workload Demands Using 2D and 3D Spatial Engineering Information Formats", *J. Constr. Eng. Manage*.
12. David Frederick Ross (2013), "Competing Through Supply Chain Management: Creating Market-Winning Strategies Through Supply Chain Partnerships", 1998 Edition, Springer.
13. Fulford and Standing R C (2014), "Construction Industry Productivity and the Potential for Collaborative Practice", *International Journal of Project Management*, Vol. 32, No. 2, pp. 315-326.
14. Goldenberg M and Shapira A (2007), "Systematic Evaluation of Construction Equipment Alternatives: Case Study", *Journal of Construction Engineering and Management*, Vol. 133, No. 1, pp. 72-85.
15. Gong J and Caldas C H (2010), "Computer Vision-Based Video Interpretation Model for Automated Productivity Analysis of Construction Operations", *J. Comput. Civ. Eng.,* Vol. 24, No. 3, pp. 252-263.
16. Gransberg D D, Popescu C M and Ryan R C (2006), "Construction Equipment Management for Engineers, Estimators and Owners", Taylor & Francis, London.
17. Hajji A M (2013), "Estimating the Emissions of Nitrogen Oxides (NOX) and Particulate Matter (PM) from Diesel Construction Equipment by Using the Productivity Model", *World Journal of Science, Technology and Sustainable Development*, Vol. 10, No. 3, pp. 212-228.
18. Idoro G I (2011), "Effect of Mechanisation on Occupational Health and Safety Performance in the Nigerian Construction Industry", *Journal of Construction in Developing Countries*, Vol. 16, No. 2, pp. 27-45.
19. Irizarry Karan and Jalaei J E F (2013), "Integrating BIM and GIS to Improve the Visual Monitoring of Construction Supply Chain Management", *Automation in Construction*, Vol. 31, pp. 241-254.
20. Koo D H and Ariaratnam S T (2008), "Application of a Sustainability Model for Assessing Water Main Replacement Options", *Journal of Construction Engineering and Management*, Vol. 134, No. 8, pp. 563-574.
21. Le-Hoai L, Lee Y D and Lee J D (2008), "Delay and Cost Overruns in Vietnam Large Construction Projects: A Comparison with Other Selected Countries", *KSCE Journal of Civil Engineering*, Vol. 12, No. 6, pp. 367-377.
22. Mattarneh S (2015), "A Study of Factors Causing Cost Overruns in Jordanian Construction Industry [Dissertation]", Al-Isra University, Amman, Jordan.

23. Nasir H, Ahmed H and Haas C P M (2013), "Goodrum: An Analysis of Construction Productivity Differences Between Canada and the United States"*, Constr. Manage. Econ*., pp. 1-13 (ahead-of-print).

24. Oglesby H and Parker A Howell (2012), "Productivity Improvement in Construction", McGraw Hill.

25. Prasertrungruang T and Hadikusumo B H W (2007), "Heavy Equipment Management Practices and Problems in Thai Highway Contractors", *Engineering, Construction and Architectural Management,* Vol. 14, No. 3, pp. 228-241.

26. Robert I, Peurifoy P E, Clifford J, Schexnayder P E and Shapira A (2006), "Construction Planning, Equipment and Methods", *International Edition*, 7th Edition, McGraw-Hill, New York.

27. Samee K and Pongpeng J (2016), "Structural Equation Model for Construction Equipment Selection and Contractor Competitive Advantages", *KSCE Journal of Civil Engineering*, Vol. 20, No. 1, pp. 77-89.

28. Schexnayder P E and Hancher F (2009), *The True Cost of Equipment Failure*. 3rd Edition, Netta Hook, Germany.

29. Sweis Sweis, Abu Hammad and Shboul G R A A (2008), "Delays in Construction Projects: The Case of Jordan", *International Journal of Project Management*, Vol. 26, No. 1, pp. 665-674.

30. Tatari O and Skibniewski M (2006), "Integrated Agent Based Construction Equipment Management: Conceptual Design", *Journal of Civil Engineering and Management*, Vol. 12, No. 3, pp. 231-236.

31. Valli P and Jeyasehar C A (2012), "Genetic Algorithm Based Equipment Selection Method for Construction Project Using MATLAB Tool", *Iran University of Science & Technology*, Vol. 2, No. 2, pp. 235-246.

32. Waris A, Khamidi M F and Idrus A (2013), "Heavy Equipment Acquisition in Malaysian Construction Industry", Proceedings of the International Symposium on Business, Engineering and Industrial Applications, Kuching, Malaysia.

33. Waris M, Liew M S, Khamidi M F and Idrus A (2014), "Criteria for the Selection of Sustainable Onsite Construction Equipment"*, International Journal of Sustainable Built Environment,* Vol. 3, No. 1, pp. 96-110.

34. Waris M, Liew M S, Khamidi M, Gao T, Ergan S, Akinci B and Garrett J H (2013), "Proactive Productivity Management at Job Sites: Understanding Characteristics of Assumptions Made for Construction Processes During Planning Based on Case Studies and Interviews", *J. Constr. Eng. Manage*.

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