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# QUANTIFYING THE IMPACTS OF LABOUR FLOW ON RESIDENTIAL HOUSING CONSTRUCTION PROJECTS PERFORMANCE: THE CASE OF JORDAN

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The construction industry is a very complex and competitive environment that has demands of delivering projects at a certain quality standard and a competitive price. In order to achieve that, there is a need for a management system that efficiently integrates the Construction Supply Chain (CSC). The integration process incorporates the inflows within the construction supply chain components and the outflows with external suppliers, contractors, subcontractors, client, etc. Labour flow in the CSC faces many challenges and disruptions such as low productivity, labour shortage and migration. This research analyses the extent of impact that labour flow has on construction projects performance in terms of time delays in isolation of the other flows within the CSC. In doing so, preliminary investigations, main survey and simulation were utilised to finalise the research main aim. The results indicated that labour flow can delay projects by 90% of the actual schedule with 8.4% average probability of occurrence. The main survey revealed that there is a difficulty in finding ground workers and compaction workers. This appears to be the situation in Jordan and main contractors need to deal with this issue by trying new ways of attracting labourers to the construction industry.

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

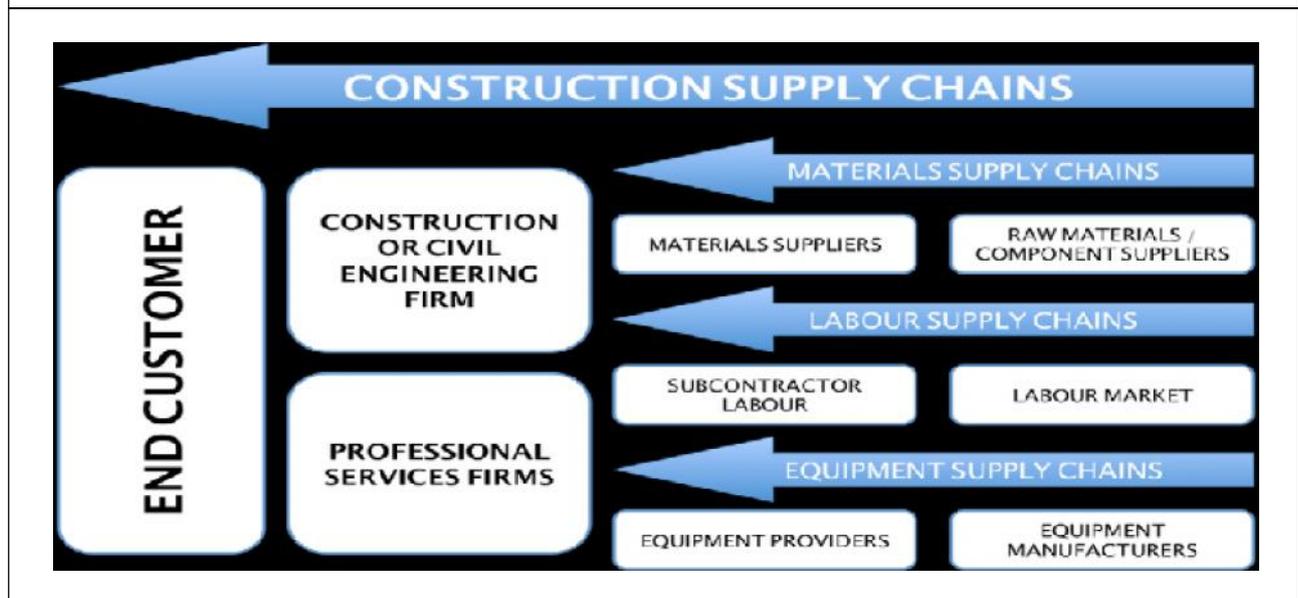
## INTRODUCTION

Cost overruns and delays are common and frequent phenomena with most construction projects (Le Hoai *et al.*, 2008; and Abd El-Razek *et al.*, 2008). According to Cox and Ireland (2002), the CSC includes three main flows namely; materials, labour and equipment (Figure 1). Managing labour flow in construction suffers from some serious problems such as: labour shortage,

migration and low productivity (Assaf *et al.*, 1995; Kaming *et al.*, 1997; Faridi *et al.*, 2006; Oguzoglu *et al.*, 2007; and Rolfe, 2013). Dealing with labour flow problems is important but, can be complicated as it involves different factors. There are many implications of labour flow problems on projects. As an example, labour shortage's main implication on projects is that some activities may need to be extended beyond their normal duration.

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Figure 1: The Myriad of Construction Supply Chains (Cox et al., 2006)



Skilled and semi-skilled labour shortage is a worldwide concern. Zaki *et al.* (2015) stated that this issue has become a main challenge for the global challenge in construction as labour supply is below the demand in this industry. Local workforce participation is not very encouraging and it is recognised that vocational training programs for skilled labourers do not meet the requirements and demands of the construction industry as skilled labourers leave the construction industry due to many reasons in particular, safety issues. Therefore, labour shortage can disrupt the construction process and therefore lead to additional delays and disruptions to other activities.

Moreover, the high demand in the industry for labourers accompanied with their supply may result in increased financial demands which consequently increases the project cost and becomes a financial burden on both contractors and clients (Zaki *et al.*, 2015).

According to the Central Bank of Jordan (2015), the construction industry in Jordan

contributes 5.8% to the Jordanian Gross Domestic Product (GDP). However, the construction industry in Jordan can be further developed as it suffers from cost overruns, delays and low productivity (Odeh and Battaineh, 2002; and Mattarneh, 2015). Low productivity can lead to both cost overruns and project delays. Moreover, Hillesund and Stave (2015) declared that the Syrian refugees' influx impacted the Jordanian labour market by increasing the number of unskilled labourers which led to an increase in Supply to a level that exceeded the demand for this profession. Consequently, unskilled labour wages were lowered which influenced labourers to either migrate or shift to other industries looking for better earnings. Labour productivity, shortage and migration problems can be the main source of labour flow delays in Jordan

### Problem Statement and Research Objectives

Jordanian construction projects suffer from a variety of delays; some are related to the construction supply chain whereas some are the

result of other factors. Construction supply chain labour flow delays, such as low productivity, labour migration, and shortages in labourers can lead to both time and cost overruns, and define how profitable the project is to both client and contractor. Through appropriate management, a reduction in impact, or total avoidance, of delays resulting from labour flows can be achieved.

The objectives of this research are to:

- Develop a simulation scenario that simulates the influence of labour flow delay on construction projects' performance; and
- Examine the sensitivity of projects' performance to labour flow and to what extent it may affect the project.

## RESEARCH DESIGN AND METHODOLOGY

Preliminary investigations, questionnaires and simulation were utilised to finalise the objectives of this research as explained:

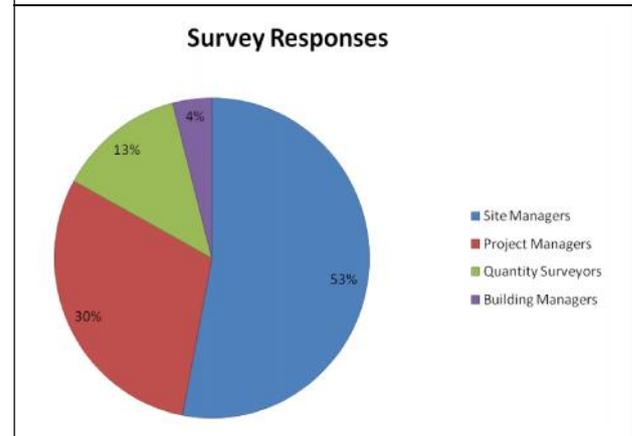
### Preliminary Investigations

Two residential housing construction projects were visited on regular bases over 90 days. The sites observations helped in identifying the CSC flows in practise, issues and problems related. The observations helped in identifying problems related to the labour flow such as; low productivity and labour shortage. Moreover, delays related to labour flow were considered as one of the main sources of delays according to the project reports.

### Questionnaires

In order to develop the simulation scenario, a questionnaire was circulated to members of the construction industry to gather information related to the labour flow in construction.

Figure 2: Survey Respondents



The questionnaire asked participants to answer the following question; do you experience a shortage of skilled labour during the project? If so, please specify the specific skill, the potential delay it may cause to the whole project in days and the probability of that occurring. The respondents to the main survey are displayed in Figure 2.

### Simulation

The simulation process consisted of a general Critical Path Method (CPM) network of the skeleton level of a typical medium residential housing project, which was obtained from one of the projects that was visited and the delays that were pointed out from the survey. The simulation method was conducted in four stages:

1. Acquire critical path from a medium-sized Jordanian residential housing construction site.
2. Analysis of the critical path for activities linked to the labour flow.
3. Apply PERT technique in order to more accurately analyse the risks and time impacts of the labour flow on the supply chain.
4. Associate survey results with the critical path to develop the simulation scenario.

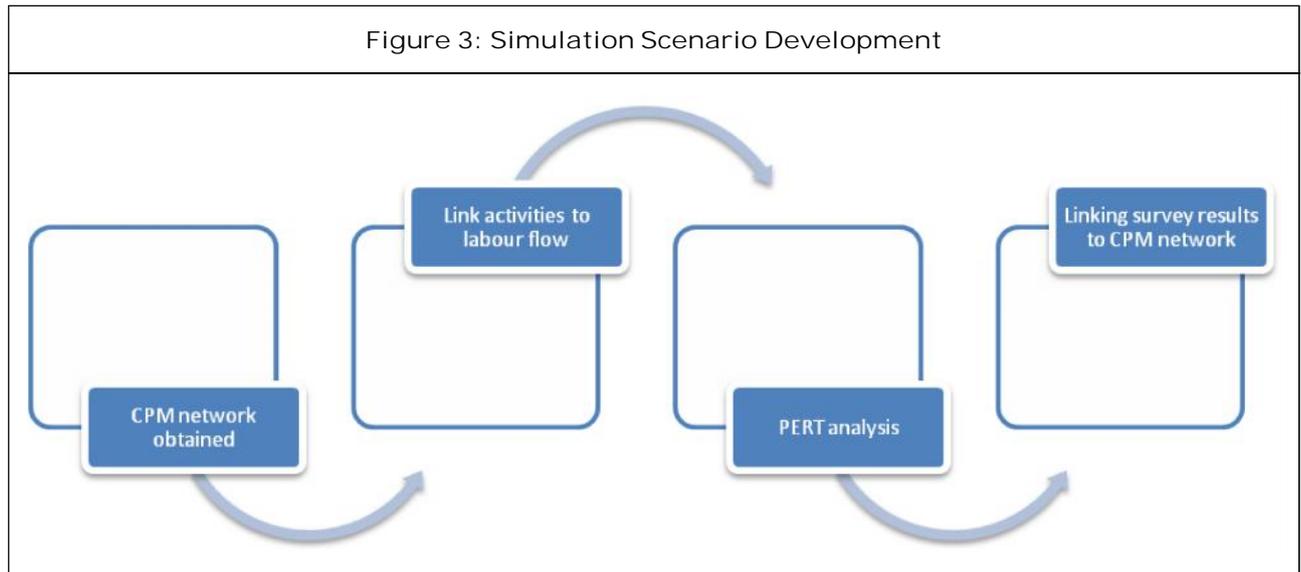


Table 1: Comparison of Actual vs Labour Flow Delays Scenario

Scenario	Duration in Days	Delay in Days	Delay Percentage
Actual	135	0	0
Labour Delay	263	125	0.9

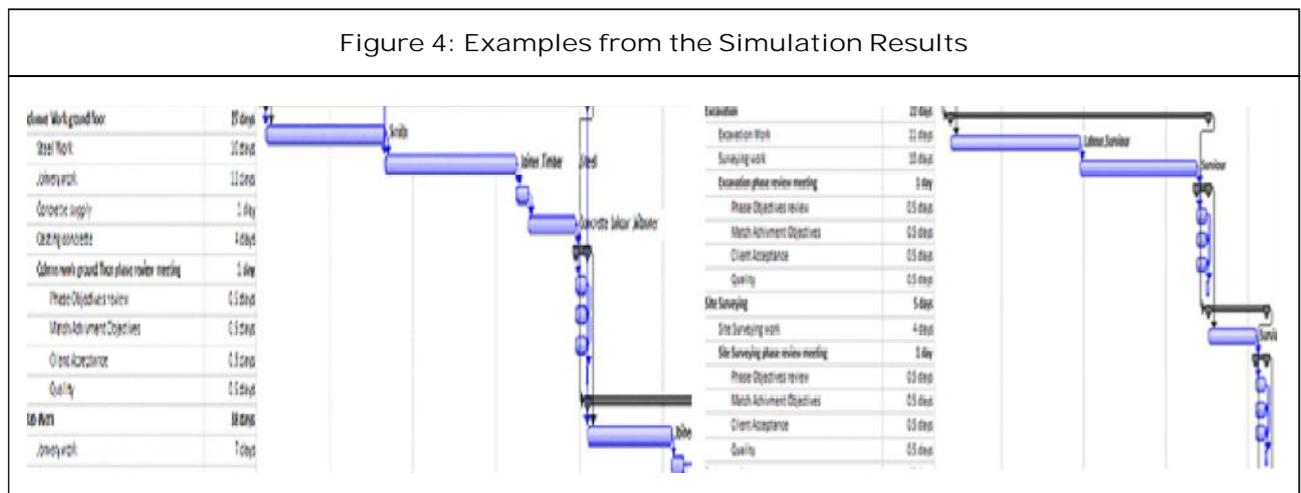
Calculation of the impact of the labour flow on the supply chain and project performance compared the activities pessimistic duration (the pessimistic duration plus the maximum pessimistic potential delay) to the actual. Moreover, the steps in developing the simulation scenario are illustrated in Figure 3. The following

equation clarifies the process of calculating delays in the simulation scenario.

Activities pessimistic duration = Highest pessimistic potential delay form main survey + Activity pessimistic duration

### ANALYSIS AND DISCUSSION

According to the simulation results presented in Table 1, labour flow impacted project performance by delaying the project by 90% of the actual project time; equivalent to an additional 125 days. Moreover, Figure 4 presents some examples from the simulation scenario.



Analysis of the survey results demonstrated that the average probability of labour flow delays occurring is 8.4%. Ground workers caused the highest impact with a 16.4% probability of occurrence, a 2-day delay on the activity's duration, followed by compaction workers with a probability of occurrence of 11%, a 9-day delay on the duration, electricians and scaffolders resulting in 9% probability of occurrence, a 3-day and 7-day delay on duration respectively.

Moreover, the survey revealed that there is difficulty in finding ground workers and compaction workers. Main contractors could overcome this problem by trying new ways of attracting labourers. There can be many reasons for labour shortage as labour skills themselves are indeed varied; skilled, semi-skilled and unskilled. Leaving this issue unresolved increases the risk of labour delays that ultimately affects the extent of delay on the whole project. As discussed previously, labour migration is an issue. This could be true in the Middle East where conflicts are occurring. Shortage in high skilled labour is another area of concern, this could be overcome by training and investment in order to increase productivity and decrease potential delays.

Labour shortage and migration problems can be the main source of labour flow delays in Jordan, however, the following may provide some possible solutions to the labour flow problems:

1. Opening training opportunities to low skilled labourers to become professional/qualified;
2. More safety on sites may help to attract individuals to some highly skilled professions;
3. Hiring from other industries; and
4. Encourage knowledge transfer between high skilled and other labourers.

## CONCLUSION

As discussed in this paper, Labour flow in the CSC can heavily impact project's performance. Labour 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 labour flow can aid in avoiding potential delay sources, additional costs and improve control over construction project management parameters. Moreover, reducing health and safety hazards, attracting labours from other industries and providing professional training programs may possibly reduce disruptions in this flow and therefore improve that flow in the CSC.

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