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Critical Factors that Affect Construction Productivity in Iraq

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ABSTRACT

Iraq is suffering from long years of conflicts, which affects construction sector, as well as other sectors. These conflicts create particular factors, in addition to the common factors, that affect construction production. This study identifies and ranks the factors that affect construction productivity in Iraq from the viewpoint of contractors. A structured questionnaire was distributed and completed by 63 contractors working in construction projects. The identified factors were ranked according to their levels of influence. Feedback was analyzed using chi-square and relative importance index techniques. The factors were grouped according to their source, namely, external, human, and management. Results show that the most important factors are external factors. The study concludes that improving construction productivity does not solely depend on the efforts of individual labors because other more influential factors impact productivity. This study highlights the particular factors that affect construction in Iraq, in light of the exceptional circumstances of the country. This study helps managers focus on these factors and take precautions to increase labor productivity.

Keywords:*Construction, Productivity, Relative Important Index, Iraq, Political Conditions.*

INTRODUCTION

Long years of conflict have made Iraq suffer, which affected its construction sector, as well as other sectors. Aerial bombings during the 1991 Gulf War seriously damaged buildings, bridges, and other facilities. Vandalism and attacks from 2004 to 2007 also affected and ruined completed projects. Subsequently, reconstruction became necessary to meet economic development and human needs. To meet this goal, the Iraqi government invested extensively in reconstruction and rebuilding affected infrastructure projects.

The government has declared plans to develop several construction projects by 2014. However, production rates were low, and most projects were not completed. Despite reasonable availability of laborers in Iraq, labor productivity remains a significant problem. Therefore, identifying the critical factors that affect labor productivity in construction projects in Iraq is important.

Understanding the characteristics of Iraqi laborers is important in improving construction productivity. This study identifies factors that affect the construction productivity of Iraqi laborers. The outcomes of this research could help managers identify productivity barriers and mitigate problematic situations to improve productivity.

BACKGROUND

Construction productivity can be illustrated by an association between output and input. In other words, productivity is the relationship between outputs of goods and services and inputs of human and non-human resources in the production process (Harrison, 2007). This definition implies an interaction between labor and other resources, such as capital, materials, and equipment. Several factors affect productivity, and understanding these factors could definitely improve productivity and create value for the construction industry.

Productivity is a vital issue in construction construction because most construction work suffers from waste and losses. Choy & Ruwanpura(2006) found that productivity losses in construction projects range from 40% to 60%. According to Canadian researchers, 44% of the time is spent on unproductive activities.

Construction is a remarkably tedious, dirty, and physically exhausting work(Goodrum, 2009), and statistically analyzing productivity is not an easy task because it involves long sequential processes, craftsmanship, several materials and tools, and unpredictable site conditions (AL-Zwainy *et al.*, 2012).

One challenge in analyzing productivity is the different unit of measurement for each activity (Goodrum, 2009). In addition, the complexity of construction site operations creates complex relationships between activities and processes that affect site productivity(Choy and Ruwanpura, 2006), which increases the difficulty of identifying factors that affect productivity identify [4]. Consequently, most projects have difficulties, such as material, financial, tools, and local contractor's construction costs (Soham and Rajiv, 2013). These difficulties affect labor productivity in construction.

FACTORS IMPACT PRODUCTIVITY

Several studies around the world have sought to identify the factors that affect labor productivity in construction projects. For example, Abdul Kadir *et al.* (2005) conducted a survey to evaluate and rank the delay factors of construction productivity for Malaysian residential projects, and listed 50 factors related to construction labor productivity. The most frequently mentioned factors are material shortage at project site, non-payment to suppliers causing the stoppage of material delivery to the site, late issuance of progress payment by the client to main contractor, lack of foreign and local workers in the market, and coordination problems between the main contractor and subcontractor. These factors are only applicable to Malaysian construction and do not include those factors that could be more influential in other countries.

In Kuwaiti construction sites, labor productivity is affected by certain factors identified by Jarkas and Bitar (2012), the most important factors of which included clarity of technical specifications, extent of variation/ change orders during execution, and coordination level among various design disciplines. None of these factors relate to labor. By contrast, Shehataand El-Gohary (2011) focused on labor-related factors, such as waiting for materials, talking, eating and drinking, absenteeism, and waiting for tools.

Mahamid (2013) categorized into five the factors that affect the productivity of Palestinian construction: labor,managerial, materials and equipment, environmental, and financial. These categories comprised a total of 31 factors. The top five factors that negatively affect labor productivity include rework, lack of cooperation and communication between construction parties, financial status of the owner, lack of labor experience, and lack in materials. Mahamid examined the factors that could affect productivity. The ranking of these factors may not be applicable to other countries, such as Iraq, despite the similarities between the two countries, particularly in terms of lack of security and stability.

The Committee of National Research Council (2009) organized a workshop to identify the activities that improve construction productivity and performance of the United States construction industry. The committee came up with five interrelated activities with significant potential that will lead to breakthrough improvements in construction efficiency. These activities include the following: use of interoperable technology applications; improving the job site; greater use of prefabrication, preassembly, modularization, and off-site fabrication, techniques and processes; innovative, widespread use of demonstration installations; and effective performance measurement.

Al-Zwainy *et al.* (2013) developed a model for estimating construction productivity in Iraq using multivariable linear regression. Ten factors were utilized during model development for productivity forecasting: age, experience, number of the assist labor, floor height, size of the marble tiles; security conditions, health status of the work team, weather conditions, site condition, and availability of construction materials. However, factors relating to the security situation were not taken into account. These factors are crucial in Iraq and significantly affect labor productivity.

Sohamand Rajiv (2013) used relative importance index (RII) and Analytical Hierarchy Process (AHP) techniques to rank the factors affecting productivity. In descending order, the factors identified through RII technique are delay in payments, skill of labor, clarity of technical specification, shortage of materials, and motivation of labor, where is through AHP technique, the factors are high/low temperature, rain, high wind, motivation of labor, and physical fatigue. However, despite the inclusion of many factors, no classification was done in a way that sources of such factors could be clearly seen.

Others researchers provided evidence to confirm the relationships between particular factors and productivity. Among such factors are, buildability and

(Low, 2001), wage (Guiwen and Rongli, 2009), equipment technology (Haas, 2009), technical change (Goodrum, 2009), age structure of employees (Mahlberg *et al.*, 2013), rainfall (El-Rayes and Moselhi, 2001), thermal environment (Mohamed and Srinavin, 2002) and training (Abdel-Wahab *et al.*, 2008).

The above studies showed that some factors that influence construction productivity can be controlled, whereas others are beyond company control. These factors vary across projects owing to variable environments, characteristics, and project management efforts (Park, 2006). The key factors that affect construction production and the significance of these factors differ among countries. For example, moat of the previous studies overlooked the political and social aspects, which are critical factors in Iraq. Therefore, empirical studies are necessary in the investigation of factors that affect construction production in Iraq. This study attempts to fill this gap taking in account the troubling business environment in Iraq.

METHODOLOGY

A questionnaire survey delivered personally and via electronic mail was used to collect data to investigate and rank the factors affecting construction production. Postal survey was not used in this study because mail service is not available in all parts of Iraq. The sample was randomly chosen from companies at the Iraqi Ministry of Construction and Housing.

The questionnaire was composed of close-ended questions and provided space for respondents to give additional information about the importance of the troubling business environment adopted for this study. The factors chosen based on previous studies included security and political conditions, weather conditions, rework, site layout, laborer efficiency, adequate material and machinery, equipment technology, planning and scheduling, constructability, physical limitations of laborers, wages and benefits, training, safety performance, overtime, supervision, cash flow, variation orders, labor culture and attitude, leadership, skills of laborers, labor experience, labor motivation, construction methods, team spirit of the crew, technical specifications, governmental regulations, health status of laborers, communication, and subcontracting.

The questionnaires were sent to 250 construction companies and targeted the staff working in construction projects. Participants were invited to rate each factor on a five-point Likert scale, where 1 represented "least important" and 5 represented "extremely important."

Prior to questionnaire distribution, four of experts with more than 20 years' experience in building construction were interviewed to provide extra information and verify the draft of the questionnaire. Cronbach's alpha coefficient was used to assess the reliability of the questionnaire.

DATA ANLAYSIS

Statistical techniques were used to analyze the data and assess the importance of factors that affect productivity. These techniques include Chi-Square (CS) and RII. RII is used to assess the relative importance of each factor based on the numerical scores from the questionnaire responses.

RESULTS AND DISSCUSSIONS

Reliability

The reliability ranges from 0 to 1. Scores above 0.70 are considered acceptable (Nunnally and Bernstein, 1994).Cronbach's alpha was computed at 0.706, which indicates that the items are from a scale with reasonable internal consistency reliability.

Response Rate

Of the 250 questionnaires dispatched to the selected sample, 63 were satisfactorily completed, which is equivalent to a 25.2% response rate. According to Akintoye(2000) and Dulaimi *et al.* (2003), this figure is acceptable because the normal response in the construction industry is between 20% and 30%.

Table 1: General Respondent Demographic

GRD	*Groups*	*Frequency*	*Per cent*	*Cumulative Per cent*
Educational	Diploma	0	0	0
	Bachelor	61	96.8	96.8
	Master	1	1.6	98.4
	PhD	1	1.6	100
Age	20-29 yrs	5	7.9	7.9
	30-39 yrs	13	20.6	28.6
	40-49 yrs	35	55.6	84.1
	50 + yrs	10	15.9	100
Occupation	Director	7	11.1	11.1
	Manager	9	14.3	25.4
	Resident Engineer	22	34.9	60.3
	QA/QC	10	15.9	76.2
	Project Engineer	10	15.9	92.1
	Q/S	5	7.9	100.0
Experience	5-9 years	5	7.9	7.9
	10-14years	22	34.9	42.9
	15-19years	26	41.3	84.1
	20-24years	8	12.7	96.8
	25 years and more	2	3.2	100.0

GENERAL DEMOGAPHIC RESPONDENTS

The first question gathered the general respondents' demographics (GRD). Table 1 shows that most respondents (96.8%) hold a bachelor's degree, half of the respondents (55.6%) were 40 to 49 years old. Several of them (34.9%) identified their occupation as resident engineers. The feedback from respondents also indicated that a large group of the respondents (41.3%) had 15 to 19 years work experience.

Table 2: Factors affect construction production

	Factors	*RII*	*Rank*	*CS /P-value*
1-	**Equipment Technology**	**0.76**	**7**	$\chi^2 = 78.03$, $p = 0.000$
2-	Wages and Benefits	0.70	11	$\chi^2 = 38.35$, p = 0.000
3-	**Site Layout**	**0.79**	**4**	$\chi^2 = 53.11$, p = 0.000
4-	Variation Orders	0.58	18	$\chi^2 = 15.56$, p = 0.004
5-	Governmental Regulations	0.49	25	$\chi^2 = 42.32$, p = 0.000
6-	Overtime	0.62	15	$\chi^2 = 19.46$, p = 0.001
7-	Team Spirit of Crew	0.52	23	$\chi^2 = 39.14$, p = 0.000
8-	Safety Performance	0.66	13	$\chi^2 = 12.32$, p = 0.015
9-	Labors' Health Status	0.49	27	$\chi^2 = 41.84$, p = 0.000
10-	**Weather Conditions**	**0.86**	**2**	$\chi^2 = 61.05$, p = 0.000
11-	**Adequate Material and Machinery**	**0.77**	**6**	$\chi^2 = 38.98$, p = 0.000
12-	**Security and Political Conditions**	**0.94**	**1**	$\chi^2 = 78.40$, p = 0.000
13-	**Labor's Efficiency**	**0.78**	**5**	$\chi^2 = 58.35$, p = 0.000
14-	Labor's Culture and Attitude	0.57	19	$\chi^2 = 13.59$, p = 0.009
15-	Construction Methods	0.56	22	$\chi^2 = 9.94$, p = 0.042
16-	Communication	0.48	27	$\chi^2 = 13.75$, p = 0.008
17-	Subcontracting	0.34	28	$\chi^2 = 66.76$, p = 0.000
18-	Labor's Experience	0.56	21	$\chi^2 = 31.37$, p = 0.000
19-	Technical Specifications	0.50	24	$\chi^2 = 29.46$, p = 0.000
20-	Training	0.69	12	$\chi^2 = 18.51$, p = 0.001
21-	**Labor's Motivation**	**0.73**	**9**	$\chi^2 = 64.38$, p = 0.000
22-	**Rework**	**0.82**	**3**	$\chi^2 = 42.32$, p = 0.000
23-	Labor Skills	0.57	20	$\chi^2 = 22.63$, p = 0.000
24-	Labor's Physical Limitations	0.53	*	$\chi^2 = 6.44$, p = 0.168
25-	**Planning and Scheduling**	**0.75**	**8**	$\chi^2 = 21.37$, p = 0.000
26-	Constructability	0.63	14	$\chi^2 = 16.76$, p = 0.002
27-	Leadership	0.61	16	$\chi^2 = 30.25$, p = 0.000
28-	Cash Flow	0.59	17	$\chi^2 = 10.25$, p = 0.036
29-	**Supervision**	**0.72**	**10**	$\chi^2 = 36.76$, p = 0.000

* Ignored because of $p > 0.005$

FACTORS THAT AFFECT CONSTRUCTION PRODUCTIVITY

The second question collected the respondents' viewpoint regarding the factors that affect construction productivity. A scale of 1 to 5 was provided for the respondents to rate their choices, where 1 represented "least important" and 5 represented "extremely important."

Table 2 presents the perception of respondents of the significance of factors that affect productivity. The table shows that most results are considered highly significant at levels of significance between p = 0.1 and p = 0.05, which indicates that observed frequencies do not differ from their expected values owing to randomness outcome assumption. However, a p value of 0.168 was recorded for the factor "laborers' physical limitations," which is not significant at any level of significance. This result implies a 16.8% probability that the difference between observed and expected frequencies is attributed to chance. Therefore, the result regarding the factor "laborers' physical limitations" is ignored.

The results signified that "security and political conditions" are the most important factors affecting productivity, given an RII value of 0.94. This score was based on the finding that more than half of the respondents (69.8%) believe that security is an extremely important factor.

This result is inconsistent with those of previous studies, such as that of AL-Zwainy *et al.* (2012) that identified security factor as having moderate effects on the productivity of marble finishing works in Iraq. The inconsistency may be attributed to the difference in time when the survey was conducted. This factor has received less attention compared with other factors in previous studies across different countries probably because it is not decisive in those countries. Security and political factors affect all sectors in Iraq, particularly the construction sector. Therefore, providing a safe work environment for labors is important to enhance their productivity.

A high percentage of respondents (47.6%) suggested that "weather conditions" is very important, whereas a quarter (25.4%) of them considered this factor as the most important. Consequently, this factor was ranked second with an RII value of 0.86.

This result is consistent with some previous studies, such as Soham and Rajiv (2013), who found that weather conditions are the most important factors that affect productivity. Halligan et al. (1994) included weather conditions among the factors that cause loss of productivity. Some researchers claimed that heavy rainfall suspends highway construction because of saturated soil (El-Rayes and Moselhi, 2001).

The weather in Iraq is characterized by a large disparity in temperatures depending on the region and season. Temperature in summer reaches above 50 °C and below 4 °C in winter. In addition, heavy snowfalls occur during winter in northern Iraq, which affect the ability of laborers and equipment. According to National Electrical Contractors Association (2004), productivity drops at temperatures between above 27 °C and below 4 °C. Thus, management should take weather conditions into consideration when scheduling projects to mitigate the influence of this factor.

The third factor was "rework" with an RII value of 0.82. Almost half of respondents (49.2%) considered this factor as extremely important. Rework refers to avoidable work because of incorrect implementation the first time of a process or activity (Love and Edwards, 2004). Generally, it is a consequence of poor quality. The result is consistent with the previous studies in terms of confirming the effect of rework on time and productivity (Love and Edwards, 2013, Han et al., 2013). Some researchers quantified the effect of rework on project schedule and found that the time needed to redo the work was 7.1% of total work (Josephson et al., 2002). Other researchers confirmed that rework contributes to schedule overruns.

The factors ranked from 4th to 10th are "site layout," "labor efficiency," "adequate material and machinery," "equipment technology," "planning and scheduling," "laborers' motivation," and "supervision," with RII values of 0.79, 0.78, 0.77, 0.76, 0.75, 0.73, and 0.72, respectively. Figure 1 shows the 10 most important factors affecting construction productivity.

The rest of the factors were ranked from 11th to 29th with RII values from 0.70 to 0.34. Table 2 shows that the differences between RII values are very slight, indicating that all factors are important. Therefore, all factors are worth considering as regards their effect on construction productivity. However, this study focuses on the 10 most important factors shown in Figure 1 because reducing factors and addressing these factors well was considered the better approach compared to introducing a large number and not tackling them properly (Jugdev and Muller, 2005).

The factors were classified into three groups according to the source to display the results in a framework for better understanding. These groups are external factors, human factors, and management factors, as shown in Figure 2.

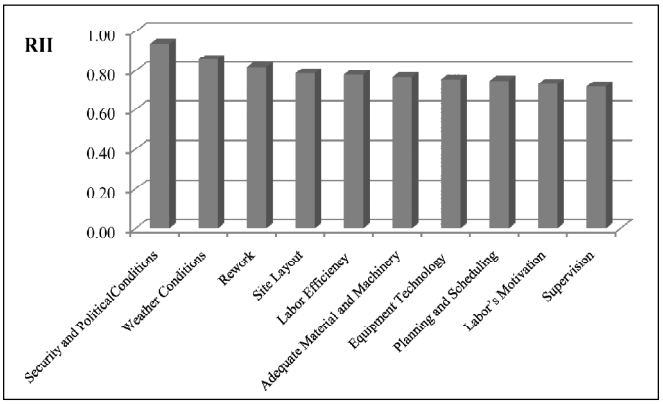

Figure 1: The RII of critical factors affecting construction productivity

External factors comprise "security and political conditions" and "weather conditions" and have been ranked the highest considering the RII value of 0.9. Human factors include all factors related to the individual laborers, such as "labor efficiency" and "laborers' motivation" and have been ranked third with RII value of 0.76.

Project managers involved in and associated with the project from its inception until completion are responsible for multiple tasks, such as providing materials and equipment, planning, budgeting, and ensuring a safe environment for laborers. Therefore, the factors "planning and scheduling," "site layout," "adequate material and machinery," "rework," "supervision," and "equipment technology" can be placed under the management factors group, which was ranked fourth with a RII value of 0.77.

CONCLITIONS

The survey results show that external factors are the most important factors that affect construction productivity in Iraq. In view of these results, improving construction productivity does not solely depend on the efforts of individual laborers because other factors affect productivity. Some of these factors are controllable, but others are beyond control limits. Appropriate planning can mitigate the effect of these factors. Specifically, adequate precaution is necessary to secure the workplace and reduce the intimidation of laborers.

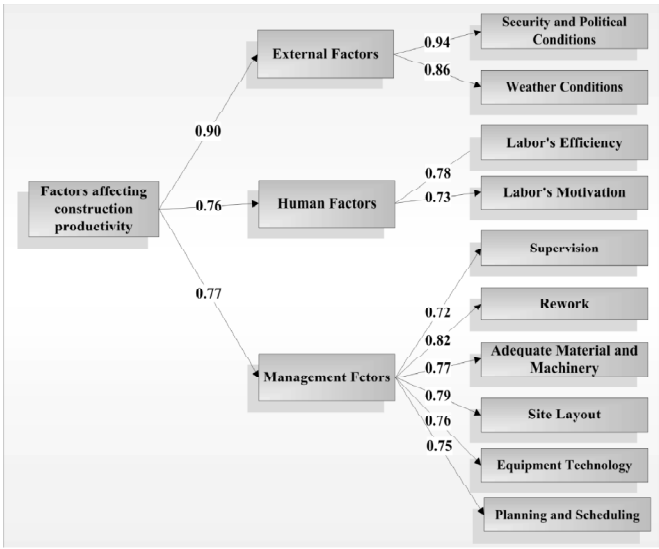

Figure 2: Classifications of critical factors affect construction productivity

The outcomes of this study are useful for project managers in developing strategies for improving construction productivity. These strategies will ensure the smooth flow of work and increase productivity.

This study is limited to the exploration and ranking of factors affecting construction productivity. Therefore, further studies on the consequences of each factor on construction productivity are recommended.

BIOGRAPHICAL NOTES

Samiaah Al-Tmeemy is the head of Survey department at Technical Institute-Baquba-Iraq as well as teaching. She received PhD in construction management from the University of Malaya. Her current research interests include quality management and project success.

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