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## Article

# Critical factors affecting construction labor productivity: A comparison between perceptions of project managers and contractors

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## OPERATIONS, INFORMATION & TECHNOLOGY | RESEARCH ARTICLE

# Critical factors affecting construction labor productivity: A comparison between perceptions of project managers and contractors

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**Abstract:** The present study aims to identify critical factors (CFs) affecting construction labor productivity (CLP) from the perception of project managers compared to contractors' viewpoint. By a comprehensive review of the previous studies, this study managed 45 CFs affecting labor productivity in the construction industry, which was grouped as primary 6 categories, including manpower, management, work condition, project, and external factors. A total of 203 valid samples were collected by 56 project managers and 147 contractors who completed a structured questionnaire survey according to their previous participation in or directly implementation construction projects. These CFs were ranked based on their relative important index and descriptive statistics (i.e., mean and standard deviation). The results' analysis indicated that the wide difference between project managers' and contractors' perspectives on the most influential factors impacting construction labor productivity.



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Mr. Nguyen Van Tam is a lecturer at the Faculty of Construction Economics and Management, National University of Civil Engineering, Vietnam.. His research focuses on building information modeling, construction project management, digitalization in the construction industry, productivity, and motivation.

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### PUBLIC INTEREST STATEMENT

Labor productivity plays a key role in assessing the success of construction projects which reflects the significant effect of this resource in the construction sector, meaning that any enhancement in labor productivity will contribute a high deal to enhance the project effectiveness. Based on referencing and considering previous studies, the authors synthesized and identified 45 CFs influencing construction labor productivity which was categorized into major 6 groups that are manpower, management, work condition, project, and external factors. The findings demonstrated the difference between project managers' and contractors' perspectives on the most influential factors affecting construction labor productivity on the basis of their descriptive statistics and the RII index through data were collected in an investigation in Vietnam. The results are expected to build a platform to implement better appropriate tasks towards improving construction labor productivity.

**Subjects: Engineering Project Management; Building Project Management; Project Management; Construction Industry**

**Keywords: critical factors; construction labor productivity; affecting; project managers; contractors**

## 1. Introduction

The construction industry plays an important role in the economic structure in most countries. The value of the construction sector contributes from 6% to 9% of an economy's gross domestic product (GDP) (Arditi & Mochtar, 2000; Chitkara, 1998). Labor productivity plays a key role in assessing the success of construction projects which reflects the significant effect of this resource in the construction sector, meaning that any enhancement in labor productivity will contribute a high deal to enhance the project effectiveness (i.e., quality, cost, revenue, and time performances) (Mahamid, 2013b). In many countries, the construction labor cost would account for between 30% and 50% of the total cost of a construction project, so construction labor productivity as a determinant impacting almost construction projects' profitability (El-Gohary & Aziz, 2014; Hanna et al., 2002; Mctague & Jergeas, 2002). Improving labor productivity is a primary concern for any profit-oriented institutions because it reflects the effective and efficient conversion of resources into marketable products and it determines business profitability (Wilcox et al., 2000). In this regard in the construction industry, many researchers have been conducted to purpose improvement labor productivity of construction practitioners (i.e., construction managers, engineers, architects, and builders). Poor construction labor productivity is a major cause of influencing quality, duration, and cost of construction projects (Mahamid, 2013b). Also, previous studies indicated that the loss of labor productivity in the construction industry is affected by various factors related to workforce, management, equipment and tools, materials, technology, and environment (Alaghbari et al., 2019; Enshassi et al., 2007; Mustapha & Naoum, 1998). However, the perception of what factors affecting construction labor productivity may different depending on the roles of respondents in the implementation of construction projects (Perera et al., 2014). Although in the previous studies, there are numerous researchers focused on identifying CFs on labor productivity in construction projects, in most of the study perspectives of project managers and contractors were neglected. Therefore, the aim of this study is that identify and evaluate the critical factors affecting construction labor productivity based on the perception of construction project managers in comparison with contractors' perspective. The findings are expected to build a platform to implement better appropriate tasks towards improving construction labor productivity.

The goal of this study assessed the critical factors affecting labor productivity in the construction industry under both views of project managers and contractors through data collected in an investigation in Vietnam.

To achieve this, specific objectives are as follows:

- To determine critical factors impacting construction labor productivity.
- To evaluate critical factors affecting construction labor productivity.
- To demonstrate how the difference in most influential factors affecting construction labor productivity under perceptions of project managers and contractors.
- To highlight recommendations to improve construction labor productivity.

## 2. Critical factors affecting construction labor productivity

Project managers participate in all aspects of a construction investment project, including pre-construction activities, construction administration, and post-construction. The project managers understand the client's goals and priorities and ensure that all project consultants are in line with these goals. The project managers manage the human resources according to the target capacity, budget, time frame, and quality of the project. The project managers typically manage the

construction managers and/or the contractors on behalf of the client. Essentially, the project managers become an extension of the client's internal team and can guide all consultants following the client's goals.

Contractors are chosen through a bidding process by the client and are involved during construction and in the daily direction and operation of projects. They are mainly credited for ensuring that all work is completed correctly and on time. Contractors hire subcontractors, like plumbers and carpenters, for specialized work. The physical work completed on-site is done by the contractor and their team of construction workers.

Productivity has been defined as the ratio of the outputs that are produced to the inputs used to produce the outputs (Coelli et al., 2005). In the construction context, labor productivity has been defined as the ratio between the units of work accomplished (i.e., outputs quantity) and the hours of work (i.e., inputs for labors) (Enshassi et al., 2007; Ghoddousi & Hosseini, 2012).

In order to improve labor productivity, identifying CFs affecting CLP is necessary. Therefore, various factors influencing construction labor productivity have been identified and classified by numerous researchers from different countries as represented in the previous studies.

For many years, the topic of factors influencing labor productivity in the construction industry has been a concern by numerous researchers (i.e., Alaghbari et al., 2019; Ghoddousi et al., 2015; Gunduz & Abdi, 2020; Hiyassat et al., 2016; Hwang et al., 2017; Jarkas & Bitar, 2012; Kadir et al., 2005; Kazaz & Acikara, 2015; Khan et al., 2011; Lim & Alum, 1995; Mahamid, 2013a, 2013b; Mustapha & Naoum, 1998; Schmid & Adams, 2008; Ugulu et al., 2016; Van Tam et al., 2018). For example, in terms of contractors' perspective, the study of (Lim & Alum, 1995) indicated top factors affecting construction labor productivity in Singapore include, (1) difficulty in the recruitment of supervisors, (2) difficulty in recruitment of workers, (3) high rate of labor turnover, (4) absenteeism at the worksite, and (5) communication problems with foreign workers, whereas, Mahamid et al. (2013) stated that factors of (1) rework, (2) lack of communication, (3) financial status of the owner, (4) labor experience, (5) lack of materials which have a significant impact on labor productivity in the Palestine construction industry (Mahamid, 2013a). From project managers' perspective, the results of a study was conducted by (Jarkas et al., 2014) in Qatar revealed that the top five factors affecting construction labor productivity are (1) lack of financial incentive schemes, (2) slow decision-making process by owners, (3) remuneration scale, (4) delay in responding to requests for information, and (5) shortage of skilled labor force, while Ghoddousi et al. (2015) shown that factors of (1) amount of remuneration, (2) work satisfaction, (3) timeliness of remuneration, (4) ethical behavior of manager, (5) promotion opportunities which have the most effect on productivity in Iranian construction projects (Ghoddousi et al., 2015).

Consequently, various factors that impact the productivity of the construction workforce have been identified and classified by many studies from different countries. However, the frequency and importance of these factors vary from project to project or nation to nation, and even within the same project, depending on circumstances (P. Olomolaiye et al., 1998). Therefore, an effort to divide factors into major global groups, it may best encompass and relate to the various relevant factors is necessary. Based on referencing and considering previous studies, the present study synthesized some of the most important factors impacting construction labor productivity. As provided in Table 2, a total of 45 critical factors influencing labor productivity in the construction industry, which are divided into six categories as follows: (1) manpower (7 factors), (2) management (13 factors), (3) motivation (8 factors), (4) work condition (5 factors), (5) project (7 factors), and (6) external (5 factors) Table 1.

By comprehensive literature review of the outcomes from previous studies, the hypothesis for this study is formulated as follows:

**Table 1. Critical factors affecting construction labor productivity**

Categories	Factors	Related sources
Manpower factors	Absenteeism	(Lim & Alum, 1995, Mahamid et al., 2013, Alaghbari et al., 2019, Enshassi et al., 2007, Mahamid, 2013a)
	Age of labor	(Alaghbari et al., 2019, Hiyassat et al., 2016, Enshassi et al., 2007, Hai & Van Tam, 2019)
	Labor's education level	(Alaghbari et al., 2019)
	Labors' experience and skills	(Mahamid et al., 2013, Alaghbari et al., 2019, Jarkas et al., 2012, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007)
	Personal problems	(Mahamid et al., 2013, Enshassi et al., 2007)
	Strength and physical of labor	(Alaghbari et al., 2019)
	Work discipline	(Jarkas, 2015, Van Tam et al., 2018)
Management factors	Ability of construction management	(P. O. Olomolaiye et al., 1987)
	Availability of equipment/tools	(Mahamid et al., 2013, Zakeri et al., 1996, Enshassi et al., 2007, Mahamid, 2013a)
	Availability of labors	(Alaghbari et al., 2019, P. O. Olomolaiye et al., 1987, Mahamid, 2013a)
	Availability of materials	(Zakeri et al., 1996, Alaghbari et al., 2019, Hiyassat et al., 2016, Jarkas et al., 2012, Jarkas, 2015, Enshassi et al., 2007)
	Communication	(Lim & Alum, 1995, Mahamid et al., 2013, Hiyassat et al., 2016, Jarkas et al., 2012, Jarkas, 2015, Enshassi et al., 2007)
	Construction methods	(Hiyassat et al., 2016, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007, Mahamid, 2013a)
	Financial status of stakeholders	(Mahamid et al., 2013, Hiyassat et al., 2016, Mahamid, 2013a)
	Lack of supervision	(Jarkas et al., 2012, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007)
	Lack of supervisors' experience	(Mahamid et al., 2013, Jarkas, 2015)
	On-site storage	(Mahamid, 2013a)
	Rework	(Mahamid et al., 2013, Hiyassat et al., 2016, Jarkas, 2015, Jarkas et al., 2015, P. O. Olomolaiye et al., 1987)
	Site management	(Mahamid et al., 2013)
	Working overtime	(Alaghbari et al., 2019, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007)

(Continued)

Categories	Factors	Related sources
Motivation factors	Amount of remuneration	(Lim & Alum, 1995, Mahamid et al., 2013, Mahamid, 2013a)
	Creating competition	(Enshassi et al., 2007)
	Lack of labor recognition programs	(Hiyassat et al., 2016, Enshassi et al., 2007, P. O. Olomolaiye et al., 1987)
	Motivation of laborers	(Van Tam et al., 2018)
	Promote opportunities	(Hiyassat et al., 2016, Mahamid, 2013a)
	Rewards/Punishments	(Hiyassat et al., 2016)
	Timeliness of remuneration	(Mahamid et al., 2013, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007)
	Work satisfaction	(Srinavin & Mohamed, 2003)
Work condition factors	Accident	(Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007)
	Healthy and safety conditions	(Hiyassat et al., 2016)
	Height of worksite	(Enshassi et al., 2007)
	Work security	(Kazaz & Ulubeyli, 2007)
	Working space	(Enshassi et al., 2007)
Project factors	Design changes	(Srinavin & Mohamed, 2003)
	Design complexity	(Jarkas, 2015, Jarkas et al., 2015)
	Drawing quality	(Zakeri et al., 1996, Jarkas, 2015, Jarkas et al., 2015)
	Effective project	(Kazaz et al., 2008)
	Project location	(Mahamid et al., 2013, Hai & Van Tam, 2019)
	Project type	(Enshassi et al., 2007)
	Sub-contractor	(Srinavin & Mohamed, 2003)
External factors	Economic conditions	(Srinavin & Mohamed, 2003)
	Geological and hydrological conditions	(Van Tam et al., 2018)
	Regulation and law	(Jarkas et al., 2015, Enshassi et al., 2007)
	Social culture	(Hiyassat et al., 2016)
	Weather conditions	(Zakeri et al., 1996, Hiyassat et al., 2016, Jarkas et al., 2012, Jarkas, 2015, Jarkas et al., 2015, Enshassi et al., 2007, Mahamid, 2013a, Hai & Van Tam, 2019)

*Hypothesis 1: Manpower factors have an impact on construction labor productivity.*

*Hypothesis 2: Management factors have an impact on construction labor productivity.*

*Hypothesis 3: Motivational factors have an impact on construction labor productivity.*

*Hypothesis 4: Work condition factors have an impact on construction labor productivity.*

*Hypothesis 5: Project factors have an impact on construction labor productivity.*



**Table 2. Ranking of manpower factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Work discipline	3.946	0.840	0.789	1	3.839	0.934	0.768	2
Labors' experience and skills	3.821	1.081	0.764	2	3.952	0.995	0.790	1
Age of labors	3.714	1.124	0.743	3	3.306	0.962	0.661	7
Strength and physical of labors	3.714	1.091	0.743	4	3.401	0.970	0.680	5
Absenteeism		3.696	1.094	0.739	5	3.667	0.946	0.733
3								
Labor's education level	3.536	0.934	0.707	6	3.431	0.904	0.686	4
Personal problems	3.429	1.093	0.686	7	3.313	0.890	0.663	6

Note: M is Mean, SD is Standard Deviation, and RII is Relative Importance Index.

*Hypothesis 6: External factors have an impact on construction labor productivity.*

### 3. Research methodology

The present study was conducted on the basis of a questionnaire survey aimed at effectively collecting all the necessary data. As mentioned above, a total of 45 critical factors that affect labor productivity in the construction sector was identified. These factors were then tabulated in the form of a questionnaire.

The structured questionnaire was composed of two main parts. The first part contained general information on the participants (i.e., qualifications, positions, and professional experience) whose main purpose was to describe the participants in order to effectively ensure reliability and strengthen research findings. The second part included the list of these identified factors. Participants were selected for interviews based on their previous participation in or direct implementation of construction projects in Vietnam. Based on their experience, they will evaluate the degree of influence of the factors to labor productivity in the construction industry following a 5-point Likert scale (i.e., 1-Very low effect, 2-Low effect, 3-Moderate effect, 4-High effect, 5-Very high effect).

#### 3.1. Pilot test

Before distributing the questionnaire, a pilot study was carried out to verify the questionnaire and ensure that the information returned by project managers and contractors would be appropriate to the goals of the present study. This stage was carried out by sending the questionnaire project to eight experts with many years of experience and comprehensive knowledge on this subject. They assessed the validity of the questionnaire content, comment on the readability of the linguistics, and to add additional factors and a comprehensive of the questionnaires. After receiving their comments, the questionnaire was slightly changed.



### 3.2. Measurement method

For analyzing data, this study used the method of Relative Importance Index (RII) to measure the impact of these CFs affecting CLP. The RII method was used by numerous studies (i.e., Alaghbari et al., 2019; Gunduz & Abdi, 2020; Hiyassat et al., 2016; Jarkas, 2015; Jarkas et al., 2012). The RII index was calculated based on the following formula:

$$RII = \frac{\sum_{i=1}^5 W_i \times X_i}{5 \sum_{i=1}^5 X_i} \quad (1)$$

Where:  $W_i$  is the rating given to each factor by the participant ranging from 1 to 5;  $X_i$  represented the percentage of respondents scoring and reflected the order number for the respondents;  $i$  is the order score ranging from 1 to 5.

Responses from the first part can be obtained through the appropriate response choice. In the second part participants needed to assess the factors that influence construction labor productivity on a Likert scale from 1 (very low effect) to 5 (very high effect). The RII index is applied to evaluate these factors influencing labor productivity in the construction sector as perceived by the participants and, therefore, a comparative analysis is possible. The study findings of (Hickson & Ellis, 2014) indicated that the RII method is a proven system for analyzing laborer's satisfaction, making it appropriate for the objectives of this study. The research of (Nyoni & Bonga, 2016) applied the RII method to assess attitudes related to the factors studied. Lundby and Fenlason (2000) confirmed that the RII index can discover certain factors that contribute most to management and work concerns and help decision-makers allocate organizational resources (Lundby & Fenlason, 2000). In addition, the RII of the groups was calculated by increasing the average of the RII factors in each group (Alaghbari et al., 2019).

### 3.3. Sampling and data collection

The collection of case-specific data was conducted by respondents who engaged with construction projects in Vietnam and working in several roles for project managers and contractors. A total of 250 samples were distributed by email and face-to-face interviews. Only 216 answers were received, and 203 qualified responses for research, representing an effective rate of 81.2%. Among the 203 valid respondents, the majority of participants (147 samples) who are working for construction contractors account for 72.41% of the total. Only 56 participants who are working as project managers, which occupy 27.59%.

## 4. Results and discussions

In the present study, in order to compare the perceptions of project managers and contractors on CFs affecting CLP, there are two software applications were applied, which are MS Excel 365 and SPSS 22. A total of 45 critical factors influencing labor productivity in the construction industry has been identified and ranked on the basis of their descriptive statistics (i.e., mean and standard deviation), and the RII index.

### 4.1. Manpower factors group

As demonstrated in Table 2, the ranking of seven critical factors is evaluated under the manpower group. The surveyed project managers ranked "work discipline" (RII = 0.789) is the first position, while the factor of "labors" experience and skills' (RII = 0.790) was ranked the first by contractors. This evidence indicates that these two factors have a significant impact on labor productivity in the construction industry following the perception of both project managers and contractors, which was further supported by server previous studies (i.e., Durdyev & Mbachu, 2011; Enshassi et al., 2007; Gerges et al., 2011).

In terms of project managers' perspective, with RII = 0.764, "labors" experience and skills' factor was ranked 2<sup>nd</sup> in this group, followed by "age of labors," "strength and physical of labor," "Labor absenteeism" were ranked 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> with RII are 0.743, 0.743, and 0.739, respectively.

Finally, “labor’s education level” (RII = 0.707), and “personal problems” (RII = 0.686) were assessed at the end of this group, which reveals that these CFs have a low impact on CLP. However, from the perspective of contractors, the “work discipline” factor was evaluated 2<sup>nd</sup> with RII = 0.768, followed by “labor absenteeism,” “labor’s education level,” “personal problems,” and “strength and physical of labor” were ranked 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup>, and 6<sup>th</sup> in this category with RII ranging between 0.768 and 0.663, whereas “age of labor” with RII = 0.661 was ranked at the end of manpower group.

#### **4.2. Management factors group**

The ranking of the 13-factor under management group is illustrated in Table 3. In terms of contractors’ perception, “rework” (RII = 0.786) was ranked the first in this group, which indicates that this factor has a very high effect on labor productivity in the construction sector. This ranking in the line with the study of (Ng et al., 2004) revealed that “rework” is the main factor of dissatisfaction that leads to a negative impact on the labor productivity of construction workers in Hong Kong. However, this factor was ranked 7<sup>th</sup> (RII = 0.736) by project managers, while “the ability of construction management” was evaluated as the 1<sup>st</sup> in the management category under the project managers’ perspective. Interestingly, the “financial status of stakeholders” was ranked 2<sup>nd</sup> following both perceptions of contractors and project managers with RII are 0.772 and 0.796, in turn.

With the RII ranging between 0.704 and 0.675, the surveyed project managers ranked three factors are “working overtime,” “communication,” and “construction methods” at the end of this group, which proves that these CFs have a very low impact on CLP. However, contractors assessed that factors of “working overtime” (0.702), “lack of supervisors’ experience” (RII = 0.667), and “availability of labors” (RII = 0.663) have a low influence on labor productivity in the construction industry.

#### **4.3. Motivation factors group**

As provided in Table 4, factors of “timeliness of remuneration” (RII = 0.782) and “amount of remuneration” (RII = 0.764) were ranked the first and the second, respectively, by project managers. In contrast, the surveyed contractors indicated that “amount of remuneration” was ranked the 1<sup>st</sup> in this category, while “timeliness of remuneration” was ranked the 2<sup>nd</sup> with RII are 0.767 and 0.752, in turn. The ranking reveals that this two-factor as determinant impact labor productivity in the construction sector. This evidence was supported by the studies of (Ghoddousi et al., 2014; Tabassi & Bakar, 2009), which explained that managers are well aware that construction workers still have to deal with low incomes, which has been identified as a problem in many countries, and late payments have a dramatic impact on the main aspects of productivity in the construction sector (Jarkas & Radosavljevic, 2013; Kaliba et al., 2009; Perera et al., 2014; Tam et al., 2004).

In terms of the perception of contractors, factors such as “rewards/punishments” (RII = 0.743), “motivation of laborers” (RII = 0.733), and “lack of labor recognition programs” (RII = 0.702), which indicates that these factors have a moderate impact on construction labor productivity. Finally, with RII between 0.671 and 0.650, three factors are “work satisfaction,” “promote opportunities,” and “creating competition” which were ranked 6<sup>th</sup>, 7<sup>th</sup>, 8<sup>th</sup> in this category. However, from the project managers’ perspective, factors of “motivation of laborers,” “lack of labor recognition programs,” and “creating competition” were ranked at the end in the motivation group, with RII are 0.718, 0.675, and 0.668, respectively. This proves that these factors have a low influence on labor productivity in the construction industry.

#### **4.4. Work condition factors group**

Table 5 indicates the ranking of seven-factor related to the work condition category. The result statistics of contractors’ respondents indicates that “healthy and safety conditions” with RII = 0.762 was ranked the 1 in this group, which proves that this factor has a very high impact on construction labor productivity. This ranking in the line with the studies of (Ghoddousi & Hosseini, 2012; Ghoddousi et al., 2015) which demonstrated that the construction industry is

**Table 3. Ranking of management factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Ability of construction management	4.071	0.850	0.814	1	3.680	0.929	0.736	6
Financial status of stakeholders	3.982	0.963	0.796	2	3.858	0.951	0.772	2
Lack of supervision	3.875	0.634	0.775	3	3.637	1.022	0.727	7
Availability of labors	3.857	0.819	0.771	4	3.313	0.957	0.663	13
Availability of materials	3.839	1.156	0.768	5	3.837	0.965	0.767	3
Site management	3.714	1.074	0.743	6	3.816	0.909	0.763	4
Rework	3.679	1.309	0.736	7	3.932	1.005	0.786	1
On-site storage	3.679	1.011	0.736	8	3.596	0.926	0.719	9
Availability of equipment/tools	3.643	1.212	0.729	9	3.796	0.943	0.759	5
Lack of supervisors' experience	3.554	1.043	0.711	10	3.333	0.878	0.667	12
Working overtime	3.518	1.128	0.704	11	3.510	0.939	0.702	11
Communication	3.482	1.206	0.696	12	3.571	0.876	0.714	10
Construction methods	3.375	1.169	0.675	13	3.619	0.939	0.724	8

knowns for its poor working conditions and the adoption of health and safety measures in some developing countries. Factors such as “Working space” (RII = 0.728), “height of worksite” (RII = 0.707), “accident” (RII = 0.663), and “work security” (RII = 0.645) were ranked the 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, and 5<sup>th</sup> in the work condition group.

For the perception of project managers, with RII = 0.771, the factor of “accident” was ranked the first in this category, while “healthy and safety conditions” were assessed the 2<sup>nd</sup> with RII = 0.754, which proves that these two-factor have a very high impact on labor productivity in the construction industry. Followed by factors like “work security,” “working space,” and “height of worksite” were ranked at the end of the work condition group with RII between 0.746 and 0.682. This ranking shows that these CFs have a low impact on CLP.

**Table 4. Ranking of motivation factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Time liness of remuneration	3.911	0.880	0.782	1	3.762	1.002	0.752	2
Amount of remuneration	3.821	1.011	0.764	2	3.837	0.929	0.767	1
Work satisfaction	3.804	1.313	0.761	3	3.354	0.985	0.671	6
Promote opportunities	3.732	1.228	0.746	4	3.340	0.925	0.668	7
Rewards/ Punishments	3.679	1.309	0.736	5	3.714	0.986	0.743	3
Motivation of laborers	3.589	1.290	0.718	6	3.667	1.042	0.733	4
Lack of labor recognition programs	3.375	1.001	0.675	7	3.510	0.968	0.702	5
Creating competition	3.339	1.405	0.668	8	3.252	0.867	0.650	8

**Table 5. Ranking of work condition factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Accident	3.857	0.943	0.771	1	3.313	1.012	0.663	4
Healthy and safety conditions	3.768	1.009	0.754	2	3.810	0.960	0.762	1
Work security	3.732	0.963	0.746	3	3.225	1.098	0.645	5
Working space	3.536	0.852	0.707	4	3.639	1.033	0.728	2
Height of work site	3.411	1.092	0.682	5	3.537	0.846	0.707	3

#### 4.5. Project factors group

The results of [Table 6](#) indicate that seven factors of the project group have been ranked by the RII index under perceptions of project managers and contractors. The surveyed project managers evaluated “design changes” as the 1 in this group with RII = 0.786, whereas “drawing quality” (RII = 0.761) was ranked the first position by contractors. The ranking demonstrates that the quality of design factor as a determinant having a significant impact on construction labor productivity. This finding in line with the study of (Enshassi et al., 2007), which showed that the

**Table 6. Ranking of project factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Design changes	3.929	0.871	0.786	1	3.442	0.937	0.688	4
Effective project	3.696	0.913	0.739	2	3.633	1.001	0.727	2
Drawing quality	3.679	0.855	0.736	3	3.803	0.991	0.761	1
Project location	3.571	1.024	0.714	4	3.184	0.868	0.637	7
Design complexity	3.554	1.111	0.711	5	3.633	0.966	0.727	3
Sub-contractor	3.446	1.174	0.689	6	3.381	1.106	0.676	5
Project type	3.250	1.014	0.650	7	3.293	0.916	0.659	6

drawing quality and specification alteration during the construction project implementation was the major factor affecting productivity.

The factor of “effective project” was ranked the second in this group under both the perceptions of project managers and contractors, with RII are 0.739 and 0.727, respectively, which shows that this factor has a high impact on CLP. From the contractors’ perspective, with RII ranging between 0.688 and 0.627, remaining factors under the project group such as “design changes,” “sub-contractor,” “project type,” and “project location” were ranked at the end of this group. However, project managers ranked “sub-contractor” and “project type” it is the 6<sup>th</sup> and 7<sup>th</sup> in the project group, which demonstrates that these CFs have a low effect on CLP.

#### 4.6. External factors group

Table 7 provides the ranking of factors relevant to the external group, five critical factors are identified under this category. The project managers’ respondents ranked the factor of “economic conditions” it is the first with RII = 0.779, followed by “weather conditions” (RII = 0.736) was evaluated the second. However, with RII = 0.761, “weather conditions” were ranked the 1<sup>st</sup> by contractors, followed by “economic conditions” (RII = 0.748) was ranked the second, which indicates that two CFs have a very high influence on CLP. This ranking in the line with study of (Van Tam et al., 2018), which showed that almost all buildings have been constructed in natural spaces where are influenced by weather conditions (i.e., temperature, humidity, rain, and storm). From both viewpoints of project managers and contractors, factors such as “regulation and law,” “regulation and law,” and “geological and hydrological conditions” were ranked at the end in the external group. This evidence demonstrates that these CFs have a low impact on labor productivity in the construction industry.

#### 4.7. Top ten critical factors affecting construction labor productivity

The overall-perceived impacts of all 45 factors under the project managers’ and contractor’s perspectives were ranked by the RII method. Accordingly, Table 8 provides the most influential factors impacting labor productivity in the construction industry under the perceptions of project managers and contractors. Particularly, in terms of project managers’ perspective, the top 10 CFs affecting CLP are “the ability of construction management,” “financial status of stakeholders,” “work discipline,” “design changes,” “timeliness of remuneration,” “economic conditions,” “lack of supervision,” “accident,” “availability of labors,” and “availability of materials.” However, from the

**Table 7. Ranking of external factors on project managers and contractors**

Factors	Project managers				Contractors			
	M	SD	RII	Rank	M	SD	RII	Rank
Economic conditions	3.893	0.966	0.779	1	3.741	1.028	0.748	2
Weather conditions	3.679	1.377	0.736	2	3.803	0.881	0.761	1
Regulation and law	3.607	1.139	0.721	3	3.238	0.855	0.648	4
Social culture	3.482	0.934	0.696	4	3.211	0.878	0.642	5
Geological and hydrological conditions	3.375	1.169	0.675	5	3.517	0.968	0.703	3

perspective of contractors, the top 10 CFs affecting CLP includes “labors” experience and skills,’ “rework,” “financial status of stakeholders,” “work discipline,” “availability of materials,” “amount of remuneration,” “site management,” “healthy and safety conditions,” “weather conditions,” and “drawing quality.”

As demonstrated in Table 8, for project managers’ awareness, the factor of “the ability of construction management” was ranked the first position among all critical factors, whereas, “labors” experience and skills’ were ranked the first-factor affecting construction labor productivity from contractors’ viewpoint. The experience and skills of the construction workforce is accumulated fact from the learning and working effectively in the case of the same skill or task is repeated more than one time (Mahamid, 2013a). This factor plays an important role to improve the labor productivity of contractors’ respondents. This finding is in the line with several previous studies (i.e., El-Gohary & Aziz, 2014; Hiyassat et al., 2016; Horner et al., 1989; Jarkas, 2015; Mahamid et al., 2013), which showed that experience and skill of labors have a very high impact on construction labor productivity in the United Kingdom, Saudi Arabia, Bahrain, Egypt, and Jordan. For any construction project, monitoring, and supervising are important task because it may affect the quality, time, and cost of the project. The study of (Maloney, 1983) emphasized the essential role of workforce management, and to improve construction productivity, managers need to positively manage and supervise the construction workforce in the workplace. According to Kazaz et al. (2008), for the supervision levels of construction workers on-site, the general contractor has little control, at best, over the construction workforce of subcontractors. The incompetence of supervisors is an issue, workers are highly concerned with the supervision personnel and questions of their competency (Jarkas & Radosavljevic, 2013; Ohueri et al., 2018).

Both viewpoints of project managers and contractors show that factors of “financial status of stakeholders,” “work discipline,” and “availability of materials” that has a significant impact on construction labor productivity. Construction activities are implemented with many resources, one of which financial plays a key role. Many buildings needed a large amount of capital and almost of contractors perceive it exceptionally troublesome to bear the high daily execution expenses in the case of payments are delayed. This phenomenon can impact the availability of labor, supplying materials, motivation, and loyalty of laborers, and the communication between

**Table 8. Top 10 critical factors affecting construction labor productivity under the perceptions of project managers and contractors**

Rank	Project managers				Contractors			
	Factors	M	SD	RII	Factors	M	SD	RII
1	Ability of construction management	4.071	0.850	0.814	Labors' experience and skills	3.952	0.995	0.790
2	Financial status of stakeholders	3.982	0.963	0.796	Rework	3.932	1.005	0.786
3	Work discipline	3.946	0.840	0.789	Financial status of stakeholders	3.858	0.951	0.772
4	Design changes	3.929	0.871	0.786	Work discipline	3.839	0.934	0.768
5	Time liness of remuneration	3.911	0.880	0.782	Availa bility of materials	3.837	0.965	0.767
6	Economic conditions	3.893	0.966	0.779	Amount of remuneration	3.837	0.929	0.767
7	Lack of supervision	3.875	0.634	0.775	Site management	3.816	0.909	0.763
8	Accident	3.857	0.943	0.771	Healthy and safety conditions	3.810	0.960	0.762
9	Avail ability of labors	3.857	0.819	0.771	Weather conditions	3.803	0.881	0.761
10	Avail ability of materials	3.839	1.156	0.768	Drawing quality	3.803	0.991	0.761

laborers and contractors (Mahamid, 2013a). Besides, one of the fundamental factors to enhance the quality and performance of work is to have good job discipline in the working environment. The study of (Kazaz & Ulubeyli, 2007) indicated that work discipline plays an important in all construction activities, and it is essential in many countries due to a part of manpower in the construction industry is still largely composed of people who have come from areas in which a rigidly patriarchal society is the norm. To construct a building must use a large number of materials, so material availability is a determinant that impacts construction activities. Lack of materials is affected by several causes such as supply and demand, local materials, inflation, and political status. These problems may lead to material shortage, so decrease construction labor productivity (Kadir et al., 2005; Kaming et al., 1997; Makulsawatudom et al., 2004).

## 5. Conclusions

The present study aimed to identify a total of 45 critical factors affecting construction labor productivity, which was categorized into the main six groups that are manpower, management,



work condition, project, and external factors. The data was collected by 203 valid-surveyed questionnaires with participants of construction project managers and contractors, and these critical factors were ranked based on their RII index and descriptive statistics (i.e., mean and standard deviation). The findings indicated that the most significant critical factors affecting construction labor productivity under project managers' perception such as "the ability of construction management," "financial status of stakeholders," "work discipline," "design changes," "timeliness of remuneration," "economic conditions," "lack of supervision," "accident," "availability of labors," and "availability of materials." Meanwhile, in terms of the perception of contractors, the most influential factors impacting labor productivity in the construction industry such as "labors experience and skills," "rework," "financial status of stakeholders," "work discipline," "availability of materials," "amount of remuneration," "site management," "healthy and safety conditions," "weather conditions," and "drawing quality."

Based on the results, the following recommendations are suggested as a way to improve labor productivity in the construction industry:

*Improving construction workforce experience and skills:* Numerous studies encouraged that construction laborers should participate in programs of regular training to learn practical skills and real experience (Alaghbari et al., 2019; Enshassi et al., 2007; Liberda et al., 2003; Mahamid, 2013a; Ohueri et al., 2018). Therefore, the authors highlight construction stakeholders should create programs of workshops and training to enhance the construction laborers' experience and managerial skills of the construction parties (Mahamid et al., 2013).

*Enhancing work motivation of the construction workforce:* The studies were conducted by (Doloi, 2007; Ghoddousi et al., 2015; Khan et al., 2011; Zakeri et al., 1997) indicated that it is necessary to promote and reward construction laborers as a way of enhancing motivation and work satisfaction to improve labor productivity in the work environment. Besides, the majority of construction practitioners acknowledged the importance of being recognized for their abilities by being rewarded (Momade & Hainin, 2019; Ohueri et al., 2018). Therefore, construction enterprises should provide rewards as a means of demonstrating appreciation for the employees which shows that the managers valued their tasks. As a result, they have a tendency to dedicate themselves to their organizations, which is the best way to improve labor productivity (Sekhar et al., 2013).

*Improving management competency on construction sites:* Contractors should create workshops and training courses to help managers to improve the managerial experience and skills as well as keep management activities on construction sites to enhance quality and prevent incorrect productions. Besides, material delay and material arrangement, tool, and equipment management should be improved by adopting a proper material management system. Contractors also should design a material supply for each specific construction project. This schedule should involve the time required to supply materials and the materials available on the local market to supply the required materials in time (Ameh & Osegbo, 2011; Ghoddousi & Hosseini, 2012).

This study contributes to the topic of construction labor productivity by demonstrating the differences in perceptions of project managers and contractors in construction projects. However, the results of the present study should be considered because of its limitations. This includes considering the potential lack of awareness of project managers or contractors regarding operational aspects of construction projects, which could be a reason behind some discrepancies with the outcomes' researches in the past. Another factor limitation to consider is that concerns the fact that the cultural and socio-economic factors of the construction industry might influence the awareness of project managers and contractors. Hence, the outcomes of this study should be generalized in other contexts with caution.

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## Disclosure statement

The authors confirm that this study presented in this article has no conflict of interest.

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