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Critical factors affecting construction labor productivity in Egypt

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Abstract: The construction industry plays an important role in any developing country. This sector will promote the infrastructure required in socioeconomic development which also a major contributor to the overall economic growth. One of the main factors that had influence in the construction industry growth is productivity which mainly associated with the labor performance. Labor in construction industry could be defined as all workforces involve in the process that had to carry out to accomplish and to achieve goal. The labor productivity insufficiency will affect the performance of the overall project. The objective of this research is to identify and rank the relative importance of factors perceived to affect labor productivity on Egyptian construction projects. To achieve this objective, a statistically representative sample of contractors was invited to participate in a structured questionnaire survey, comprising 27 productivity factors, classified under the following four primary groups: (a) Technological; (b) Management; (c) Human/Labor; and (d) External. Among the factors explored, the subsequent ten are discerned to be the most significant in their effects on labor productivity: (1) Payment delay; (2) Skill of labor; (3) A shortage of experienced labor; (4) Lack of labor supervision; (5) Motivation of labor; (6) Working overtime, (7) Construction managers lack of leadership, (8) High humidity, (9) Clarity of technical specification, (10) High/low temperature. The results obtained fill a gap in knowledge of factors affecting labor productivity in Egypt, which can be used by industry practitioners to develop a wider and deeper perspective of the factors influencing the efficiency of operatives, and provide guidance to construction managers for efficient utilization of the labor force, hence assist in achieving a reasonable level of competitiveness and cost effective operation.

Keywords: Construction, Labor Productivity, Factors, Management; Relative Importance Index (RII), Rank, Improvement, Egypt

1. Introduction and Background

Construction labor productivity has become a big problem in construction industry. In most countries, labor cost comprises 30 to 50% of the overall project's cost (Guhathakurta and Yates1993; McTague and Jergeas 2002), and thus is regarded as a true reflection of the economic success of the operation. A similar conclusion was echoed by Stoekel and Quirke (1992). Because construction is a labor-intensive industry, the significance of this effect not only justifies the concern over its labor productivity, but it can also be argued that labor power is the only productive resource, hence construction productivity is mainly dependent upon human effort and performance.

There are many challenges that are faced by construction industry in Egypt, but one of the most important challenges

is labor productivity in construction. Every project has some difficulty in construction like material, money, tools and local contractor's construction cost.

Looking to the current scenario of continuous downfall of construction labor productivity, it is highly necessary to identify the factors which affect it and then work out the critical ones out of the available factors. Depending on the measurement objectives and the availability of data, several productivity definitions are encountered.

In 1950, the Organization for European Economic Cooperation (OEEC) introduced a formal definition of productivity as "a quotient obtained by dividing output by one of the production factors". Consequently, it became possible to speak of the productivity of capital, investment or raw materials according to whether the output is being considered in relation to capital, investment or raw materials

(Sumanth 1985). The US Department of Commerce defines productivity as “Dollars of output per person hour of labor input” (Adrian 1987).

Peles (1987) interpreted productivity as “the performance accomplished by operatives”, whereas Handa and Adballa (1989) defined productivity as “the ratio of outputs of goods and/or services to inputs of basic resources, e.g., labor, capital, technology, materials and energy”. The American Association of Cost Engineers moreover, defines productivity as a “relative measure of labor efficiency, either good or bad, when compared to an established base or norm” (Allmon *et al.* 2000). While Arditi and Mochtar (2000) referred to productivity as “the ratio between total outputs expressed in Dollars and total inputs expressed in Dollars as well”, Horner and Duff (2001) expressed productivity as “how much is produced per unit input”. A number of studies have been carried out to determine the factors affecting labor productivity in construction projects. Lim and Alum (1995) explored various factors impacting the construction productivity in Singapore, and shortlisted the followings as most significant: lack of qualified supervisors; shortage of skilled labor; high rate of labor turnover; labor absenteeism; and communications with foreign laborers. Makulsawatudom *et al.* (2004) researched the influence of twenty three factors on the productivity of the construction industry in Thailand, and deduced that: lack of material; incomplete drawings; incompetent supervisors; lack of tools and equipment; labor absenteeism; poor communication; instruction time; poor site layout; inspection delay; and rework, are the most critical. Abdul Kadir *et al.* (2005), in addition, surveyed the perceived effects of fifty productivity factors on Malaysian residential projects, and identified the followings five as most important to labor efficiency: (a) shortage of material; (b) nonpayment to suppliers causing stoppage of materials delivery to sites; (c) change orders by consultants; (d) late issuance of construction drawings by consultants; and (e) the incapability of site management.

The American association of cost engineers, Jarkas and Bitar (2012) carried out a survey in Kuwait. The objective of that research was to identify and rank the relative importance of factors perceived to affect labor productivity on construction sites. To achieve that objective, a statistically representative sample of the contractors was invited to participate in questionnaire survey, comprising 45 productivity factors. As per their finding important factor were: (1) Clarity of technical specifications, (2) Extent of variation/change orders during execution, (3) Coordination level among various design disciplines. El-Gohary and Aziz (2014) carried out the survey. The questionnaire comprised thirty productivity factors where they classified them under the following three primary categories: (a) human/labor; (b) industrial; (c) management. They used relative importance index method. This index was computed for every factor for each specific year of the participants’ experience. Wen and Chan (2014) carried out the study of a systematic review on labor productivity in the construction industry. The aims of their review were to investigate the state of the art and trends

in Critical Labor Productivity (CLP) research, and to identify key research areas.

2. Research Objective

The objective of this research is to identify and rank the relative importance of factors perceived to affect labor productivity on Egyptian construction projects in which can be used by industry practitioners to develop a wider and deeper perspective of the factors influencing the efficiency of operatives, and provide guidance to construction managers for efficient utilization of the labor force, hence assist in achieving a reasonable level of competitiveness and cost effective operation.

3. Research Methodology

This research is based on a survey designed to gather all necessary information in an effective way. The survey presents 27 productivity factors generated on the basis of related research works on construction productivity, Mistry and Bhatt (2013). These factors were classified into the following four categories based on previous literature and as advised by local experts: Technological related factors, Human/labor related factors; Management related factors and External related factors to consider the effect of the different levels of the participants’ experiences.

4. Data Analysis Approach

For analyzing data, the Relative Importance Index (RII) technique was used according to the following formula (Lim and Alum 1995; Enshassi *et al.* 2007; and Jarkas and Bitar 2012):

$$RII(\%) = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + n_1}{5(n_5 + n_4 + n_3 + n_2 + n_1)} * 100$$

Where: n_1, n_2, n_3, n_4 and n_5 , = the number of respondents who selected: (1) Very weak influence (2) Weak influence (3) Medium influence (4) Strong influence, (5) Very strong. (Ranging from 1 to 5) is the weighting given to each factor by the respondents. The RII was used to rank (R) the different factors affecting on labor productivity. These rankings made it possible to cross-compare the relative importance of the factors as perceived by respondents.

Each individual factor’s RII perceived by all respondents should be used to assess the general and overall rankings in order to give an overall picture of the labor productivity.

5. Questionnaire Design

The design philosophy of the questionnaire was based on the fact that they had to be simple, clear and understandable for the respondents and at the same time they should be able to be interpreted well by the researcher. The questionnaire has a definite advantage of requiring a smaller time to be responded and is more accurate in the final outcome.

Factors affecting the construction labor productivity were identified through the literature based on previous research together with input, revision and modifications by local experts where a total of 27 factors were identified. The participants were required to rate the factors in the way they affect construction labor productivity considering time, cost and quality using their own experiences on building sites. A total of 55 questionnaires were completed by, contractors, consultants, managers, and experienced engineers.

6. Results

The perceived effect of each of the 27 factors explored on construction labor productivity in Egypt is determined. The overall factors are classified under four major categories as follows: eight, under the “Technological category”; four, under the “Human category”; eleven, under the “Management category”; and four, under the “External category”

The relative importance indices, rank within the corresponding category, and the overall ranks of the factors investigated are presented, discussed, and compared to previous related research findings as follows

6.1. Technological Group

The relative importance indices and ranks of the eight factors classified under the technological category are shown in Table 1

Table 1. RII Ranking of Technological Factors.

No.	Factor	Factors affecting labor productivity	RII Ranking
1	Factor 1	Clarity of technical specification	79.27
2	Factor 7	Inspection delay/stringent by the engineer	74.81
3	Factor 5	Rework	73.82
4	Factor 3	Coordination level among design disciplines	73.09
5	Factor 4	Design complexity level	72.73
6	Factor 2	The extent of variation/change order During execution	72.36
7	Factor 6	Site layout	71.07
8	Factor 8	Site restricted access	63.27

Table 1 shows that the surveyed participants ranked “Clarity of technical specification” as the most important factor affecting labor productivity in this group, with a RII of 79.27%. This top ranked factor is further ranked as the ninth in its effect among all factors explored.

6.2. Human Group

The relative importance indices and ranks of the four factors classified under the human category are shown in Table 2

Table 2. RII Ranking of Human Factors.

No.	Factor	Factors affecting labor productivity	RII Ranking
1	Factor 10	Skill of labor	86.91
2	Factor 12	A shortage of experienced labor	84.36
3	Factor 9	Motivation of labor	83.27
4	Factor 11	Physical fatigue	76.00

Table 2 shows that the surveyed participants ranked “The Skill of labor” as the most important factor affecting labor productivity in this group, with a relative importance index of 86.91%. This top ranked factor is further ranked as the second in its effect among all factors explored, which confirms the significant impact of this factor

6.3. Management Group

The relative importance indices and ranks of the eleven factors classified under the Management category are shown in Table 3

Table 3. RII Ranking of Management Factors.

No.	Factor	Factors affecting labor productivity	RII Ranking
1	23	Payment delay	87.64
2	14	Lack of labor supervision	84.00
3	15	Working over time	81.09
4	13	Construction managers lack of leadership	80.00
5	19	Proportion of work subcontracted	76.60
6	22	Construction method	75.64
7	16	Crew size and composition	73.82
8	17	Unsuitability of storage location	73.45
9	21	Shortage of materials	72.00
10	18	Accidents as a result of poor site safety program	69.45
11	20	"Unrealistic scheduling and expectation of labor performance	68.00

Table 3 shows that the surveyed participants ranked “The Delay of payment” as the most important factor affecting labor productivity in this group, with a RII of 87.64%. This top ranked factor is further ranked as the First in its effect among all factors explored, which confirms the significant impact of this factor

6.5. External Group

The relative importance indices and ranks of the four factors classified under the External category are shown in Table 4

Table 4: RII Ranking of External Factors.

No.	Factor	Factors affecting labor productivity	RII Ranking
1	Factor 25	High humidity	79.64
2	Factor 24	High/low temperature	76.73
3	Factor 26	High wind	74.91
4	Factor 27	Rain	68.52

Table 4 shows that the surveyed participants ranked “The High Humidity” as the most important factor affecting labor productivity in this group, with a relative importance index of 79.64%. This top ranked factor is further ranked as the eighth in its effect among all factors explored, which confirms the significant impact of this factor.

6.6. The Overall Ranking

The overall perceived effects of the factors surveyed are

summarized in Table 5. The top ten ranked factors affecting the efficiency of operatives in Egypt, are as follows:

(1) Payment delay; (2) Skill of labor; (3) A shortage of experienced labor; (4) Lack of labor supervision; (5) Motivation of labor; (6) Working overtime, (7) Construction managers lack of leadership, (8) High humidity, (9) Clarity of technical specification, (10) High/low temperature.

The results show that 3 of the top 5 ranked factors are from the (Human factors group) which indicated that it's the most significant group among the whole groups.

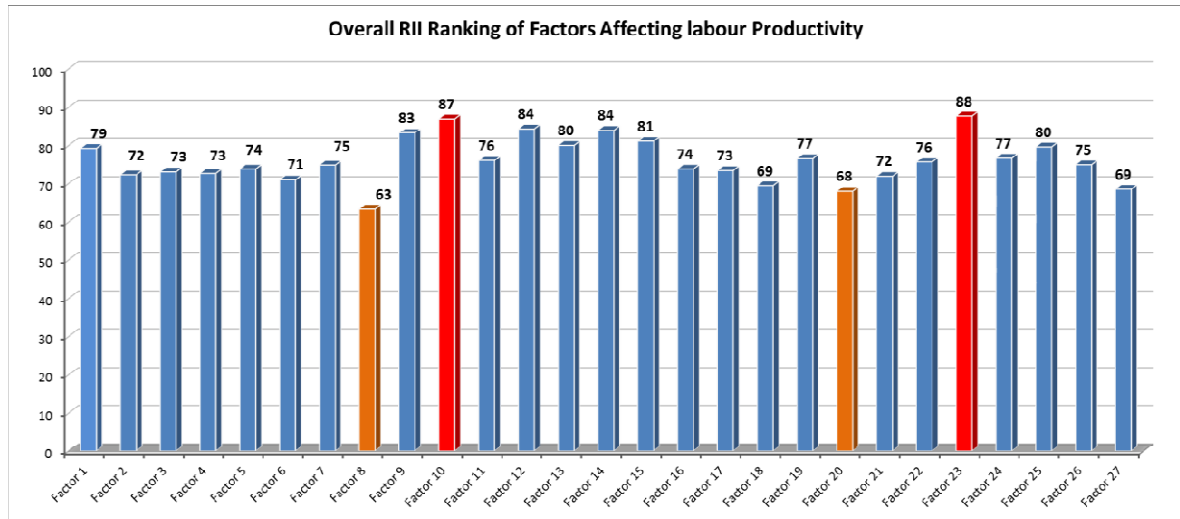


Figure 1. Overall Ranking.

Table 5. Overall Ranking of Factors affecting Labor Productivity According to Survey Results.

No.	Factor	Group	Factors affecting labor productivity	RII Ranking
1	23	Management	Payment delay	87.64
2	10	Human	Skill of labor	86.91
3	12	Human	A shortage of experienced labor	84.36
4	14	Management	Lack of labor supervision	84.00
5	9	Human	Motivation of labor	83.27
6	15	Management	Working over time	81.09
7	13	Management	Construction managers lack of leadership	80.00
8	25	External	High humidity	79.64
9	1	Technological	Clarity of technical specification	79.27
10	24	External	High/low temperature	76.73
11	19	Management	Proportion of work subcontracted	76.60
12	11	Human	Physical fatigue	76.00
13	22	Management	Construction method	75.64
14	26	External	High wind	74.91
15	7	Technological	Inspection delay/stringent by the engineer	74.81
16	5	Technological	Rework	73.82
17	16	Management	Crew size and composition	73.82
18	17	Management	Unsuitability of storage location	73.45
19	3	Technological	Coordination level among design disciplines	73.09
20	4	Technological	Design complexity level	72.73
21	2	Technological	The extent of variation/change order During execution	72.36
22	21	Management	Shortage of materials	72.00
23	6	Technological	Site layout	71.07
24	18	Management	Accidents as a result of poor site safety program	69.45
25	27	External	Rain	68.52
26	20	Management	Unrealistic scheduling and expectation of labor performance	68.00
27	8	Technological	Site restricted access	63.27

“Fig. 1” shows that the surveyed participants ranked “The Payment Delay” as the most important factor affecting labor

productivity among the overall factors with RII (87.64%) as illustrated in Figure 5

Comparing this study with the latest previous studies in the last 3 years in; Nigeria, New Zealand, Kuwait, USA, Turkmenistan, Turkey, India and Egypt; it features the top 5

factories effecting on labor productivity for each country as shown in table 6-a, b.

Table 6A. Overall Ranking of top 5 Factors affecting Construction labor productivity in Previous Studies in Last 3 years.

Ranking	Indonesia Soekiman et al. (2011)	New Zealand Tran and Tookey (2011)	Kuwait Jarkas and Bitar (2012)	USA Mahesh (2012)
1	Lag of Materials	Reworks	Clarity of technical specifications	Lack of required construction material
2	Labors strikes	level of skill and experience of the workforce	The extent of variation/change orders during execution	Shortage of power and/or water supply
3	Delay in arrival materials	adequacy of method of construction	Coordination level among various design disciplines	Accidents during construction
4	Financial difficult of owner	Build-ability issues	Lack of labor supervision	Lack of required construction tools/equipment
5	Unclear instruction to laborer	inadequate supervision and coordination	Proportion of work subcontracted	Poor site condition

Table 7B. Overall Ranking of top 5 Factors affecting Construction labor productivity in Previous Studies in Last 3 years.

Ranking	Turkmenistan Durdyev et al. (2012)	India Mistry and Bhatt (2013)	Egypt El-Gohary and Aziz (2014)
1	Schedule Pressure caused by Government	Payment Delay	Laborer experience and skill
2	Schedule Pressure caused by Government	Skill of Labor	Incentive programs
3	Working overtime	Clarity of Technical Specifications	Availability of the materials and their ease of handling
4	Financial Weakness of the Contractor	Material Shortage	Leadership and competency of construction management
5	Rework	Motivation	Competency of labor supervision

And also; a comparison between the top 10 factors in the latest studies as shown in Table 7

Table 7. Comparison between survey result and the previous study.

El-Gohary and Aziz (2014) Ranking		Research Ranking		
S	Factor	RII Ranking	Factor	RII Ranking
1	Laborer experience and skill	93.29	Payment delay	87.64
2	Incentive programs	91.87	Skill of labor	86.91
3	Availability of the materials and their ease of handling	90.34	A shortage of experienced labor	84.36
4	Leadership and competency of construction management	88.40	Lack of labor supervision	84.00
5	Competency of labor supervision	87.43	Motivation of labor	83.27
6	Construction technology (construction method, and material)	86.64	Working over time	81.09
7	Labor operating system (daily wage, lump sum....etc.)	86.16	Construction managers lack of leadership	80.00
8	Planning, work flow, and site congestion	84.54	High humidity	79.64
9	Constructability (integrated design and construction)	82.01	Clarity of technical specification	79.27
10	Clarity of instructions and information exchange	80.73	High/low temperature	76.73

7. Conclusion

As part of its aim, this study identifies and ranks the factors constraining labor productivity of Egyptian contractors in Egypt, which are measured, based on the views of construction professionals. The findings of the research are generally aligned with the results of previous studies related with labor productivity.

The results indicate that the most significant factors affecting labor productivity are:

- 1) Payment delay and Motivation of labor: matching with the results of India Mistry and Bhatt (2013).

- 2) Skill of labor and a shortage of experienced labor: matching with the results of New Zealand Tran and Tookey (2011) and Egypt El-Gohary and Aziz (2014)
- 3) Lack of labor supervision: matching with the results of Kuwait Jarkas and Bitar (2012)

In conclusion, it is believed that the outcomes of this paper can assist in achieving high labor productivity by focusing and acting upon the most important factors. Furthermore, by focusing on the significance of the evaluated factors constraining labor productivity, Egyptian construction companies could be well guided in their efforts to addressing the factors in a time, cost and quality-effective manner.

Recommendations

Based on the outcomes of this research paper, recommendations to improve labor productivity are as follows:

Deeper studies on the effect of the delay of payment on the labor productivity need to be made.

Establishing special programs and training in order to improve the skills of the workforce.

Construction managers need to prepare professional techniques of labor motivation.

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