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Factors Affecting Labor Productivity: Perspectives of Craft Workers

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Abstract

Labor productivity has a significant impact on time, cost, and quality of a construction project. Especially the competitive environment of the construction industry forces construction companies to increase their labor productivity values in order to keep their positions in the industry. In this respect, identification and evaluation of factors that affect the labor productivity becomes a crucial issue for industrial practitioners. In the academic literature, there are many studies that investigated these factors and their relationships with the labor productivity. In these studies, the factors were categorized under different groups and ranked according to their importance levels. However, in most of these studies, both the standard deviation among these factors under the same group and the mean value of each group were neglected. In addition, perspectives of managers were taken into account in general while those of craft workers were ignored. The aim of the current study is to re-evaluate the factors under the same groups by considering their standard deviations and mean values from the craft workers' point of view. For this purpose, after a detailed literature review, 37 factors were identified and categorized under four groups such as organizational, economical, physical, and socio-physiological factors. A questionnaire survey were then applied to craft workers to obtain the necessary data which was analyzed by means of the Relative Importance Index (RII) technique. The results revealed that, although the ranking of the factors remained the same, their importance levels have changed

Keywords: Labor productivity, craft workers, Relative Importance Index (RII), construction management.

1. Introduction

Construction projects are accepted as prestigious in many countries and the industry makes a significant contribution to the national economics [1]. For example, in developed countries, construction industry constitutes approximately 10% of the national income [2]. Besides its economic size, construction industry also provides employment with rates of 7 % and 8 % in Europe and USA, respectively [1,3]. However, the economic contribution of construction industry is more significant in developing countries compared with developed ones [4].

Although, construction industry made an appreciable improvement dependently to the technological development [5], non-value adding activities still comprises 50 to 70% of work time in a typical work site [6]. Therefore, labor productivity becomes one of the most important factors that affect both time and cost performances of the construction projects [7].

In this study, it was aimed to introduce the factors affecting labor productivity in Turkish Construction Industry by considering craft workers' perspectives. For this purpose, 37 different factors were analyzed under 4 factor groups named as organizational, economical, physical and socio-psychological. In addition, the distribution of each factor within a group was examined by statistical analysis.

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2. Literature Review

Construction industry is mostly defined as a labor intensive industry. Therefore, labor productivity became a crucial issue for the profitability of the construction projects [8]. Similarly, due to the industry's economic size, an increase in labor productivity will also make a significant contribution to the national income. Accordingly, examining the factors affecting labor productivity attracted the attention of many researchers and numerous researches were conducted. Actually, these factors are local. In other words, factors may vary from region to region, from project to project and even on the same project depending on different conditions [9]. Therefore, in the literature most of the studies were conducted in different countries.

In these studies, different perspectives of different project participants such as project managers, contractors and craft workers were considered. Although, the number and groups of factors differ in each study, data collection and ranking methods are considerably similar. In Table 1 some of these studies and their results are summarized.

As seen in Table 1 these studies were mostly conducted in undeveloped or developing countries. Except Jarkas and Radosavljevic [13], the other researchers investigated the factors by categorizing them under different factors groups. Similarly, Jarkas et. al. [10] analyzed demotivational factors under a simple factor group. RII was the dominating method used for ranking these factors in these studies.

The results of these studies proved that most influencing factors varies from region to region. For example, different two studies conducted in Kuwait and Qatar by the same researchers revealed different results. The most effective factor affecting labor productivity in Kuwait was found as "clarity of specifications" while in Qatar it was "skill of labor" [15, 16]. Similarly, "unavailability of material on time at the workplace", "payment delay", "competence of project manager", "rework", "lack of financial incentive scheme" and "labor experience and skill" factors were evaluated as the most influencing factors in India, Kuwait, Lithuania, Palestine, Qatar and Egypt respectively [8,10,11,12,13,14].

Besides factors, factors groups also varied from region to region in these studies. "Management factor group", "managerial factor group", "project related factor group" "labor group", "technological factor group" and "supervision factor group" were evaluated as most significant factor groups in Egypt, Palestine, Lithuania, Qatar, Kuwait and Indonesia, respectively [8,11,12,15,16,17]

Kazaz et al [18] investigated 37 factors categorized under four factors group by considering managers' perspectives in Turkey. The results revealed that organizational factors group and quality of site management was rated as the most effective factors group and factor, respectively. In this study, it was aimed to investigate these 37 factors by considering craft workers' perspective.

Table 1. Literature Summary of the Factors Affecting Construction Labor Productivity

Country	Researchers	Years	Number of Investigated Factors	Number of Investigated Factor Groups	Ranking Methods	Results
Egypt	El Gohary and Aziz [8]	2014	30	3	RII ^a	Labor experience and skills were ranked as the most important factors and management factor category was determined the most effective group.
Qatar	Jarkas et al.[10]	2014	38	1	RII ^a	Lack of financial incentive scheme was ranked as the most effective factor.
Palestine	Mahamid [11]	2013	31	5	II ^b	Rework was rated as the most important and weather changes was rated as the least important factors. Managerial factor group was rated as the most effective group.
Lithuania	Gudiene et al.[12]	2013	71	7	RII ^a	Project related factor group was rated as the most significant group and competence of project manager was rated as the most effective factor.
Kuwait	Jarkas and Radosavljevic [13]	2013	23	-	RII ^a	Payment delay was rated as the most significant factor on labor productivity.
India	Thomas and Sudhakumar [14]	2013	44	10	II ^b ,FI ^c ,SI ^d	Unavailability of material on time at the workplace was rated as the most effective factor.
Qatar	Jarkas et al.[15]	2012	35	4	RII ^a	Skill of labor and labor group was rated as the most effective factor and factor group, respectively.
Kuwait	Jarkas and Bitar[16]	2012	45	4	RII ^a	Clarity of technical specifications was rated as the most significant factor and technological factor groups was rated as the most significant group.
Indonesia	Soekiman et al. [17]	2011	113	15	RII ^a	Lag of material was rated as the most effective factor and supervision group was rated as the most effective factor group.
Turkey	Kazaz et al. [18]	2008	37	4	RII ^a	Organizational factor group was determined as the most effective group and quality of site management was rated as most influencing factor.

a: RII (Relative Importance Index) b: II (Importance Index)c: FI (Frequency Index) d: SI (Severity Index)

3. Methodology

The results of the studies conducted by considering craft workers' perspective revealed that craft workers can better assess the factors affecting their productivity [19]. In this sense, in this study the factors determined by Kazaz et.al [18] were re-evaluated by considering craft workers' perspectives. Kazaz et. al [18] determined 37 different factors and categorized them under 4 groups named as organizational, economical, physical and socio-psychological. Then, these factors were organized on a 5-point Likert-scale where 1 and 5 represents "not significant" and "extremely significant", respectively. Additionally, in this study an open-ended question was also included to the questionnaire to determine whether there exist other factors in craft workers' perspective. The questionnaire was administered face-to-face to 126 craft workers employed in 4 different construction projects in Turkey.

The results of the questionnaires were statistically evaluated by using the Relative Importance Index (RII). In this context, first RII scores of each factor and then the mean RII scores of each factor group were determined. In addition, standard deviation and coefficient of variation of each group were also calculated. The numeral interval of RII method used for 5-point Likert scale is shown in Table 2. After, each factor was ranked according their RII scores under each factor groups. The distances between each factor's RII score and weighted mean of each group were also determined. Finally, factors with a distance of one and two standard deviation were categorized under the same group.

Table 2. Numeral Intervals of RII Methods

Min RII Points	Definition	Max RII Points
1,00	not significant (NS)	1,80
1,80	somewhat significant (SS)	2,60
2,60	Significant (S)	3,40
3,40	very significant (VS)	4,20
4,20	extremely significant (ES)	5,00

4. Results

The Test of Internal Consistency was used to test the reliability of the questionnaire. To be reliable, the Cronbach's alpha value, which is calculated at the end of this test, must be range between 0,600 and 1,000 [20]. In this study the Test of Internal Consistency was conducted for each factor group and the Cronbach's alpha values of socio-psychological, economical, physical and organizational factor groups were calculated as 0.670, 0.664, 0.788 and 0.646, respectively which were in the accepted interval.

The results of the questionnaire revealed that according to the craft workers' perspective working in social insurance factor which was categorized under economical factors group was the most important factor affecting their productivity with a RII score of 4,68. On the other side, organizational factors group turned out to be the most influencing group with a weighted mean score of 4,06. In Table 3 analyze results of the factors and factor groups are summarized.

Table 3. Ranking of Factor Groups

Name of Group	Number of Investigated Factors	Median RII	Effect Level	Rank	Standard Deviation	Coefficient of Variation
Organizational	10	4.09	VS	1	0.45	0.11
Economical	6	4.02	VS	2	0.95	0.24
Socio-psychological	12	3.54	VS	3	0.62	0.18
Physical	9	3.40	VS	4	0.48	0.14

Mean RII score, standard deviation and coefficient of variation values are used to interpret the distribution of factors, compactness ratio and degree of homogeneity of each group [11]. A high compactness ratio of a group increases the consistency of the factors within the group [11]. Figure 1 illustrates dispersion of influencing factors under each factors group in accordance with the mean RII scores.

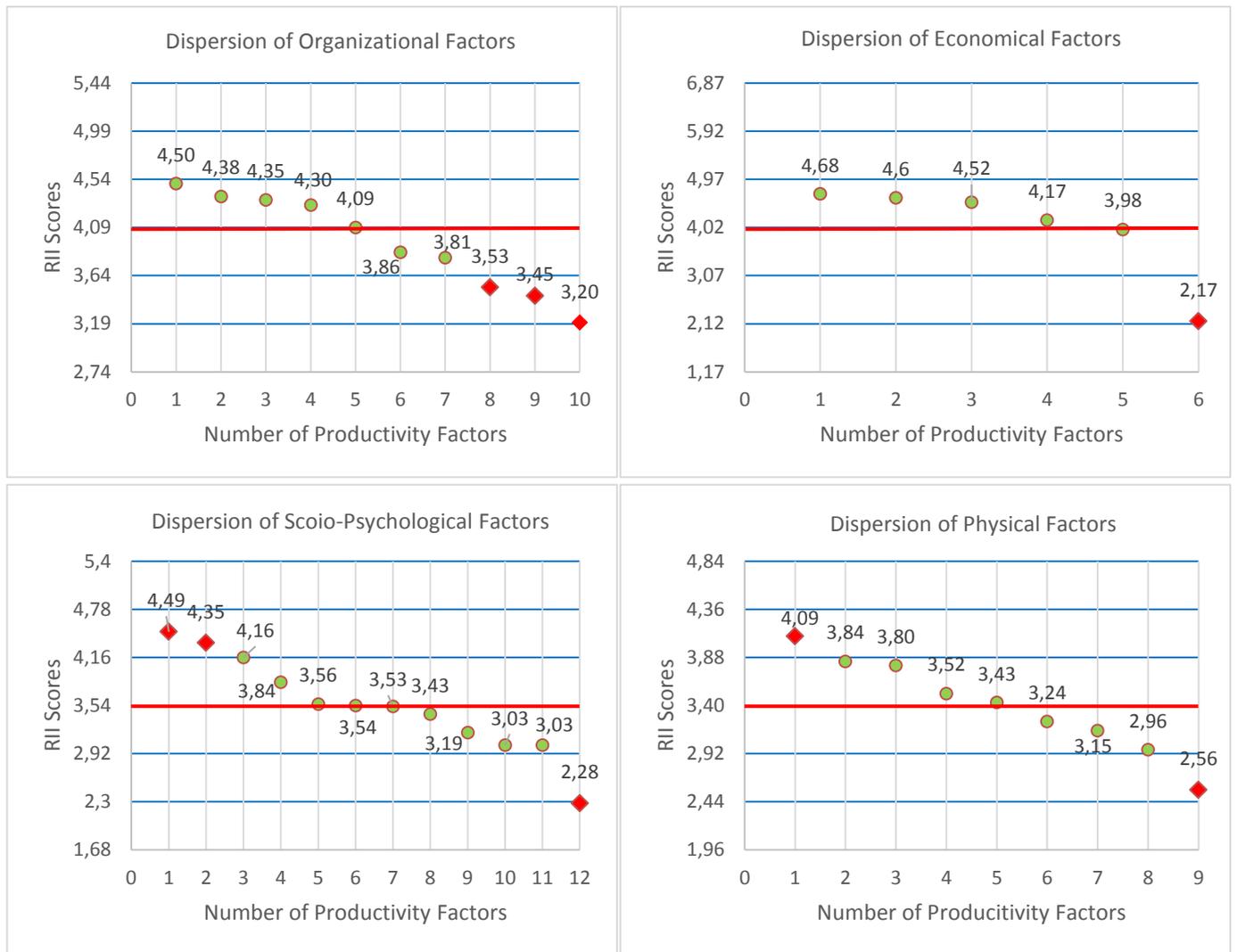


Figure 1. Dispersion of Productivity Factors

The questionnaire results revealed that organizational factors group has the highest weighted mean score and the lowest standard deviation compared to the other ones. This result also establishes that the compactness ratio of the factors within this group is high. In addition, 4 factors' (camping conditions, quality of site management, systematic flow of work, relaxation allowances) RII score were above the weighted mean of the group while 5 of them namely; site layout, supervision, occupational education and training, crew size and efficiency and firm reputation below. 3 of the factors namely; occupational education and training, crew size and efficiency and firm reputation, which RII scores were below the weighted mean of the group, were located in a distance more than 1 standard deviation. Therefore, it can be deduced that these factors have less influence on labor productivity compared to the other factors within the group according to the craft workers.

In economical factors group, which contained 6 factors, 5 factors namely; working in social insurance, on-time payment, amount of pay, discontinuity of work and incentive payments were located above the weighted mean with approximate RII scores. This result shows that the importance degrees of these factors were perceived as same by craft workers. Only union membership factor was located about 2 standard deviation distance below the weighted mean. Although, 5 factors, which were above the weighted mean, showed a high compactness ratio, the distance of the union membership factor affected the standard deviation and coefficient of variation of the group. Therefore, economical factors group had the highest standard deviation and coefficient of variation among the factors groups.

In socio-psychological factors group 4 factors namely; health and safety conditions, work discipline, social activity opportunities and distance from home were located above, 4 factors as; cultural differences, worker participation in decision making, sharing problems and their results and creating competition were located below and 4 factors namely; distance from population centers, relation with workmates, giving responsibility and work satisfaction were located around the weighted mean value of the group. 2 of the factors (health and safety

conditions and work discipline) were located in a distance of more than 1 standard deviation and hence, were accepted as very important by the craft workers compared to other ones. On the other hand, the factor with lowest RII score (creating competition) was located more than 2 standard deviation below the weighted mean and was perceived as insignificant by craft workers.

In physical factors group 5 factors namely; weather conditions, overtime, schedule compression, design complexity and disruptions were located above and 4 factors namely; error tolerance, site congestion, working at similar activities and shift were located below the weighted mean value of the group. The most important factor (weather conditions) according to craft workers' perception had a distance of 1,5 standard deviation from the mean value. Similarly, the factor (shift) with the lowest RII score was located about 2 standard deviation distance below the mean value.

5. Conclusion

Labor productivity has a big impact on the profitability of construction projects and hence, this topic has attracted the attention of many researchers. Although, there are numerous studies which investigate the factors affecting labor productivity, in most of them the factors were not grouped under different factor groups. In the studies, in which the factors were categorized, the dispersion of the factors within a group was usually neglected.

In this study, it was aimed to analyze the dispersion of the factors within a group and the compactness of each factors group. For this purpose, a questionnaire consisting of 37 factors categorized under organizational, economical, physical and socio-psychological factors group was administered to 126 craft workers employed in 4 different construction projects. The results revealed that although 3 factors were located in a distance more than 1 standard deviation above the weighted mean value, organizational factors group has the highest weighted mean and lowest standard deviation values. Therefore, factors under organizational factors group are perceived as equal important by craft workers. Similarly, in both economical and physical factors groups, the factors were also perceived as equal important by craft workers. Only, factors categorized under socio-psychological factors group had different importance degrees according to craft workers' evaluation.

References

- [1] Proverbs, D. G.; Holt, G. D.; Olomolaiye, P. O. Factors impacting construction project duration: a comparison between France, Germany and the U.K., *Journal of Building and Environment* 34 (1999) 197–204.
- [2] Navon, R. Automated project performance control of construction projects, *Journal of Automation in Construction* 14 (2005) 467–476.
- [3] Thieblot, A. J. Technology and labor relations in the construction industry *Journal of Labor Research* 23 (2002) 559–573.
- [4] Altaf, H. Construction productivity factors, *Journal of Professional Activities*, 14 (1979): 189–195.
- [5] Goodrum, P. M. and Haas, C. T. Partial factor productivity and equipment technology change at activity level in US construction industry, *Journal of Construction Engineering and Management* 128 (2002) 463–472.
- [6] Diekmann, J., Krewedl, M., Balonick, J., Stewart, T., and Won, S. Application of lean manufacturing principles to construction. ProjectTeam Number 191, Construction Industry Institute, Univ. of Texas at Austin, Austin, TX, 2004
- [7] Al-Saleh, H. (1995). Improving construction productivity in Saudi Arabia The 4th Saudi Engineering Conference
- [8] El-Gohary KM, Aziz RM. Factors influencing construction labor productivity in Egypt *Journal of Management in Engineering* 30 (2014) 1-9
- [9] Olomolaiye, P. O., Jayawardane, A. K. W. and Harris, F. C. *Construction Productivity Management*. Wesley Longman, 1998
- [10] Jarkas A.M., Radosavljevic M., and Wuyi L., Prominent demotivational factors influencing the productivity of construction project managers in Qatar. *International Journal of Productivity and Performance Management*, 63 (2014) 1070 - 1090
- [11] Mahamid I. Contractors perspective toward factors affecting labor productivity in building construction. *Journal of Engineering, Construction and Architectural Management* 20 (2013), 446-460
- [12] Gudienė N., Banaitis A., and Banaitienė N., Evaluation of critical success factors for construction projects – an empirical study in Lithuania. *International Journal of Strategic Property Management*, 17 (2013), 21-31
- [13] Jarkas A.M and Bitar C.G. Motivational factors impacting the productivity of construction master craftsmen in Kuwait. *Journal of Management in Engineering*, 29 (2013)
- [14] Thomas A.V., and Sudhakumar J. Critical Analysis of the Key Factors Affecting Construction Labour Productivity –An Indian Perspective. *International Journal of Construction Management*, 4 (2013) 103-125
- [15] Jarkas, A.M., Kadri C.Y., and Younes J.H., A Survey of Factors Influencing the Productivity of Construction Operatives in the State of Qatar. *International Journal of Construction Management*, 3 (2012) 1-23
- [16] Jarkas A.M and Bitar C.G. Factors affecting construction labor productivity in Kuwait. *Journal of Construction Engineering and Management*, 138 (2012)
- [17] Soekiman A., Ppribadib K.S., Soemardi W. and Wirahadikusumah R.D., Factors Relating to Labor Productivity Affecting the Project Schedule Performance in Indonesia *Journal of Procedia Engineering* 14 (2011) 865–873
- [18] Kazaz A, Manisalı E and Ulubeyli S. Effect of basic motivational factors on construction workforce productivity in Turkey. *Journal of Civil Engineering and Management* 14(2) (2008) 95–106
- [19] Dai J, Goodrum P.M and Maloney W.F. (2009). Construction craft workers' perceptions of the factors affecting their productivity. *Journal of Construction Engineering and Management*, 135 (2009)
- [20] Kaiser HF, Rice J. Little Jiffy, Mark IV *Journal of Educational and Psychological Measurement*, 1974