

Experimental Study on Statistical Analysis to Improve Labour Productivity in Construction Industry

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ABSTRACT

Productivity is a measure of the efficiency of factors of production. This note will focus on measures to improve labour productivity in construction industry.

Labour Productivity is an important aspect of construction industry that may be used as an index for efficiency of production. Efficient management of construction resources can lead to higher productivity which can help to achieve cost and time saving. Construction is labour oriented industry. It heavily relies on the skills of its workforce. The labour is industry's most valuable asset. It is important to improve efficiency of production by improving productivity of labour. Decreasing productivity of project has always been major concern for construction Industry. Aim of this project is to study the importance of measurement of labour productivity in construction industry, after finding the factors affecting labour productivity. Factors affecting labour productivity will be analysed using RII method. Measurement of labour productivity will be done using work study method. RII method will reveal top ten ranked factors which affect labour productivity. The data collection done by work study method will clearly show skilled labour as highly important factor affecting labour productivity. From the analysis of data collected it can be observed that measurement of labour productivity will help in saving the time of the project as well as cost of project without hampering the quality of work.

Key Words: *Construction Industry, Construction projects, Labour Productivity, RII method, Statistical Analysis, SPSS.*

I. INTRODUCTION

Labour Productivity is one of the most important factors affecting the overall performance of any organization either large or small. At the micro-level, improved productivity decreases unit costs and serves as an indicator of project performance. At the macro-level, improved productivity is a vital tool in countering inflationary effects and determining wage policies. Improved labour productivity is thus always counted among the basic means of solving economic problems.

In this study the factors that promote positive motivational behaviour among construction workers to improve production in the construction site. Is identified Furthermore, the study will identifies consistencies in the behaviour of motivated, satisfied, committed and loyal employees in the construction field since these are important characteristics in the workplace.

In addition to the advantages at the fundamental level, the advantages of productivity improvement can be summarized as follows:

- Decrease in total cost and duration of production
- Improved quality.
- Increased employment and wages without inflationary pressures
- Enhanced purchasing capacities among employees, employers and customers.

1.1 OBJECTIVES AND SCOPE OF STUDY

The project undertaken by various construction firms differ widely, but the planning system adopted for all the firms are mostly one at the same. Rather than adopting the same system a detailed study on specific firms business and its computing system could help firm in a more comprehensive manner.

- Maximization of labour productivity.
- To investigate the implementation for work study on site.
- To identify factors affecting the construction labour productivity in current practice.
- To study on the construction labour productivity techniques.
- Minimizing the cost and time by proper scheduling for labours.
- Insisting minimum requirement of labour in each work.
- To analyse the factors affecting the labour productivity.

II. LITERATURE REVIEW

For this study, some of the important literatures were reviewed and presented briefly.

Eddy M. Rojas¹ and et al (2006) The study of labour productivity in the construction industry is gaining increasing attention as the industry faces multiple problems related to its workforce. This paper presents the results of a survey instrument applied to determine the relative level of relevance of construction labour productivity drivers and opportunities. Owners, general contractors, electrical contractors, mechanical contractors, consultants, and others participated in this survey. Management skills and manpower issues were identified as the two areas with the greatest potential to affect productivity according to survey respondents. Surprisingly, external factors, which are often cited as a major cause for reduced productivity in the construction

industry, were considered to be one of the least relevant productivity drivers. These results suggest that respondents consider the improvement of labour productivity within their reach and control rather than determined by external conditions.

H. Randolph Thomas and et al (2006) New management thinking, like that of lean production, has suggested that better labour and cost performance can be achieved by improving the reliability of flows. In this context, lean thinking portrays reliable flows as the timely availability of resources, i.e., Materials, information, and equipment. Little attention has been given to labour as a flow. Further, little discussion can be found related to flexible capacity management strategies. Efforts to utilize lean thinking in construction, so far, have generated limited evidence to support the need for more reliable labour flows. This paper investigates the lean principle that more reliable flows lead to better labour performance. Actual data from three bridge construction projects are examined to document the instances of poor flow resource Reliability and its effect on labour performance. Inefficient labour hours are calculated. The results show that there is strong support that more reliable material, information, and equipment availability contributes to better performance. However, the projects showed considerable deficiencies in the utilization of the labour resource. It is concluded that lean improvement initiatives should focus more on workforce management strategies to improve labour utilization that will lead to better labour performance.

William F. Maloney and et al (2005) This paper presents a philosophical argument for new construction labour productivity models based on actual factors affecting productivity. The paper reviews various work-study models that have been borrowed from industrial engineering. These are the delay, activity, and task models. Using research data, these models are shown to be inadequate and unreliable productivity models. It is suggested that these models emphasize work methods, and that the best opportunity to improve productivity is to focus on the factors that management can control. Two reliable productivity models validated specifically for construction situations are presented. These are the factor model, which accounts for project, site, and management factors affecting productivity, and the expectancy model of motivation, which describes why a crew exerts an effort to perform and how this effort relates to productivity. The essential features of the models are described, and it is suggested that the models can be integrated into a single comprehensive model to quantify the factors affecting productivity and to forecast performance.

Wellington Didibhuku Thwala¹ and et al (2004) Is to identify the factors that promote positive motivational behavior among construction workers as to improve production in the construction site. Furthermore the study will identify consistencies in the behaviour of motivated, satisfied, committed and loyal employees in the construction field since these are important characteristics in the workplace Resource management and leadership. A survey will be later conducted.

There are definite differences between different cultures as to how people can be motivated; this also must be taken into consideration. Management should play an active and continuous role in managing on site

motivational processes; employee's desired outcomes should be tied to performance; and management should focus on eliminating performance obstacles. Workers are an asset to the business and it is up to the management to value them. It cannot be a solution to hire and fire continuously as has been the common practice, recruiting goes with resources and money; and it is through the management that the companies grows, thus contributing to the economy of the country by developing the workers; thus reducing unemployment.

Adnan Enshassi1 and et al (2002) Remains an intriguing subject and a dominant issue in the construction sector, promising cost savings and efficient usage of resources. Productivity is one of the most important issues in both developed and developing countries. The developed countries are aware of the importance of economic growth and social welfare. The developing countries which face unemployment problems, inflation and resource scarcity seek to utilize resources and in such a way to achieve economic growth and improve citizens' lives. Productivity is an as it is considered a newly-developed area, and a huge number of projects have been planned for the near future. The aim of this research is to identify factors affecting labour productivity within building projects, and to rank these factors according to their relative importance from a contractor's viewpoint. The analysis of 45 factors considered in a survey indicates that the main factors negatively affecting labour productivity are: material shortage, lack of labour experience, lack of labour surveillance, misunderstandings between labour and superintendent, and drawings and specification alteration during execution.

Osama Moselhi and et al (2002) This paper describes a study conducted to investigate the impact of change orders on construction productivity and introduces a new neural network model for quantifying this impact. The study is based on a comprehensive literature review and a field investigation of projects constructed in Canada and the USA. The field investigation was carried out over a 6-month period and encompassed 33 actual cases of work packages and contracts. Factors contributing to the adverse effects of change orders on labour productivity are identified and a model presented.

2.1 LITERATURE SUMMARY

The literature deals about the critical factor which is helpful to improve the labour productivity in the construction industry.

III.METHODOLOGY

- Study of literature review.
- Study of organization, monitoring and motivation.
- To frame the questionnaire on construction labour productivity.
- Data collection from construction project relevant to labour utilization (through direct interviews).
- Questionnaires preparation based on factor responsible for labour productivity.
- Identifying the factors affecting the productivity.
- Arriving a new format labour utilizations.

- Finding and conclusions.

IV. DATA COLLECTION AND ANALYSIS

This study is concentrated only on contractors in order to get their feedback pertaining to construction labour productivity. Questionnaire forms were distributed for the purpose of this survey.

A total of 65 questionnaire forms have been distributed to different class and grade of contractor. The distribution was done by post and by hand. From a total of 50 questionnaire forms, 10 questionnaire forms were sent via post and only 5 returns. Meanwhile, another 40 questionnaire forms were distributed by hand and 30 returns. Another 10 questionnaire forms were sent via email and only 5 returns. It makes a total of 40 out of 50 questionnaire forms return and it give to an overall of 77 % respondents that filling up the questionnaire forms completely.

RELATIVE IMPORTANT INDEX (RII):

The questionnaires are collected and analysed using statistical software package SPSS. The ranking of factors was calculated based on Relative Importance Index.

$$RII = \epsilon a * \frac{n}{N} * \frac{100}{5}$$

RII = Relative Important Index

a = Constant Expression weight

n = frequency of response

N = Total no. of response

4.1 POSITION IN COMPANY

The respondents replied to the survey can be classified into four main categories according to their position hold in their company. The first category is top management level, which consist of project manager, assistant project manager and General Manager. They are responsible for the top management decisions and administration of the company. From the returns gathered, it shows that 15 of them fall into this category that covers 30 % of the total respondents.

The second category for the respondents in this survey is middle management level, which includes engineer senior engineer and junior engineer.

Their main responsibility is to manage and co.ordinate the construction project. They will need to be stationed at the construction site most of the time as the project progresses. This category of respondent covers 64% of the total replies, with 32 respondents. The return from this category became the major respondents to this survey.

The third category of respondent is contractor including supervisor level consisting of site supervisor which plays an important role in the construction project as they are the person who will be stationed at site to supervise the construction work from the beginning until completion of the project. Only one respondent fall in this category, this covers 20% of the total respondents.

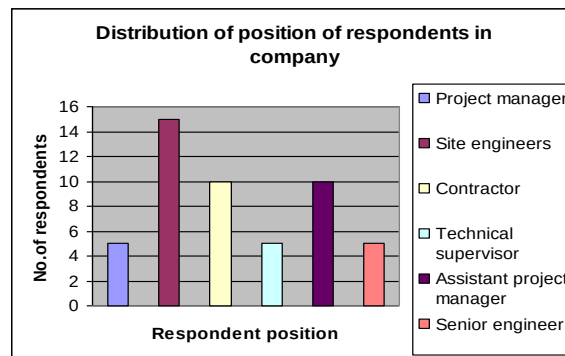


Fig. 1 Distribution of position of respondent in company

4.2 AGE

This survey has group the respondents into three major range of age. Highest replies are from the age group ranging from 20 – 29 years old with 10 replies, followed by an age ranging from 30 – 39 with 22 respondent and 10 replies by age ranges from 40 – 49 years old and above 50 years with 8 replies. respondent's age is as shown in figure.

Age	Frequency	Percentage	Valid percentage	Cumulative
20-29	10	20	20	20
30-39	22	44	44	64
40-49	10	20	20	84
Above 50	8	16	16	100
Total	50	100	100	

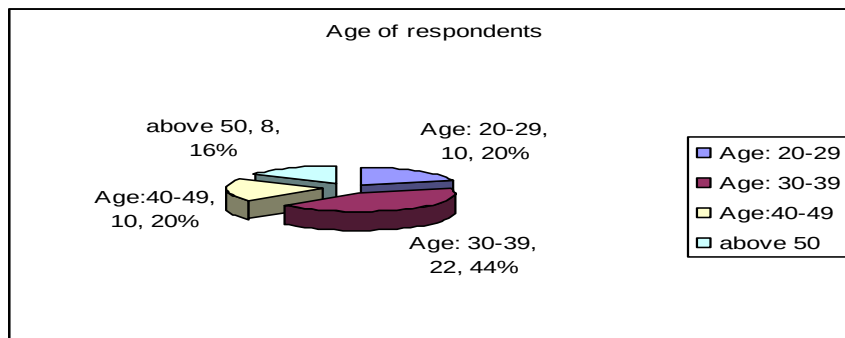
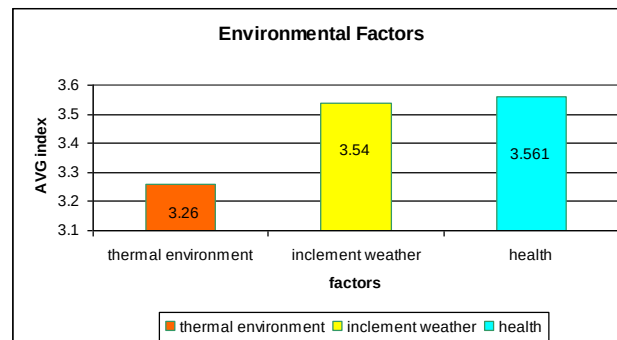


Fig. 2 Age of respondents

4.3 ANALYSIS OF ENVIRONMENT FACTORS



There are three factors in relation to environment. the average index value according to their rank are factor A1 with 3.56, factor A2 with 3.54 and factor A3 with 3.26 In overall, the average index value for factor A1 and factor A1 have reach above than 3.5 and close to 4.0 values. Hence, it can be concluded the respondents agreed that both factors mentioned earlier are causal to the demotivating factors affecting the construction labor productivity. However, for factor A3, with an average index value of 3.26 shows that the respondents are averagely agreed to the factors that causal to the demotivating factors affecting the construction labor productivity.

The average index value for factor A1 and A2 are close to a value of 4 which means agree. These factors were related to the construction activities, and are interrelated together. There are almost all construction projects that encounter weather at their worksite. For instance, information gathered from the interview session done is that this inclement weather leads to discontinuity of works at the worksite that may affect the workers motivation. This is especially when the workers at the worksite is completing the sub-structure and superstructure works. At this stage, work has to be stopped for a certain period of time. As discussed earlier in chapter, even though inclement weather is beyond our control, the occurrence of it may affect the construction labor productivity very much. From the analysis done, it shows that the inclement weather is the main environment factor that de-

motivating the construction projects productivity. Thus, it has to be taken into consideration seriously by the employer in order to plan in advance in case of inclement weather occur at their worksite to avoid discontinuity of works. Environmental conditions can result in difficult working conditions and can cause workers to fatigue more easily.

In the existing literature, weather, the major subset of environmental conditions, is typically treated as a direct cause of productivity loss. However instead that weather may lead to difficult working conditions, which in turn may lead to crew responses such as fatigue, slowed pace of work, idle time, or poor-quality work

4.4 ANALYSIS OF MANPOWER FACTORS

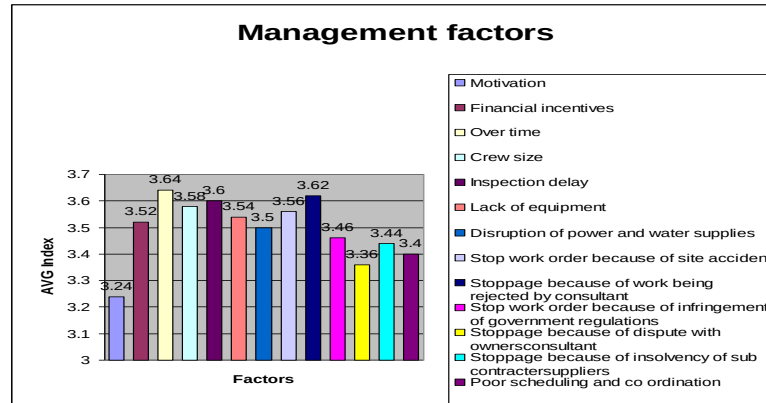
In respondent point of view pertaining to factors affecting the productivity by rank according to their average index. Among of all factors, it shows that factor B1 have the highest average index value of 3.60. Second highest with an average index value of 3.58 is factor B2, followed by B3, B4 and B5 with 3.54, 3.48 and 3.46 average index value respectively. Meanwhile, ranked from the sixth to ninth place are factor B6, B7, B8 and B9 with an average index value of 3.44, 3.38, 3.39 and 3.36. Meanwhile factor B10 and B11 are ranked at the tenth place with an average index value of 3.30

Overall, only five factors have reach above 3.5 for the average index value, which close to an agree answer. It can be concluded that the average index values for the top five factors are above than 3.5 which indicate that in average the respondents agreed that the five factors are the causal of factors affecting the construction labor productivity. However, the factors ranked from the sixth to twelve place are ranges from 3.0 to 3.5, which indicate that the factors are averagely agreed as the causal of demotivating the construction labor productivity.

The top five factors according to rank are discipline, absenteeism at worksite, labor disruption, lack of skill and difficulty in recruitment of workers. All of these factors have an average index value above than 3.5 which is close to 4 values that is agree answer.

As discussed earlier in Chapter , manpower plays an important role in performing the work at the construction site. However, they are also giving a problem to the employer in many aspects especially in terms of discipline. By having a good discipline track record, workers can be trusted by the employer to undertake any jobs given. However, discipline problem can also leads other labor problem such as labor disruption and absenteeism at the worksite. Even though it is well-known that discipline problem is a waste to both the employee and employer, but this problem is still happens in the worksite. According to the interview done, discipline is quite a major problem that affects their progress of construction work.

4.5 ANALYSIS OF MANAGEMENT FACTORS

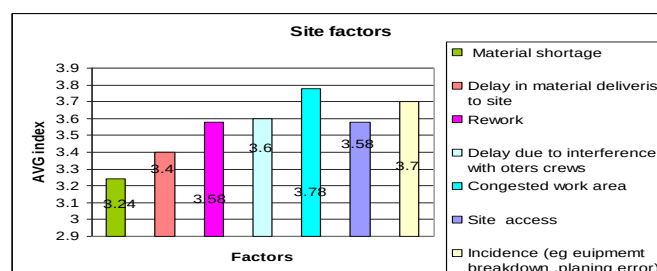


There are fifteenth sub factors under the management factors which affects the construction projects productivity. All sub-factors have been ranked to the respondent's point of view. Factor C1 is the highest factor among all which have an average index value of 3.64, followed by factor C2, C3 and C4 with 3.62, 3.60 and 3.58 average index value. Meanwhile Factor C5 and C6, C7, C8, value of 3.56, 3.54, 3.52, 3.5 are at the fifth place. In average, all the eight factors have an average index value above than 3.5 which is close to the 4 value that is agree answers. Meanwhile, the remaining ninth factors with an average index value between 3.0 to 3.5 are C9, C10, C11, C12, and C13. This shows that the factors are averagely agreed as the causal of demotivating the construction projects productivity.

It can be concluded that, among the thirteen factors listed, in average respondents agreed that only the first six factors are the causal demotivating factors affecting the construction projects productivity.

The top five factors agreed by the respondent to be the causal of demotivating factors affecting the construction projects productivity. Financial incentives leads the other factor, followed by motivation, poor scheduling and co.ordination, lack of equipment and overtime. Financial incentives factor are the highest rank among the thirteen factors listed. As discussed earlier in Chapter, financial incentives are an important factor in motivating people. This incentive is given to purposely enhance productivity and encourage the labor to work effectively. This factor is also related closely with motivation.

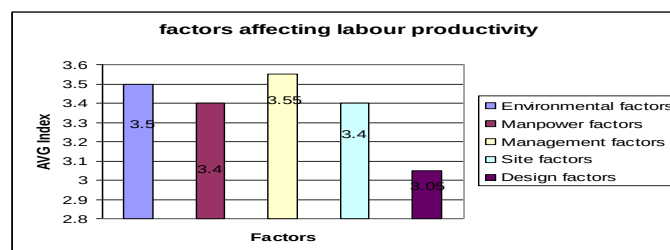
4.6 ANALYSIS OF SITE FACTORS



The above fig shows that factor D1 is the highest factor among seven factors listed, with an average index value of 3.78. Second in the rank is factor D2, followed by D3 and D4. Their average index values are 3.70, 3.6 and 3.58 respectively. Factor that falls at fifth place is D5 with an average index value of 3.53. Meanwhile factor D6 and D7 rank the sixth and seventh place, both with 3.40 and 3.24 average index values.

In general, the first five factors have reach to an average index value above than 3.5, close to 4.0 value that is Agree answer and it can be concluded that those factors are agreed by the respondents as the causative of demotivating factors affecting the labor productivity.

4.7 FACTORS AFFECTING PRODUCTIVITY IN CONSTRUCTION INDEX

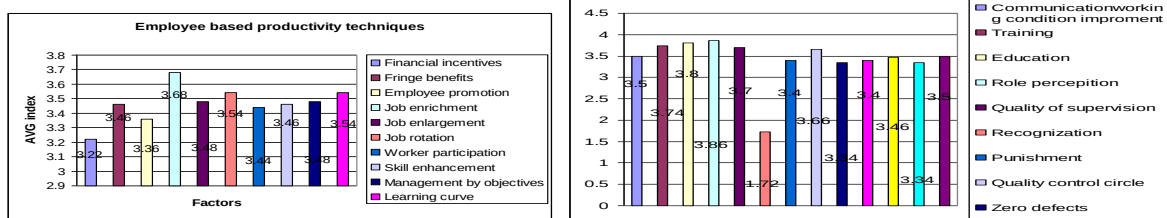


According to the analysis done in the above fig environment factors are shows highest average index value among the five factors surveyed, which is 3.63. This average index value is close to 4 values that is the agree answers.

It is followed by site factors with 3.58 average index values, manpower factors with 3.49 average index values, management factors with 3.48 average index value and design factors with 3.38 average index values. In general, all factors in the range of between 3 to 4, which is in between the Average and Agree answers. In average, the average index value for the environment factors and site factors is above than 3.5 and it can be concluded that in average the respondents agreed that both factors are the causal of the de-motivating factors affecting the construction labor productivity.

Environment plays an important part in ensuring the labor working in the good and comfortable conditions in good weather even though the environment factors are beyond our control. As discussed earlier in literature in Chapter, there are three main sub factors under the environment factor that affect the construction labor productivity. Hence, the environment factors are very important factors to be taken into consideration by the employer in adapting their planning of the construction works. This is to ensure all construction related works are properly planned and coordinated so that the environment factors can be avoided.

4.8 ANALYSIS OF EMPLOYEE BASED TECHNIQUES



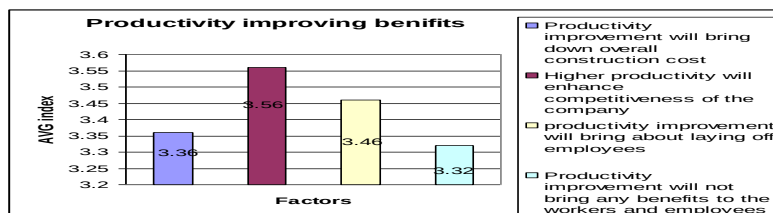
Under the employee-based techniques, there are twenty five techniques listed. From the analysis carried out in table 9.6.1 it shows that the first five factors according to their highest average index value are factor E1, E2, E3, E4 and E5 with an average index value of 3.86, 3.80, 3.74, 3.70 and 3.68. It is followed by factor E6, E7, E8, E9 and E10 with 3.66, 3.54, 3.50, 3.48 and 3.48, average index values respectively. Meanwhile, Factor E10 and E10 share the same average index value of 3.51, followed by factor E11 with 3.65, factor E12, and E12, both with 3.40, factor E13 with 3.36 and factor , both with 3.56 average index values. The seventh last in the rank are factor E14 and 3.34, factor E15 with 3.22, and factor E16, with 1.72, average index values respectively.

In general, it shows that out of twenty five techniques, only twenty of them have an average index value above than 3.5 which close to an agree answer. The remaining five factors are in average answer.

In can be concluded that in average respondents agreed to the twenty out of twenty five factors listed as to be implemented as the employee-based improvement techniques.

Figure shows that financial incentives are the highest average index value, followed by harmonization, training, zero defects and communication.

4.9 ANALYSIS OF LABOUR PRODUCTIVITY IMPROVEMENT BENEFIT



According to the analysis done the average index values according to their rank is benefit G1, G2, G3, G4, B4 with an average index values of 3.56, 3.46, 3.36, 3.32, respectively.

In general, it shows that the respondents agreed to only two benefit at the top rank that are G1 and G2. Meanwhile, benefit are averagely agreed by the respondents. The highest in ranked is the productivity improvement will bring down overall cost followed by higher productivity will enhance competitiveness of the company. In overall, respondents agree that productivity improvement will benefit the company in terms of cost that will bring down the overall cost of operation. Construction activity task is known as interrelated. When

task is completed ahead of schedule, it will then shorten the period of construction project. Hence, the direct and indirect cost contribute to construction can be reduced.

V. DESCRIPTIVE STATISTICS ANALYSIS OF IMPROVING LABOUR PRODUCTIVITY

Frequency Respondents	Rank	Range	Minimum	Maximum	Avg Index	Std Deviation	Variance
Finacial incentives	15	3	2	5	3.22	.790	.624
fringe benefits	10	3	2	5	3.46	.613	.376
employee promotion	13	3	2	5	3.36	.802	.643
job enrichment	5	3	2	5	3.68	.794	.630
job enlargement	9	3	2	5	3.48	.789	.622
job rotation	7	3	2	5	3.54	.706	.498
worker participation	11	3	2	5	3.44	.837	.700
skill enhancement	10	4	1	5	3.46	.838	.702
management by objectives	9	4	1	5	3.48	.886	.785
learning curve	7	4	1	5	3.54	.838	.702
communication working condition impartment	8	3	2	5	3.50	.886	.786
training	3	3	2	5	3.74	.828	.686
education	2	3	2	5	3.80	.728	.531
role perception	1	3	2	5	3.86	.990	.980
quality of supervision	4	3	2	5	3.70	.886	.786
recognition (award)	16	4	1	5	3.44	.972	.945
punishment (withholding)	12	3	2	5	3.40	.904	.816
quality control circle (employees voluntarily co operate to solve problem)	6	3	2	5	3.66	.848	.719
zero defects(do it right the first time)	14	4	1	5	3.34	.872	.760
time management	12	4	1	5	3.40	.881	.776

flex time (freedom and responsibilities in determining hours of work)	10	4	1	5	3.46	.908	.825
compressed workweek	14	4	1	5	3.34	.798	.637
harmonization	8	3	2	5	3.50	.789	.622

5.1 DESCRIPTIVE STATISTICS OF PRODUCTIVITY IMPROVING BENEFITS

Frequency respondents	Rank	Range	Minimum	Maximum	variance	Std. Deviation	Average index
productivity improvement will bring down overall construction cost	3	3	2	5	.562	.749	3.36
higher productivity will enhance competitiveness of the company	1	3	2	5	.660	.812	3.56
productivity improvement will not bring any benefits to the company employees and construction workers	2	4	1	5	.702	.838	3.46
productivity improvement will bring about laying off employees	4	4	1	5	.712	.844	3.32

VI. CONCLUSIONS

Labour Productivity is one of the most important factors affecting the overall performance of any organization, large or small. At the micro-level, improved productivity decreases unit costs and serves as an indicator of project performance. At the macro-level, improved productivity is a vital tool in countering inflationary effects and determining wage policies. Improved labour productivity is thus always counted among the basic means of solving economic problems. It is increasingly recognized that capital alone is an inadequate means of producing more wealth or for starting a business in developing countries. In the present study all possible factors which may effect on construction labor productivity are identified. Ranking of factors is done using the Relative Important Index (RII) method. The basic objective of this study is to study various factors affecting labor productivity and also to improve labour productivity in construction industry. Improved productivity is also required; if all production inputs are well utilized, capital improvements and enhanced productivity go hand in hand. In other words, increased productivity enhances investments without any burden to governments. In addition to the advantages at this fundamental level, the advantages of labour productivity improvement can be summarized as follows:

- Decreased total cost and duration of production
- Improved quality
- Growth in market share of product
- Increased employment and wages without inflationary pressures
- Enhanced purchasing capacities among employees, employers, and customers.

REFERENCES

- [1.] Adanan Enshassi, Sherif Mohammed, Ziad Abu Mustafal and Peter Eduard Mayer Yat-Hung Chiang and Bo-Sin Tang (2001-2002) “Factors affecting labour productivity in building projects in the gaza strip” *Journal of Civil Engineering and Management*, Vol13, No4, pp 245-254.
- [2.] Allmon, Hass, Borcherdig and Goodrum (2000) “U.S.Construction labour productivity trends”, *Journal of Construction Engineering and Management*, Vol 92, pp 97-104.
- [3.] Broomfield, price and Harris (1984) “Production analysis applied to work improvement”, *proc. Inst. of Civ. Engrs., Part 2*, 44, pp. 379-386.
- [4.] Eddy M.Rojas and Peerapon Aramvareekul (2006) “Labour Productivity Drivers and Opportunities in the Construction Industry” *Journal of civil Engineering and Management*, Vol59, pp. 78-82.
- [5.] Randolph Thomas, William F. Maloney, R. Malcolm W. Horner, Gary R. Smith, Vir K.Handa and Steve R. Sanders (2005) “Modeling Construction Labour Productivity” *Journal of Civil Engineering and Management*, Vol 116, pp 705-720.
- [6.] James Choromokos and Keith E. McKee (1981) “Construction Productivity Improvement” *Journal of the Construction Division*, Vol. 107, No. 1, pp. 35-47.
- [7.] Lema, N.M. (1995) “Construction of Labour Productivity Modelling” *University of Dar Elsalaam.*, pp. 61-81.
- [8.] Lim, Alum (1995) “Construction Productivity” *Issued encountered by contractors in Singapore. International Journal of project Management*, pp. 51-58.
- [9.] Maloney (1981) “Motivation in construction” *J.Constr. Div., ASCE*, 107(4), pp. 641-647.
- [10.] Eddy M. Rojas and Peerapong Aramvareekul (2006) “Labour Productivity Drivers and Opportunities in the Construction Industry” *Journal of Civil Engineering and management*, Vol65 PP 412-424.