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A descriptive study on factors influencing ergonomics in construction labour productivity

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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 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 divided in to different categories. In a workstation the labor productivity gets affected due to discomforts and several other factors such as forceful exertions, repetition duration, vibration in site, working environment, tools and materials, stress and pains, accommodation for labors. The factors are identified from literature study and using these factors a questionnaire survey is to be conducted among the labors in various construction projects and analysis is carried out by SPSS software.**

***Keywords*— Ergonomics, Labour productivity, Workers Satisfaction, Safety, Construction Industry.**

I. INTRODUCTION

Building and construction is one of the oldest activities of mankind. Some of the important improvements in history were the invention of nails and screws, the introduction of ceramic building materials and the invention of pre-stressed concrete[1]. The first important step in the field of work organization was the introduction of professional tradesmen. Specialization of trades was introduced in the early middle Ages[2]. In the second half of this century many new specialism arose, mostly as jobs were split up into several new trades, which often consist of one or a few tasks. In most cases the only change for the construction process was the appearance of several tradesmen in a sequential order. Teamwork still exists in road construction and other civil works[3]. As we look at the pace of innovation in other branches of industry, the building and construction industry should be characterized as most conservative. Work is still physically straining, work organization and working methods are traditional. First, the paper will describe the characteristics of the building and construction industry. Then an overview is given of the attention of ergonomists for this industry. Overall conclusions are drawn from these studies in relation to ergonomics, but also to company performance. To conclude, a vision is given of future developments and on the conditions that need to be met in order to attain success. Innovation is the key. Although becoming extinct is a doom watch, it is most likely that many traditional construction forms will lose a substantial part of their market position unless they change their policy. Project success depends upon how well the personnel can work effectively to accomplish objectives. The study aims to identify and evaluate the main factors affecting the labour productivity and also give possible recommendations to improve ergonomics of construction projects. The level of success in carrying out construction project development activities will depend heavily on the quality of the managerial, financial, technical and organizational performance.

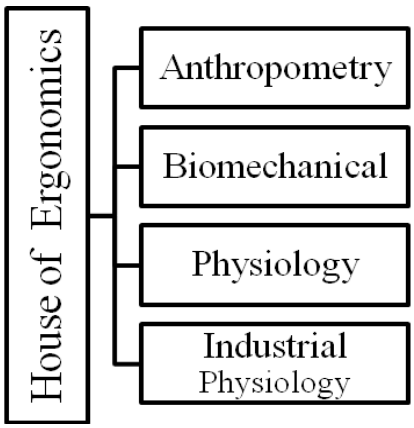
Ergonomics is the science of fitting jobs to the people who work in them. Adapting the job to fit the worker can help reduce ergonomic stress and eliminate many potential ergonomic disorders (e.g. carpel tunnel syndrome, trigger finger, tendonitis)[4]. Ergonomics focuses on the work environment and items such as the design and function of workstations, controls, displays, safety devices, tools and lighting to fit the employee's physical requirements, capabilities and limitations to ensure his/her health and wellbeing. It may include restructuring or changing workplace conditions to reduce stressors that cause musculoskeletal disorders it also useful to increase the productivity of construction projects[5].

II. ERGONOMIC ASSESSMENTS

A 3-step process that involve:

- On-site assessment (data collection)
- Comparing actual data to guidelines / industry standards
- Report with finding recommendation (engineering, administrative or behavioural)

Figure.1 Pillars of Ergonomics



III. OBJECTIVES

THE OBJECTIVES OF THIS RESEARCH ARE STATED BELOW

- To study about the ergonomic aspects among construction labors.
- To suggest suitable safety and comfort working environment for the construction labors.
- To improve work efficiency.

IV. EMPLOYEE INVOLVEMENT

Promoting worker involvement in efforts to improve workplace conditions is a critical element to an ergonomics process. It also has several benefits, including:

- Enhanced worker motivation/job satisfaction.
- Added problem-solving capabilities.
- Greater acceptance of change.
- Greater knowledge of the work and organization.

V. SCOPE OF THE STUDY

In the present scenario construction industry has complexity in its nature because it contains large number of parties as clients, contractors, consultants, stakeholders, shareholders, regulators, labours and others. The failure of any construction project is mainly related to the problems and failure in productivity. The most important parenthesis which disturbs the labour productivity is due to lack of ergonomics in construction site. 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. So this study is important to identifying and to evaluating the main factors affecting the productivity of construction projects and to improve the ergonomic condition for the labours.

VI. LITERATURE STUDY

Mr.S.S.Janagan, et al (2014) In this study a checklist is prepared to compare the characteristics of local and migrant labors. Different parameters such as Resource Utilization, Communicative Ability, Work Quality, Job Knowledge, Profit Sensitivity, Cost Sensitivity and Safety Consciousness etc., are used to compare local and migrant labors. Problems are identified based on the checklist and solutions are identified in such a way that improves productivity[6].

Vladimir Bures, et al (2014) The aim of paper is to provide with review of labor productivity within the context of knowledge society. It covers theoretical frame of productivity, knowledge management and how labor productivity may be positively influenced by the existence society in management programmers in particular[7].

Vijay Antony Raj et al(2014) This project is done in identification of factors irrespective to labors. Based on those factors a questionnaire has been prepared in labors point of view. In this thesis , questionnaire survey have been conducted with various companies among 75 labors and using SPSS software their response have been extracted for studying the impact of human resource management practices on productivity and financial performance in construction industry and appropriate solution was given for all impacts[8].

MojtabaValinejadShoubi., et al., (2012) The purpose is to investigate all significant factors which should be taken into account in an ergonomic program to develop the best remedial method against the costly, harmful and irreversible work related injuries[9].

Erminia Attaianese., et al.,(2010) The article presents a preliminary survey of some principles driven by human factors/ergonomics discipline, analyzing the role they play in the architectural design process, in order to define a design methodology supporting the building designer to create working and living spaces actually fitting the needs of inhabitants[10].

Jan Dula, W Patrick Neumann (2009) Managers usually associate ergonomics with occupational health and safety and related legislation, not with business performance. In many companies, these decision makers seem not to be positively motivated to apply ergonomics for reasons of improving health and safety[11].

W.P. Neumann J. Winkel., etal.,(2006) The purpose of this paper is to investigate a strategic change from parallel cell-based assembly to serial-line assembly in a Swedish company with special reference to how production system design elements affect productivity and ergonomics[12].

Deidre, Rutherford(2005) Hazardous manual tasks continue to be a significant issue for the Queensland construction industry and one that needs to be managed. In addition, the construction industry is facing challenges such

as an aging workforce, skills shortages, and competitive market conditions[13].

Michael J. Horman., et al.,(2003) The results show that there is strong support that more reliable material, information, and equipment availability contributes to better performance. It is concluded that lean improvement initiatives should focus more on workforce management strategies to improve labor utilization that will lead to better labor performance[14].

Paul m. Goodrum and Carl t. Haas (2002) the paper examines the relative impact of different types of equipment technology for five technology factors: energy, control, functional range, information processing, and ergonomics. Through ANOVA and regression analyses, it is found that activities that experienced a significant change in equipment technology also witnessed substantially greater long-term improvements in partial factor productivity than those that did not experience a change[15].

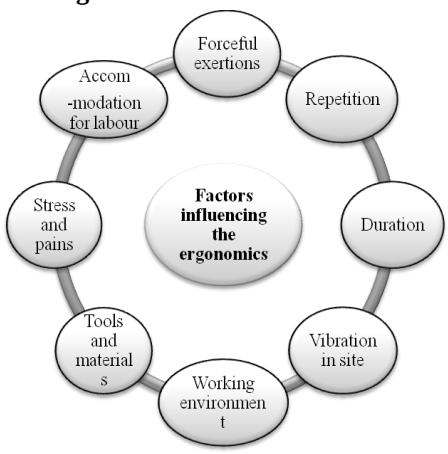
VII. METHODOLOGY

In construction industry, planning is important to achieve its goal. The aim can be attained by sequencing the flow of work into a typical methodology. The methodology represents adopted for successful completion of the project. The methodology involves collection of literature and conducting study on application of ergonomics in improving construction labour productivity. The study also continued to find the key factors affecting the ergonomics of construction project. Based on the factors a questionnaire was prepared and surveyed from various companies. The collected data was analyzed using SPSS Software. The analysis was done to identify the key factors affecting the performance of construction project. Based on the data obtained analysis was done and conclusion was arrived.

VIII. FACTORS IDENTIFICATION

There are numerous factors affecting the labour productivity of construction project. The following factors which affect the application of ergonomics in improving construction labor productivity of the project are selected from literature study and the factors are broadly classified as:

Figure.2 Factors Identification



IX. DESCRIPTIVE STATISTICS

In this survey totally 178 questionnaires were distributed to the targeted respondent in order to identify the factors affecting labour productivity in construction industry. In those 152 responses has been received. The responses rate of this survey was 83%. The response rate will be explained in the below table and chart by using SPSS software and give some suggestion to improve the labour productivity in construction industry.

Table.1 Response rate

DESCRIPTION	SURVEY COLLECTED
Questionnaire Distributed	178
Response Collected	152
Male Respondents	80
Female Respondents	68
Respondent Rate	81%

Totally 178 questionnaires were distributed to various construction workers through manual survey. In this 152 construction workers responses has been received. Among this 152 response 80 construction workers are comes under Male category and 68 construction workers are comes under female category.

Table.2 Demographic profile of the respondent

Sl.No	demographic profile of respondent	Category	no. of respondent	%
1	Gender	Male	80	62.3
		Female	68	40.8
2	Experience	0-5 year	38	25.2
		5-10 year	36	28.1
		10-15 year	25	24.8
		15 years above	26	34.9
3	Occupation	Mason	38	32.2
		Lay man	32	36.4
		Mazdoor	36	30.1
		Bar bender	30	29.1
5	Age	Below 18	36	29.3
		18 - 30	30	30.4
		30 - 40	32	32.1
		Above 40	30	29.1
6	Salary	Below 5000	36	29.6
		5000 to 8000	39	38.8
		8000 to 10000	30	31.6

In this analysis totally 178 questionnaires were distributed in that 152 response were collected. In gender 80 construction workers are comes under the male category and the response rate of this male construction workers 62.3% and 68 construction workers are comes under female category and the response rate of this female construction workers was 40.8%. In that 152 response 29.2% of construction workers are belong under below 18 year of age people. 30.4% of construction workers are belong in 18 - 30

year of age people and 32.1% of constructions workers are belong in 30-40 year of age people and 29.1% of construction workers are comes in above 40 year of age group. In Experience 28.2% of construction workers are belong in 0-5 year of experience in construction site and 28.1% of construction workers are belong in 5-10 year of experience, 24.8% of construction workers are belong in 5-10 year of experience and 34.9% of construction workers are belong in above 10 year of experience. In salary 36 construction workers out of 152 construction workers are belonging under the category of rupees below 5000 and the response rate of this construction workers was 29.6% and 39 construction workers out of 152 construction workers are belonging under the category of rupees 5000 – 8000 and the response rate of this category of construction workers was 38.8% also 30 construction workers are belonging under the category of rupees 8000 to 10000 and the response rate of this construction workers was 31.6%. In occupation 38 construction workers out of 152 respondent are comes under the mason category and the response rate of this category was 32.2% and 32 construction workers are comes under the category of layman and the response rate of this category was 36.4% and 36 construction workers are comes under the Mazdoor category and the response rate of this category was 30.1%. Among this 152 respondent of construction workers 30 respondent of construction workers are comes under the category of bar bender and the respondent rate of this category was 29.1%.

X. RELIABILITY TEST

In this study, the method utilized for evaluating is Cronbach's reliability. To establish the internal consistency, Cronbach's Alpha value was used to access the reliability of the scale considering the minimum value of 0.7 (cronbach 1970, Nunnally 1978) the calculator value was 0.826 which exceed the threshold limit.

Table.3 Reliability test

Cronbach's Alpha	No. of Items
0.826	30

XI. KMO AND BARTLETT'S TEST

Prior to the extraction of factors, KMO and Bartlett's test has to be performed

Table.4 KMO and Bartlett's test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.690
Bartlett's Test of Sphericity	Approx. Chi-Square	910.400
	df	435
	Sig.	.000

Factor analysis was administered to identify the important of factors affecting labour productivity and to establish here suitability for further analysis. The KMO measure of sampling adequacy was 0.690 confined that they was significant correlation among the variable to apply the factor analysis.

Table.5 Factors affecting labour productivity

Sl.No	Workers Factors	No. of. Variables	Eigen values	Percentage of variance explained	Cumulative percentage of variance explained
1	Forceful exertion	5	5.112	17.038	17.038
2	Repetition	4	1.993	6.644	23.682
3	Duration	5	1.873	6.244	29.927
4	Vibration in site	4	1.622	5.406	35.333
5	Working environment	2	1.457	4.856	40.188
6	Tools and Material	2	1.376	4.587	44.776
7	Stress and pains	2	1.296	4.320	49.095
8	Accommodation for labours	3	1.154	3.848	57.074

The narrated ten dimensions of factors influencing ergonomics in construction workers explained to the extent of 57.074 percent. The most important perceived factors among the construction workers is 'Forceful exertion' since its respective Eigen value is 5.112, which consists of 5 factors of labour productivity. Since the second and third factors are Repetition and duration, their respective Eigen value is 1.993 and 1.873 percent respectively. The variance explained by these factors is 6.644 and 6.244 percent respectively. The next important factor is working environment and tools and materials which consist of 4 and 2 variables respectively. These two factors influencing labour productivity explained to the extent of 5.406 and 4.856 percent respectively. The Eighth and ninth factors is Stress with pains and accommodation for labours which consists of three variables respectively. Since the respective Eigen value are 1.154 and 1.016 respectively.

XII. CONCLUSION

Even though all human activities are executed in a built environment, only a few studies seem to be available about a labour productivity based on an ergonomic approach. The human- cantered labour productivity methodology presented here takes inspiration from the holistic approach of ergonomics. In a workstation the labour productivity gets affected due to discomforts and several other factors such as forceful exertions, repetition, duration, vibration in site, working environment, tools and materials, stress and pains, accommodation for labours. By using literature and site visits its clearly shows that the above factors were affected the labour productivity are identified. Based on these factors a

detailed questionnaire was prepared. By using spss software analyze various test was conducted the results clearly shows that the above nine factors are affecting the labour productivity in construction workers while doing work at construction site.

XIII. MANAGERIAL IMPLICATIONS OF THE STUDY

This study may contribute many things to the existing literature. The identified dimensions help the construction industry in general and construction workers stress in particular. Based on the findings of the study, construction professionals must implement some training programmers and also give some suggestion to improving the labour productivity in construction industry.

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