

FACTORS AFFECTING PRODUCTIVITY IN GCC CONSTRUCTION PROJECTS

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Abstract - Good project management in construction must continually pursue the efficient utilization and allocation of labor, material and equipment. These elements are all essential in the pursuit of the Gulf Cooperation Council's (GCC) vision for the future. Improvement of labor productivity should be a major concern for control of construction projects in Gulf Countries. Reducing demand for labor will minimize the need for Gulf Countries to spend their natural resource supporting migrant workers. The construction sector is diverse as it contains contractors, consultants, designers, owners, and others. The aim of this paper is to identify factors affecting labor productivity on construction projects. A literature review and factors recommended by authors from previous studies were considered to categorize the factors. 40 factors, categorized into 5 groups, were analyzed and ranked using the Relative Importance Index. The questionnaires were distributed to Project Managers, Construction Managers, Project Controllers, Architects, and other site professionals. It was concluded, the final cost of projects were often higher than estimated cost. It is recommended to improve human resources management systems through proper and continuous training programs that frame a strong assignment, vision and a planned approach to overcome disturbances on the performance of the construction projects. The discussed factors are expected to assist in completing construction projects successfully.

1. Productivity in Construction and Previous Studies

Whilst the direct unit cost per labor hour in terms of wages paid, may not be significantly high, indirect costs are significant. In the context of migrant labor, indirect costs include recruitment, flights, accommodation, technical and safety training, supervision, health care and insurances. Material procurement, which includes fabrication, delivery, handling, inventory and site logistics, requires special attention and control. Productivity in construction is often broadly defined as output per labor hour. Since labor constitutes a large part of construction cost and the quantity of labor hours in performing tasks in construction is more susceptible to the influence of management than are materials or capital, this productivity measure is often referred to as 'labor productivity'. However, it is important to note that labor productivity is a measure of the overall effectiveness of organization systems in utilizing labor, equipment and capital to convert labor efforts into useful output, and is not a measure of the capabilities of labor alone. For example, by investing in new equipment to perform certain tasks in construction, output may be increased for the same number of labor hours, thus resulting in higher labor productivity. An increase in productivity was noted prior to the mid-1960's, in the construction industry (Stall, 1983). Later, a decline in productivity became an issue of great concern in the construction all over the world. In 1968, the Construction Roundtable was established due to concern about the increased cost of construction resulting from an increase in inflation and a significant decline in construction productivity (Thomas and Kramer, 1988). It was necessary to implement, as far as possible, industry-wide principles of production throughout the construction process. It was known that careful adaptation would be required to implement the knowledge and experience gained in the manufacturing industry to construction (Alarcon and Borcharding, 1991).

Past studies and research show that a number of factors affect productivity, but there are still unidentified factors that need to be further studied even in developed countries (Makulsawatudom and Emsley, 2002). A study by Polat and Arditi (2005) stated that policies to raise productivity are not always similar in each country. Their study identified different factors affecting labor productivity and grouped them according to their characteristics such as design, execution plan, material, equipment, labor, health and safety, supervision, working time, project factor, quality, leadership and coordination, organization, owner/consultant, and external factors. Adrian (1987) classified the factors causing low productivity as industry-related factors, labor-related factors, and management-related factors. Industry-related factors, essentially, are the characteristics of the construction industry, such as the uniqueness of construction projects, varied locations, adverse and unpredictable weather, and seasonality. Labor-related factors

included lack of training and learning for labor, and lack of motivation. Management-related factors usually refer to a lack of management for tools or techniques. Olomolaiye et al. (1998) classified the productivity factors into two categories: external factors the ones outside the control of the organization management and internal factors related to the productivity factors originating within the organization. Thomas and Sakarcan (1994) built an idea to describe the factors affecting labor productivity. One study suggested that scheduled overtime always leads to efficiency losses because of the inability to deliver materials, tools, equipment, and information at an accelerated rate (Ginther, 1993).

2. Literature Review and Issue Identification

Productivity is the outcome of several interrelated factors. Discussed below are various factors affecting labor productivity and are reviewed from past studies.

2.1. TIME

During construction projects, working overtime initially results in increased output, but continuing overtime may lead to increased costs and reduced productivity (Hinze, 1999). Time used by a construction labor on productive activities averages about 30% of the total time available. An employee in the field only works effectively for 3.5 hours of an 8-hour shift and spends 20% of time on direct value-adding activities (Alinaitwe *et al.*, 2005).

2.2. SCHEDULE COMPRESSION

When there are early delays in a project, compression of the overall time frame for later activities is often used to compensate interruptions and to complete assigned tasks on schedule. From a professional scheduling perspective, schedule compression may be possible without accelerating individual work activities by utilizing float in project schedules; however in many projects, schedules are not fully resource loaded. As a consequence, an updated schedule reflecting delays may show the project finishing on time without shortening individual activities (National Electrical Contractors Association, 1983).

2.3. TYPE OF PROJECT

To accomplish optimum productivity, every member of a crew requires adequate space to perform tasks without being affected with/by other crew

members. When more laborers are allotted to perform particular tasks, in a fixed amount of space, it is probable that interference may occur, thus decreasing productivity. Additionally, when multiple trades are assigned to work in the same area, the probability of interference rises and productivity may be reduced. Interference among the various crews and laborers is due to mismanagement on construction sites. For example, a steel-fixing crew has to wait before fixing reinforcement bars if the carpenter's formwork is incomplete. Types of activities and construction methods also influence labor productivity (Sanders and Thomas, 1991).

2.4. SAFETY

Accidents have high impact on labor productivity. Various accident types occur at sites, and some may cause death and results in a total work stoppage for a number of days. An accident that causes an injured person to be hospitalized results in a work decrease of the crew for which the injured employee worked. Small accidents resulting from protruding nails and steel wires can stop work and, thus, decrease productivity (Sanders and Thomas, 1991).

2.5. QUALITY

Inefficiency of equipment, unskilled laborers and poor quality of raw material are factors which cause low productivity. The productivity rate of inefficient equipment is low. Old equipment is subject to a great number of breakdowns, and it takes a long time for laborers to complete the work, thus reducing productivity. Poor-quality material used for work is the other factor because poor materials generally lead to unsatisfactory work and can be rejected by supervisors, thus reducing productivity; also unskilled laborers causing a rework, which leads to reduced productivity.

2.6. MANAGERIAL FACTORS

Managers' skill and attitudes have a crucial bearing on productivity. In many organizations, productivity is low even though the latest technology and trained manpower are made available. Low productivity is often because of inefficient and indifferent management. Advanced technology requires knowledgeable laborers who, in turn, work productively under professionally qualified managers. As stated in Project Management Institute's standard (PMI, 2009) about, 90% of project manager time is spent in communication.

2.7. AVAILABILITY OF SKILLED MANPOWER

A lack of labor experience is the factor which negatively affects labor productivity and proves that, to achieve good productivity, labor plays a significant role. Contractors should have sufficiently skilled laborers employed to be productive. If skilled labor is unavailable and a contractor is required to complete specific tasks with less-skilled labor, it is likely that productivity will be affected. The absence of any crew member may impact on the crew's production rate because workers will, typically, be unable to accomplish the same production rate with fewer resources and with different crew members. Misunderstanding among laborers creates disagreements about responsibilities and the work bounds of each laborer, which leads to a lot of work mistakes and decreases labor productivity. Lack of compensation and increased laborer age negatively affect labor productivity because labor speed, agility, and strength decline over time and reduce productivity (Heizer and Render, 1990).

2.8. MOTIVATION

Motivation is one of the important factors affecting construction labor productivity. Motivation can best be accomplished when laborers' personal ambitions are aligned with organization strategic goals. Factors such as payment delays, a lack of a financial motivation system, non-provision of proper transportation, and a lack of training sessions are grouped in this topic (DeCenzo and Holoviak, 1990).

2.9. GUIDANCE & KNOWLEDGE OF WORK SEQUENCES

Construction projects often have design, drawings and specification changes as work proceeds. If drawings or specifications contain errors and are unclear, productivity may decrease since laborers in the field are uncertain about what needs to be done. As a result, tasks may be delayed, or have to be completely stopped and postponed until there are clear instructions. There can be a 30% loss of productivity when work changes are being performed (Thomas *et al.*, 1999). Work inspection by supervisors is an essential process before proceeding to subsequent stages. For example, contractors cannot cast concrete before an inspection of formwork and steel work, thus affecting labor productivity (Zakerietal, 1996).

2.10. MATERIAL/TOOLS

Productivity can be affected if required materials, tools, or construction equipment are not available at the correct location and time. If the improper

tools or equipment are provided, productivity may be affected (Alum and Lim, 1995; Guhathakurta and Yates, 1993). The size of construction sites and material storage locations have a significant impact on productivity because laborers require extra time to move required materials from inappropriate storage locations, thus resulting in productivity loss (Sanders and Thomas, 1991).

2.11. PROJECT MANAGEMENT FACTORS

Improper scheduling of work, shortage of critical construction equipment or labor, may result in loss of productivity. Improper planning of project-initiation procedures may lead to lost labor productivity. Also, poor site layout can contribute to a loss of productivity. According to the Association for the Advancement of Cost Engineering (AACE, 2004) laborers may have to walk or drive long distances to lunch rooms, rest areas, washrooms, entrances, and exits, affecting overall productivity.

2.12. NATURAL FACTORS

Various natural factors affecting labor productivity collected from previous studies are weather conditions and geographical conditions. Others factors such as fuel, water, and minerals also affect productivity to a certain extent. Productivity is found to be highly affected if the weather is too extreme (too cold, heavy rainfall, or too hot).

3. Methodology

This research investigates important factors affecting labor productivity in construction. Understanding these factors is helpful for construction professionals who work on all project phases, especially on the initial phase of construction planning, in order to efficiently deliver project plans. The main goal of the research is to provide essential information about factors affecting labor productivity on projects. Factors which affect construction productivity are a lack of required materials, disputes between the major parties, weather, changes during the construction, accidents, and others. The research study aims to provide knowledge of construction project-related factors that affect productivity. The data collection instruments used in the research is questionnaire survey, followed by interviews. The research passes with the following steps shown in figure 1.



Figure 1. Flow Chart Showing Research Structure

The data collection process used in this research had the option of two basic methods: questionnaires and personal interviews. A questionnaire was preferred as the best effective and suitable data-collection technique for the study. The questionnaire was a self-administered tool with web-design questions. A questionnaire in a web-survey format comparatively requires less duration and saves cost for the researcher while permitting participants to respond to the questionnaire at their convenience. However, for this approach the response rate is usually lower as compared to face-to-face interviews. Data was collected for the literature review from books, journals and articles. A survey was given to employees from different professions involved with construction in Gulf Cooperation Council (GCC) countries

3.1. QUESTIONNAIRE AND RESULTS

Participants were asked to indicate to what extent the factors in table 1 affect labor productivity on construction sites. Responses were scored as 1-Not applicable, 2- Does not affect it, 3- Somewhat affects it, 4- Affect, 5- Strong affect, 6- Substantial affect.

3.2. SURVEY AND QUESTIONNAIRE REVISION

A face to face discussion was conducted amongst ten construction professionals. This procedure improved the formation of the web-survey. A total of 120 questionnaires, were sent by e-mail to contractors, architects, owners, project managers, and project engineers of various construction organizations. Only 16 replies were received; therefore it was decided to supplement the data collection process with qualitative interviews with construction professionals.

3.3. QUESTIONNAIRE DISTRIBUTIONS

The target groups in this study were professionals from the construction industry. A list of 547 building-construction organizations was obtained from the Construction Week online the Gulf Cooperation Council's (GCC) magazine. The sample size can be calculated with the following equation for a 94% confidence level (AlShahri, M *et al.*, 2001; Moore *et al.*, 2003):

$$n = \frac{n'}{\left(1 + \frac{n'}{N}\right)} \quad (1)$$

Where, n= Total number of population, N = Sample size from a finite population, n' = Sample size from an infinite population= S²/V, S² = the variance of the population elements and, V = a standard error of the sampling population. (Usually, S= 0.5, and V = 0.06).

n'= S² / V² = (0.5)² + (0.06)² = 69.44, for N=547, n = 69.44 / [1 + (69.44 / 547)] = 62, to obtain 94% of confidence level, it was calculated to send the questionnaire to minimum of 62 participants.

3.3. DATA COLLECTED FROM THE WEB SURVEY

To successfully achieve the objective of the study, one of the most important phases is collection of accurate data. Data collection is a procedure of collecting crucial data records for a certain sample or population of observations (Bohrnstedt and Knoke, 1994).

TABLE 1. Survey Structure and Results

	<i>Factors Affecting Productivity in Construction Projects in GCC</i>		<i>Data Measurement</i>					
			1	2	3	4	5	6
1	<i>Manpower</i>							
	a)	Lack of experience.						√
	b)	Disloyalty.					√	
	c)	Misunderstanding among laborers.					√	
	d)	Lack of competition between the laborers.					√	
	e)	Age.			√			
	f)	Personal problems.						√
	g)	Living habits.					√	
	h)	Absenteeism.					√	
2	<i>External</i>							
	a)	Implementation of government laws.			√			
	b)	Rework						√
	c)	Supervision delays					√	
	d)	Inspection delays from authorities.						√
	e)	Variations in the drawings.						√
	f)	Complex designs in drawings.						√
	g)	Incomplete drawings						√
	h)	Payment delays.						√
	I)	Training sessions.					√	
	j)	Design Changes.					√	
3	<i>Communication</i>							
	a)	Change orders from designers.					√	
	b)	Change orders from owners.					√	
	c)	Disputes with owner.					√	
	d)	Disputes with designer.					√	
	e)	Misunderstanding between Owner, Contractor and Consultant					√	
4	<i>Site Resources and Resource Management</i>							
	a)	Lack of required construction materials.						√
	b)	Increase in the price of materials.					√	
	c)	Lack of required tools and/or equipment.						√
	d)	Poor site conditions					√	
	e)	Differing site conditions from the plan					√	
	f)	Poor access to site					√	
	g)	Violations of safety laws.						√
	h)	Insufficient lighting.						√
	i)	Inadequate construction methods					√	
	j)	Inadequate transportation facilities for workers.					√	
	k)	Material storage locations					√	
	l)	Quality of required work.					√	
5	<i>Miscellaneous</i>							
	a)	Shortage of water and/or power supply.						√
	b)	Working overtime.					√	
	c)	Weather conditions					√	
	d)	Accidents during construction					√	
	e)	Project objectives are not well defined						√

TABLE 2. Characteristics of Participants/ Company Classification

participants	Questionnaire distributed	Responses returned	Percentage of responses
Client	5	1	0.83%
Consultants	5	2	1.67%
Contractors	100	13	10.83%
Sub-contractors	5	0	0.0%
Suppliers	5	0	0.0%
Total	130	16	13.33%

TABLE 3. Characteristics of Participants/ Personal

No	Characteristics of participants	Range	%
1	Experience in construction industry	5 to 10years	25%
		10 to 15 years	62.5%
		+15 years	12.5%
3	Career Level	Senior Management/Director	0.0%
		Department Manager	43.75%
		Senior Level	37.5%
		Mid-Level	18.75%
4	Department Role	Management	12.5%
		Project Controls	37.5%
		Engineering	25%
		Site Execution	12.5%
		Others	12.5%
5	Scale of current project or projects	Mega Projects >1 Billion \$US	37.5%
		Large Scale (between 100 million to 1 billion)	56.25%
		Medium Scale (10 to 100 million)	6.25%

3.4. ANALYSIS METHOD USED

In order to facilitate the study, after the literature review and the focus interviews, a plan was formulated for collecting field information and creating an evaluation process and numerical values. It was necessary to provide straightforward communication to participants to ensure a clear understanding of all the applicable definitions, procedures, and guidelines that were used in collecting data. Because the data-collection process included individuals, two different ways were used to analyze the survey results.

3.4.1. Ranking

Ranking of the various factors according to their average weight (%) for affect ranges: (4- Affect, 5- Strong affect, 6- Substantial affect).

3.4.2. Analyzing

Analyze the factors in the questionnaire are significant or non-significant.

TABLE 4 Top Factors affecting Productivity in construction projects in GCC

Productivity Problems	Strong Affect (%)	Rank
Lack of required tools and/or equipment.	63%	1
Incomplete drawings	50%	2
Payment delays.	50%	2
Violations of safety laws.	44%	4
Rework	44%	4
Insufficient lighting.	44%	4
Shortage of water and/or power supply.	44%	4
Lack of experience.	38%	8
Supervision delays	38%	8
Variations in the drawings.	38%	8
Personal problems.	38%	8
Project objective is not well defined	38%	8
Inspection delays from the authorities.	38%	8
Inadequate construction method	31%	14
Accidents during construction	31%	14
Design Changes	31%	14
Disloyalty	31%	14
Inadequate transportation facilities for workers.	31%	14
Disputes with owner	31%	14
Complex designs in the provided drawings.	31%	14
Poor access within construction job site	25%	21
Change orders from the owners	25%	21
Quality of required work.	25%	21
Differing site conditions from the plan	25%	21
Training sessions	25%	21
Weather conditions	19%	26

TABLE 5. Rank of Group of Factors affecting Productivity in construction projects in GCC

Productivity Problems	Strong Affect %	Rank
External	60%	1
Miscellaneous	40%	2
Site Resources and Resource Management	33%	3
Manpower	25%	4
Communication	0%	5

4. Comparative Analysis

The study compares the current survey results with previous studies. Results of the comparative analysis show that the findings of each study are different from the others. These dissimilarities suggest that the factors affecting construction productivity change based upon geographical locations and different project types (industrial, commercial, industrial, and highways). The study concludes that dissimilarities are due to differences in climatic conditions, construction methods, use of materials, availability of innovative technology, and contractual procedures. However, there are some common factors observed among the studies, including a delay in approving the design and drawings, a delay for payments from the owner to contractors, availability and utilization of equipments, improper construction methods, rework due to errors during construction, poor planning and scheduling by the contractor, labor-related delays, a lack of communication and coordination among all parties, material availability, and weather conditions. Table 6 details the various top ten factors affecting labor productivity in construction.

5. Conclusion and Summary

This research provides study and knowledge of construction productivity and focus on factors affecting productivity in construction projects in GCC countries.

The study sought the views of clients, consultants, and contractors on the outcome of construction projects especially public projects that influence the economics. Prior knowledge of labor productivity during construction can save money and time. Investments for these projects are very high and because of the complexity in construction, various factors can highly affect overall productivity, thus the project can end up adding even more time and money in order to be completed. This research is intended to identify the causes and probable factors affecting labor productivity in construction projects. This study investigates all possible factors through a structured questionnaire administered in GCC. The survey results are subjected to analysis, and the ranking of factors is calculated using the weighting factors.

Table 6. Comparative Analysis of the Current Study with Different Countries (Nigeria, Malaysia and Singapore) Studied in the literature.

Rank	GCC (Present Study)	Nigeria (Olomolaiye et al., 1987)	Malaysia (Abdul Kadir et al., 2005)	Singapore (Lim and Alum, 1995)
1	Lack of required tools and/or equipment.	Inadequate or poor planning	Material shortage at project site	Difficulties recruiting supervisors
2	Incomplete drawings	Mismanagement of funds	Stoppage of material delivery due to financial problems.	Difficulties recruiting Supervisor workers
3	Payment delays.	Delay making decisions and approvals by owner	Change order by CO causing project delay	High rate of labor turnover
4	Violations of safety laws.	Affection for the use of low-quality material	Non timely issuance of drawings consultants.	Labor absenteeism at the work site.
5	Rework	Poor coordination and communication	Not able to organize site activities.	Communication problems with foreign workers
6	Insufficient lighting.	Late deliveries	Late issuance of payment by client	Inclement weather
7	Shortage of water and/or power supply.	Contractor's lack of experience	Late supply of materials.	Health issues
8	Lack of experience.	Discrepancies among architectural, structural,	Non-availability of labors for construction tasks.	Material storage
9	Supervision delays	Inadequate and unclear drawings	Coordination problems with subcontractor	Alcoholism and similar problems among workforce
10	Variations in the drawings.	Bad weather conditions	Equipment shortage	Disruption of power/water supply

The study showed that all the three groups - clients, consultants and contractors - of respondents generally agreed that out of a total of 40 factors the top twelve influencing factors affecting productivity arranged in descending order of weighting are:

- Lack of required tools and/or equipment
- Incomplete drawings
- Payment delays
- Violations of safety laws
- Rework
- Insufficient lighting
- Shortage of water and/or power supply

- Lack of experience
- Supervision delays
- Variations in the drawings
- Personal problems
- Project objective is not well defined

The 40 factors were categorized into five major groups and were ranked. The results show that clients, consultants, and contractors all agreed that the external group of factors affecting productivity was the most influential. Miscellaneous factors were considered the second most important factor affecting productivity in construction projects followed by site resources and resource management, manpower and communication factors.

From previous studies, it has been shown that the nature of the construction industry, usually involves the separation of design and construction functions. This has affected construction productivity through delays in drawings, design changes, and following rework. Construction clients have sometimes delayed construction projects because of their lack of suitable knowledge about construction procedures. Moreover, being an outdoor industry, construction performance is extremely affected by weather conditions. In addition to the factors discussed, health and safety regulations, and codes of practices are other external factors influencing task operations and productivity. Factors internal to construction companies include management inadequacy resulting in a waste of resources and consequent losses in productivity; adoption of modern technology and training for laborers would increase productivity.

6. Recommendations

Construction projects are high risk and often lead to a disputes and claims as work progress, which then subsequently further affects progress. The environment within construction organizations should be suitable to successfully complete projects. In construction, it is necessary to identify potential problems in advance, in order to avoid and overcome possible impacts on cost or project time. Stemming from the research, detailed below are recommendations which were found to improve labor productivity on the construction projects in GCC countries.

6.1 SCHEDULE

A detailed schedule of material supply schedule for each project should be provided by contractors. It should contain the time required to supply

materials and the availability of the local market to furnish the required materials in time. Using suitable materials and tools also has a positive effect on tasks and thus, better labor productivity can be achieved.

6.2 ORGANIZATION

Organizations should make sure sites are safe and undertake continuous safety training. Meetings should be arranged to achieve better performance in labor productivity.

6.3 MATERIALS STORAGE

Material should be stored at appropriate locations and should be easily accessible and close to constructed buildings to avoid wasting labor time for multiple-handling. Project managers should provide suitable logistic plans at the initial phase of projects.

6.4 SKILLED

Recruiting managers and project managers should select appropriate candidates for particular tasks. Friendly relations should be maintained with labors and they should be made aware of their importance to the organization.

6.5 CHANGE ORDERS

To achieve desired results, time required implementing change orders and to make corrections in drawings and specifications should be estimated and scheduled without affecting project-time completions. Regular meetings should be arranged with project stakeholders.

6.6 EXTERNAL FACTORS

Various external and natural factor risks should be considered in budget estimations to minimize delays due to closures and material shortages. There should be suitable contingency budgets to cover costs of increased material.

6.7. SITE CONDITIONS

Financial incentives and perks (like parking places) in the form of best employee of the year should be implemented to create competition among the employees, thus achieving better productivity.

6.8. DESIGN

Complex designs and incomplete drawings should be avoided and care should be taken to avoid confusion among the various construction agencies.

6.9. SITE LOCATION

If construction sites are present in remote geographical locations where public or employees' own transportation facilities cannot be made available, appropriate organized transportation should be given to the employees.

6.10. ABSENTEEISM

Absenteeism at work site can be reduced with inclusion of appropriate paid time off and vacations to all employees.

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