

Management Tools and Techniques Impacting On-site Labour Productivity

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Abstract:

The aim of this research was to investigate the implementation of the various Management Tools and Techniques in the execution of construction projects in the South African Construction Industry as a means to improve the current low levels of On-site Labour Productivity. An in-depth literature review was conducted in order to obtain a collection of current Management Tools and Techniques potentially utilised by Construction and Project Managers in South Africa's Construction Industry. This collection of Management Tools and Techniques was used to develop the questionnaire that was used in identifying those Management Tools and Techniques utilised with varying levels of emphasis by construction personnel in the South African Construction Industry. The research adopted a quantitative research approach that employed a questionnaire survey administered to randomly selected respondents using the SurveyMonkey web-based tool. The study used descriptive statistics - Frequency Analysis to identify the Frequency and level of emphasis placed on the respective Management Tools and Techniques and inferential statistics - Correlation Analysis to test the relationship between the Management Tools and Techniques and On-site Labour Productivity. Based on the findings, the study concludes that there is a Significant Positive Relationship between the particular Management Tools and Techniques implemented on construction projects, and the resultant levels of On-site Labour Productivity. Additionally, this research recommends future researchers to investigate particular Management Tools and Techniques that have been used with lower levels of emphasis but proved to have considerable correlation to On-site Labour Productivity.

Keywords: Construction, labour productivity, management, tools, techniques

1 Introduction

Literature suggests that the major problem with On-site Labour Productivity in the South African context, is that it is by no means optimal, and in fact, is at its lowest in 46 years according to Naicker (2014). Although some authors have alluded to the fact that management is a significant factor which impacts On-site Labour Productivity, few have touched on the relationship between the two. This creates a gap in the literature in establishing a well-defined relationship, either positive or negative, between management and On-site Labour Productivity. If the low levels of On-site Labour Productivity in South Africa's construction industry are to be addressed, the level of emphasis placed on those Management Tools and Techniques identified to have Significant Positive Correlation should be reconsidered.

The aim of this research was therefore to investigate the Management Tools and Techniques implemented on construction projects, by construction and project managers, and to determine

whether or not they contribute to the improved levels of On-site Labour Productivity. As such, the objectives of the research were to; Investigate the current Management Tools and Techniques implemented on construction projects within the South African Construction Industry, Establish how contractors determine the success of a project, Establish the relationship between the Management Tools and Techniques implemented on projects, and their effect on On-site Labour Productivity, and lastly, to Establish which of the Management Tools and Techniques implemented have the most significant impact on On-site Labour Productivity.

To achieve the aim and objectives of this research the methodology that was adopted involved a critical review of the current literature pertinent to construction management in order to provide a collection of the tools and techniques implemented by management on construction projects. From this, a questionnaire was distributed to various contractors in the South African construction industry. The results obtained from these questionnaires provided non-parametric data, which was then used to perform the appropriate correlation analysis in order to establish the relationship discussed in the objectives.

The findings identified those Management Tools and Techniques currently used in the South African Construction Industry. Furthermore, time performance was identified as one of the key indicators of project success, and as such was used to evaluate the relationship between the Management Tools and Techniques and On-site Labour Productivity. The Management Tools and Techniques identified by this research to have significantly positive correlation to the time performance of the respective projects provide useful insight into potential solutions to the current levels of On-site Labour Productivity. As such, these findings provide a platform for future research.

2 Literature Review

2.1 Labour Productivity Defined

Labour productivity is defined by the International Labour Office (ILO) as the amount of output per unit of input (labour). Output is measured as gross domestic product (GDP) for the aggregate economy, and input referring to the labour (ILO, 2016). The ratio through which Labour Productivity can be considered can be seen below.

Equation 1: Labour Productivity

Labour Productivity = Output (GDP) / Input (Labour).

2.2 On-site Labour Productivity in Context

On-site Labour Productivity is a significant factor affecting the success of construction projects, and is therefore of immense importance for the economic growth of a country (Naoum, 2016). According to Barbosa *et al.* (2017), the construction industry on a macro level, has been at a standstill regarding productivity, in comparison to other sectors of the economy. Globally, the construction industry has only managed to average an annual growth rate of 1% over the last twenty years Barbosa *et al.* (2017). This underperformance relative to other industries implies that labour productivity in the construction industry is of great concern and needs to be investigated to

understand the phenomenon giving rise to this lack of efficiency, and ultimately overcome this standstill.

2.3 Management and its Relation to Levels of On-site Labour Productivity

Throughout literature, management is considered as one of the primary factors affecting On-site Labour Productivity on construction projects. Management at various levels, from supervisors through to coordinators, site managers, construction managers or project managers is cited as being a major contributor to the levels of On-site Labour Productivity (Allmon *et al.*, 2000; Fischer, 2009; Durdyev and Mbachu, 2011; Attar *et al.*, 2012; BIS, 2013; Bierman *et al.*, 2016; Barbosa *et al.*, 2017).

Furthermore, this affiliation between Management and On-site Labour Productivity is prevalent through the work of various authors (Kagioglou *et al.*, 2001; Dubois and Gadde, 2002; Harris and McCaffer, 2013; Windapo, 2013).

2.4 Management Tools and Techniques applicable in the South African Construction Industry

During the Planning stage, the collection of Management Tools utilised by management include: The Project Brief; the Scope of Works; the Budget; the Work Breakdown Structure; The Construction Program; The Method Statement; Network Analysis; the Organogram; the Procurement Strategy Documentation for Subcontractors; The Health and Safety Plan; The Site Establishment Plan and the Quality Assurance Plan.

The Management Techniques on the other hand, include Forecasting and Predicting the construction activities, Planning the various activities and expenditure, Organising the various resources, and communicating the plan of action to the various subordinates (Windapo, 2013; SACPCMP, 2018).

During the Construction stage, management is more focused on the implementation of the tools and thus there are more Management Techniques that prevail. The few Management Tools that are implemented include the Health and Safety Plan; Net Work Analysis; Financial Reports and Budgeting, and Quality Control (implementation of the Quality Assurance Plan). The Management Techniques include: the Monitoring & Controlling of the various resources; the Co-ordinating of construction activities; the Motivation of the labour force; conducting Site Meetings and Tool Box Talks; the implementation of structured communication lines through the Organogram; Supply Chain Management; Materials Management; the regular updating of the Construction Program and Progress Reports; Cost Control and Financial Reporting; Quality Control through the implementation of the Quality Control Plan and lastly, Risk Management (Windapo, 2013; SACPCMP, 2018).

3 Research Methodology

The selection of a research approach is based on the nature of the research problem according to Creswell (2009). Seeing that the research question reads: “Which Management Tools and Techniques implemented on construction projects in South Africa have an impact on the levels of On-site Labour Productivity?” it was clear that this research required a quantitative approach.

3.1 Questionnaires as the Primary Tool for Data Collection

Questionnaires are a method, among several others, of extracting information and opinion from a sample of participants. In this particular method, questions are laid out in such a manner as to extrude the required information from the participants. The reason for this research having made use of the questionnaire method of data collection, was heavily based on the advantages outlined by Drever and Munn (1990). These advantages include; an efficient use of time, anonymity of respondents, possibility of a high return rate, standardising of questions (Drever and Munn, 1990). Furthermore, the use of a Likert Scale in the questionnaire provides non-parametric data (Pell, 2005), which warrants the use of Spearman Rho test to calculate correlation (Murray, 2013).

3.2 Population and Sample Size

Given the broad spectrum of the population of construction management personnel, the researchers were limited to the sample available to them, through the SurveyMonkey database created through the Department of Construction Economics and Management at the University of Cape Town. Drawing from a sample of 7535 management personnel in the industry, at a 95% Confidence Level and Margin of Error of 5%, the number of responses required equates to 366 respondents. At the end of the survey period, 64 responses were received which equates to a response rate of 17.5%. The low response rate was attributed to the prevalent time constraints, as well as the reluctance of construction management personnel in the industry to respond to questionnaires. The 64 responses comprise of all questionnaires that were fully completed. This gave the research a richer and core number to work with as evidenced by the number of respondents that engaged with the questionnaire. Additionally, these responses represent an array of specialists in the construction industry that use and employ tools and techniques that allow the smooth running of managing labour to get the intended output. This falls above the threshold of 30, as outlined by the Central Limit Theorem, and as such, the findings can be generalised.

3.3 Methods of Data Analysis

3.3.1 Mean Item Score

For various questions in the questionnaire, respondents were provided with a 5-Point Likert Scale in which they could respond to questions. The responses were then allocated a Mean Item Score (MIS), which provided a mean for the responses obtained from the Likert Scale

3.3.2 Frequency Distribution

Other portions of the responses were analysed by means of Frequency Distributions. Frequency Distributions summarise data by converting the raw data into percentages and grouping this data into respective categories. This provides useful descriptive statistics. The higher the percentage frequency of a particular response, the more important the response is deemed to be.

3.3.3 Correlation Analysis

The analysis of the data through the use of Statistical Package for Social Sciences (SPSS) confirmed that the data was indeed non-parametric, and thus warranted the use of Spearman Rho test to calculate correlation (Murray, 2013). The Correlation Analysis was used to establish the relationship between the various Management Tools and Techniques and the project's

performance with respect time. The completion of a project within the specified time, is highly dependent on the productivity of the on-site labourers. Therefore, the performance of a project with respect to time corresponds with the level of On-site Labour Productivity.

3.4 Reliability and Validity of Findings

The internal reliability of the main findings pertinent to Management Tools and Techniques utilised by respondents was achieved by means of achieving an acceptable Cronbach's Alpha. The use of Low Inference Descriptors, Peer Examination, Multiple researchers and Mechanically Recorded Data were also used to ensure reliability of the research. The means by which this research aimed to achieve validity was through examinations of the research by experienced industry professionals, in the Department of Construction, Economics and Management at the University of Cape Town, as mentioned above.

4 Findings and Discussion

4.1 Profile of Respondents

The majority of respondents (62,50%) were Managing Directors of their respective companies, whilst Project Managers constituted the second highest responses (9,38%).

The majority of respondents were highly experienced, with 73,44% of the respondents having more than ten (10) years of experience within the construction industry.

It was also found that the majority of respondents proved to have a Construction Industry Development Board (cidb) Grading that fell within the Grade 4 – 7 Categories in both General Building and Civil Construction.

4.2 The Relationship between Management Tools and Techniques and On-site Labour Productivity

4.2.1 Management Tools

All Management Tools as outlined in the Literature Review were adopted by the various respondents. Using a weighted average out of a possible 1-5 rating, the level of emphasis placed on the various Management Tools were identified and can be seen in Figure 1. It can be seen from Figure 1, that the Management Tool utilised with the most emphasis were the Scope of Works and Health & Safety Plan.

Through conducting a Spearman Correlation Test, the Management Tools identified to have moderate positive correlation to the time related performance were that of the Project Brief (0.435), Method Statement (0.546), Work Breakdown Structure (0.536) and Gantt Chart / Project Schedule (0.484). The analysis conducted shows that there is a significant relationship between management tools and the on-site labour productivity (see Table 1). All the management tools displayed a strong correlation and as a result, this is empirical to the understanding of the fact that each management tool to govern the operation of labour on site, there is a direct relationship between how it also allows productivity to be improved.

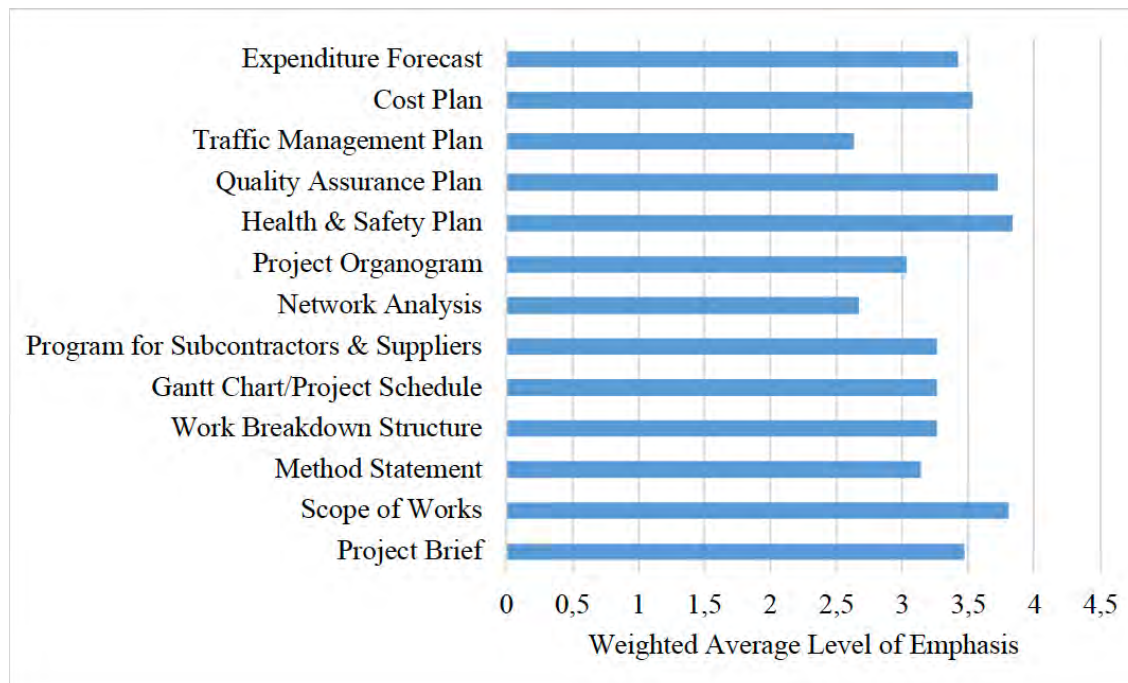


Figure 1: Level of emphasis placed on Management Tools

Table 1: Management Tools Correlation to Time

Management Tools Correlation to Time (On-site Labour Productivity)			
Management Tools			TIME
Spearman's rho	Project Brief	Correlation Coefficient	.435*
	Method Statement	Correlation Coefficient	.546*
	Work Breakdown Structure	Correlation Coefficient	.536*
	Gantt Chart / Project Schedule	Correlation Coefficient	.484*
*. Correlation is significant at the 0.05 level (2-tailed).			

4.2.2 Management Techniques

Through conducting a Spearman Correlation Test through the SPSS software package, the incorporation of Incentive Strategies for the Labour Force was identified as the only Management Technique having the highest correlation (0.571) to time-related performance.

Table 2: Management Techniques Correlation to Time

Management Techniques Correlation to Time (On-site Labour Productivity)			
Techniques			Time
Spearman's rho	Incentives Strategies for Labour Force	Correlation Coefficient	.571*
*. Correlation is significant at the 0.05 level (2-tailed).			

4.3 Discussion on the Relationship between Management Tools and Techniques and On-site Labour Productivity

4.3.1 Management Tools

Through the extraction of data points pertaining to particular questions of the Questionnaire, the variables pertaining to time-related performance and the level of emphasis placed on the various Management Tools were analysed in SPSS Software Package. This provided the various correlation coefficients, which allowed for a correlation analysis to be performed. The Management Tools identified to have the highest positive correlation to the time-related performance were that of the Method Statement, Work Breakdown Structure, Gantt Chart / Project Schedule and Project Brief, ranked from highest to lowest correlation with respect to time performance. The Method Statement is a tool used by management for the control of various aspects of a project, as well as the required resource allocation. This resource allocation considers both manpower and plant, which are consequently used in the development of the Project Schedule. As such, failure to implement a suitable Method Statement may result in the inability to effectively allocate and control resources, particularly with respect to On-site Labour.

The Work Breakdown Structure is a planning tool which organises the work to be done into more manageable work packages, and in turn contributes to development of the Project Schedule. During the execution phase, if a project is falling behind schedule for example, referring back to the Work Breakdown Structure can help identify major deliverables impacted by failing work packages. The Project Schedule is arguably one of the most important Management Tools implemented on projects, to help plan, track and monitor the progress of the project. The Project Schedule sets the benchmark against which on-site labourers ought to perform, and as such, can be expected to have a positive correlation with respect to time performance. The Project Brief is an essential tool used in outlining a project's core objectives, scope, deliverables and other essential project details. It is the document upon which many of the other tools are based on and sets the precedent for the planning of the project.

The Scope of Works proved to have no significant correlation to On-site Labour Productivity. This is somewhat counter-intuitive, as it is cited as one of the most prevalent Management Tools. Construction projects tend to be highly complex and can often experience scope-creep. Changes in the scope of works can result in the requirement for additional time, cost and resources. Additionally, this may result in lack of clarity and demotivating the labour force due to having to re-execute the works.

The Management Tools with the most emphasis placed on them in South Africa's construction industry were found to be the Project Brief; Scope of Works; Health & Safety Plan; Quality Assurance Plan and the Cost Plan. Of these Management Tools, the Project Brief was proven to have the highest positive correlation to a project's time performance. Furthermore, the Project Brief, Method Statement, Work Breakdown Structure and the Gantt Chart / Project Schedule were found to have a significant positive correlation to a project's performance with respect to time. This supports the work of Maserang (2002).

Since literature alluded towards a positive relationship between project performance and the implication of various Management Tools, it was to be expected that the remaining Management

Tools identified in the questionnaire would yield a positive correlation to On-site Labour Productivity. This was not found to be the case; however, it is to be noted that this may be due to the sample size in comparison to the population.

4.3.2 Management Techniques

Through the extraction of data points pertaining to relevant questions of the Questionnaire, the variables pertaining to time-related performance and the level of emphasis placed on the various Management Techniques were analysed in SPSS Software Package. This provided the various correlation coefficients, which allowed for a correlation analysis to be performed. The incorporation of Incentive Strategies for the Labour Force was found to be the only Management Technique with significant correlation to On-site Labour Productivity.

Incentive Strategies for the Labour Force are strategies which encourage labour to perform better, in return offering rewards for improved performance with respect to productivity and quality. This is the very reason why Incentive Strategies have proven to show a significantly positive correlation to On-site Labour Productivity.

Interestingly enough, Site Meetings, Progress Reports and Progress Meetings have proven to show negative correlation to On-site Labour Productivity. The reason for this is not certain, however may be due to these three Management Techniques not being directly related to the labours on site. Additionally, supervision of site activities also proved to have a negative correlation to On-site Labour Productivity. This may be due to the reluctance of labourers wanting to be monitored on a continuous basis. On the contrary, one would expect that the supervision of labourers would compel them to remain productive.

Quality Control also proved to have a negative correlation to On-site Labour Productivity. Quality Control can at times result in the works on site being halted for inspections, as well as result in reworks having to be carried out. This creates time delays and thus hinders On-site Labour Productivity. Literature suggests that middle management needs to co-ordinate the site activities required in order to carry out the work in a well thought out way that optimises the sequence of construction ensuring that the time taken for each work package is minimised while still meeting the quality requirements. This can be achieved if the site manager practices appropriate forms of supervision, control and motivation over the labour force. Furthermore, Murphy and Ledwith (2007) conclude that having clear project objectives and top management support are crucial success factors.

5 Conclusion and Further Research

Given the concerning levels of On-site Labour Productivity in the South African Construction Industry and the affiliation between Management and On-site Labour Productivity, the aim of this research was to investigate the Management Tools and Techniques implemented on construction projects, by construction and project managers in South Africa, and to determine whether or not they contribute to the improved levels of On-site Labour Productivity. Through a critical review of the current literature pertinent to construction management and the distributed questionnaire, the Management Tools and Techniques that are currently implemented in the South

African Construction Industry were identified. In order to establish whether or not a relationship exists between the Management Tools and Techniques implemented on construction projects and On-site Labour Productivity, the level of emphasis placed on the implementation of the various Tools and Techniques were analysed in terms of their correlation to the project's Time Performance. The Spearman Correlation Test provided the correlation coefficient between the respective Tools and Techniques and Time Performance, identifying those that are significant at a 95% confidence level.

The Management Technique identified as having the lowest level of emphasis placed on them, was that of implementing incentive strategies for the labour force, however, this was identified to have the most Significant Positive Correlation to a project's performance with respect to time. Supply Chain Management was also one of the less emphasised Management Techniques utilised by respondents which proved to manifest a negligible positive correlation to a project's performance with respect to time. While of the queried Management Techniques, the Supervision of Site Activities was found to have a negative correlation to time performance. This also proves to be contradictory to what is outlined in literature.

All things considered, literature alluded to a positive relationship between Management Tools and Techniques and On-site Labour Productivity. However, the findings of this research portray otherwise with particular Management Tools and Techniques. Such variances may be due to the scale of the Sample Size in relation to the Population. This inhibits statistical inferences to be made across the population. The findings established that the level of emphasis placed on the implementation of Incentive Strategies for labourers was low, however, the findings also established that Incentive Strategies proved to have a Significant Positive Correlation to On-site Labour Productivity. As such, further research should aim to investigate alternative, cost effective incentive strategies for labourers, as this could result in improved levels of Onsite Labour Productivity.

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