Journal of Economics and Behavioral Studies (JEBS)
Vol. 12, No. 4, August 2020 (ISSN 2220-6140)

# Towards Improving Project Performance Indicators in South African Construction Sector

Oluseyi Julius Adebowale[1], Patricia Omega Kukoyi[2], Iyabo Mercy Olagoke[3], Badmus Ademola[4]
[1]Nelson Mandela University, South Africa,
[2]University of Lagos, Nigeria,
[3]Obafemi Awolowo University, Nigeria,
[4]Osun State Polytechnic, Nigeria
adebowaleoluseyi@gmail.com

**Abstract:** Despite myriad of research effort directed at improving the performance of construction projects, poor productivity, budget overruns, quality related issues, and schedule overruns have been recurring on most construction projects. As a consequence, time, cost and quality of construction, which are among the key project performance indicators (PPIs), have suffered poor performance in many construction project undertakings. While several studies have addressed these performance dependents parameters separately and collectively, the impact of political, environmental, social, technological, economical, and legal (PESTEL) related factors on the PPIs has however not been considered. The purpose of this study, therefore, is to identify PESTEL related factors, and further determine their impact on the PPIs in the South African construction industry. South African contractors, which are registered with the CIDB (Grades 5-9) were sampled and administered questionnaires to achieve the purpose of the study. The study determined that rework, poor planning, and inadequate training are most closely associated with poor performance of the PPIs. It is believed that addressing the areas of concern identified in this study would contribute to improved performance of the PPIs in South African construction, which would ultimately engender satisfaction of construction stakeholders.

**Keywords:** *Construction, project performance indicators, productivity.*

## 1. Introduction

Cost is a major consideration during project management life cycle and considered as one of the essential parameters that define project performance (Memon et al., 2011). Cost escalation experienced in the implementations of construction projects is largely associated with planning. Cost overrun denotes the escalation in the amount of money required to deliver a project considering the initial budgeted amount (Kaliba et al., 2009). Cost management is an important tool for cost effectiveness (Enshassi et al., 2010). Estimating the completion cost of construction projects is extremely problematic as a result of the complex web of cost influencing parameters inherent in the construction process (Ahiaga-Dagbui & Smith, 2014). Overrunning construction cost, sometimes results from misunderstanding among project team members (Borse & Khare, 2016). Materials cost, design and scope changes, ground conditions, size of project, type of client, and tendering method are some of the factors that result in cost overruns in construction (Ahiaga-Dagbui & Smith, 2014). Other factors that give rise to construction cost escalation include: improper planning and budgeting, poor coordination and monitoring of projects (Doloi et al., 2012), managerial incompetence, technical error in design or estimation, deception and delusion, and corruption (Ahiaga-Dagbui & Smith, 2014). Apart from cost consideration, quality is another essential parameter upon which construction project performance is measured (Alinaitwe et al., 2007). Quality improvement is an important discourse in virtually all sectors (Forsythe, 2015).

Quality is the act of meeting the expectations of customers or compliance with customers' requirements (Iyer & Jha, 2005). The determinant of project success may vary from stakeholder to stakeholder, as different project participants have their individual project objectives (Chan & Chan, 2004). However, quality is recognized as the most important tool in market competition, as it serves as a dependable license of obtaining the loyalty of customers (Dudek-Burlikowska, 2011). Some contractors are not quality management certified, thus they regrettably compromise quality management procedures (Alinaitwe et al., 2007). Construction projects, which comply with schedule of activities, usually record timeous project completion. This is, however, not the case in most projects, as many construction projects experience avoidable and unavoidable setbacks due to the uncertainties inherent in construction operations. Time overrun in the construction industry affects project clients, project contractors, and other primary and secondary stakeholders (Ameh &

Osegbo, 2011). To the clients, delay implies a loss of revenue due to lack of production facilities and rentable space (Assaf & Al-Hejji, 2006). Equally, when there are delays, contractors are likely to deploy more resources on projects, penalized for project delay, or even lose other profitable contracts because resources for the next job are tied up on delayed projects (Ameh & Osegbo, 2011). A timely project completion would help to alleviate clients' financial liability and enables them to recoup their capital investment sooner (Ng & Zhang, 2008).

The major role of project managers is to ensure that projects are completed within the predetermined time (Sambasivan & Soon, 2007). Non-value adding time (waste), constitutes approximately 35% of the available time between activities, while the time spent on value adding activities is significantly less in construction (Josephson & Chao, 2014). There is a surfeit of evidence that among the several construction-related challenges confronting developing countries, productivity is a critical issue, and the subject is key to projects success (Akogbe et al., 2015). Poor productivity in construction is commonly attributed to several influences, rather than a single factor. These influencing factors are usually dependent on one another; one factor usually results in the occurrence of others (Dai et al., 2009). Construction productivity improvement is a product of efficiency, which engenders achievement of construction project objectives (Adebowale & Fapohunda, 2015). Contractors in South Africa grapple with poor performance of the construction PPIs, which contributes to loss in construction business (CIDB, 2012). One of the major performance challenges that confront South African construction is poor productivity, which is directly related to the PPIs. Improving the PPIs in South African construction would invariably contribute to improved productivity in the South African construction sector.

Coka (2013) reports the decline of both capital and multifactor productivity (MFP) as -1.6 % and - 0.7 % respectively in the South African construction industry. Bierman et al. (2016) similarly state that South African construction labour productivity is among the lowest in developing countries. Kukoyi et al. (2020) identify the significance of cost, quality, and time by maintaining that the parameters exert a greater influence on construction project performance than other project performance indicators. Since the PPIs are major tools to drive productivity in construction, investigations into the factors that contribute to marginalizing the PPIs are essential to improve productivity in construction operations. This study, therefore, is designed to evaluate the impact of PESTEL related factors on the PPIs to propose interventions towards improving the performance of the PPIs in South African construction. Several studies have addressed these performance dependents parameters separately and collectively. The impact of PESTEL related factors on PPIs has however not been considered, which is what this study is set to achieve. The order of presentation in this study includes the following: the next section presents the performance of projects in the South African construction industry, followed by reviews of previous research works on the PPIs. The methodology adopted for the study is subsequently presented, and then the research findings are discussed. The study is concluded and recommendations are proposed based on the research findings.

## 2. Projects' Performance in South African Construction Sector

The construction industry is a strategic industry to nations' economies, which provides infrastructural development and shelter for economic activities to thrive (Chingara & Moyo, 2014). Although the South African government has formulated policies for performance improvement in construction, statistics have however revealed that there was a decline in South African construction activities (SA construction, 2013). The CIDB reported a study that was conducted across the nine provinces of South Africa. The study reveals that 13% of the surveyed clients were unsatisfied with the performance of contractors, 24% of the surveyed contractors were dissatisfied with the performance of clients, and 9% of the surveyed projects had levels of defects, which were regarded as inappropriate (CIDB, 2012). National Development Plan (NDP) was further initiated by the South African government with a public infrastructure investment of R 810 billion over the next few years to boost the construction industry's growth (SA construction, 2015). The government also deployed in excess of R 372 billion between 2006 and 2009 to construction as part of its infrastructural development program (The Construction sector, 2010).

These development plans make the delivery of social infrastructure increased from 1.5 million housing units in 1996 to 2.1 million by 2013. Despite these momentous investments, overruns, poor productivity and quality related problems are subjects of concern in most South African construction projects (Cottle, 2014).

The South African Workforce Management Group Adcorp (WMGA) estimated that labour marginal productivity in the South African construction industry has been poor for the last four decades (Chingara & Moyo, 2014). To ensure and retain clients' satisfaction, the requirements and expectations of clients must be understood by their service providers. For more than two decades, South African construction is confronted with unique performance challenges and deliberate efforts are being made on a broad front to address these challenges (Ofori et al., 1996). The challenges in the South African construction sector have been a long-lasting issue, while there is evidence to establish the existence of these challenges (Windapo & Cattell, 2013). Windapo and Cattell (2013) posit that some of the challenges confronting the performance of the South African construction sector are public sector capacity, technology, site conditions, statutes and regulations.

An increase in the cost of material, access to available mortgage / credit and interest rate, and poverty. Research undertaken relative to labour and work conditions in South Africa construction report the negative impact of community liaison officers and ward councilors. In public sector contract as a major factor militating against performance in South African construction (CIDB, 2015). The study identifies industrial action as one of the major factors affecting the performance of the South African construction sector as a result of significant production delays due to the number of man-days lost. Ugwu and Haupt (2007) state that the challenge of poor project performance is more severe in emerging economies, which require considerable infrastructural projects to stimulate economic growth. Ugwu and Haupt (2007) further elucidate that the poor performance of construction projects in developing economies stems from the reality that developing countries give more priority to poverty alleviation, institutional strengthening, capacity utilization building, and socio-cultural dimensions that sustain harmony and co-existence. The South African construction industry is expected to play a decisive role in the country's bid to achieve rapid socio-economic development through improved projects performance (Ofori et al., 1996). The factors that impact on project performance are rarely constant from country to country and even project to project, depend on the circumstances involved in the project. There are however essential indicators, which are primary to the survival of any organization including those in the construction sector. These indicators, which are recognized as the PPIs in this study are examined.

**Cost Indicator:** The effective implementation of a construction project by keeping the execution under the control of the predetermined cost is reliant on an approach that requires sound engineering judgments (Enshassi et al., 2010). Proper monitoring of the financial activities of any project is therefore essential to prevent the prospective danger of cost overruns. Despite the awareness of the need for cost control, it is uncommon to see a construction project achieve its objective on effective cost delivery (Memon et al., 2011). In an industry such as automotive, policies to develop a long-term cost effective business has been developed (Josephson & Lindstrom 2014). In prioritising the reduction of defects and disturbances related to projects, several organizations keenly oversee their projects and ensure they shorten lead times (Josephson and Chao, 2014). Zimina et al. (2012) state that the right approach to target costing is to ensure that cost and value are the drivers of the design process rather than determining the cost after completion of the design. According to Enshassi et al. (2010), cost overrun is more rampant in the traditional or adversarial form of contract where contracts are awarded to the lowest bidder particularly in developing nations. Aibinu and Jagboro (2002) indicate that the conventional approach to managing the extra cost include a percentage (5% - 10%) of the project cost as a contingency in the pre-contract budget.

**Quality Indicator:** The quality of production is expected to be improved through the implementation of Quality Management System (QMS) such as Total Quality Management (TQM), Six Sigma, ISO 9001 or excellence models and also applying the associated tools and techniques (Aichouni et al., 2014). Aichouni et al. (2014) state that large and small corporations have adopted QMS, which has proven to be effective. Quality Function Development (QFD) is another strategy the manufacturing industry employs to identify customers' needs and convert the need into product characteristics (Delgado-Hernandez et al., 2007). Official statistics have proven that productivity in the construction industry grows more slowly than productivity in the manufacturing industry (Sezer & Brochner, 2014). Adebowale and Smallwood (2020) maintain that construction productivity improvement would contribute to lowering construction cost. Kukoyi and Smallwood (2017) identify poor productivity, accidents on site, non-value adding activities, and absenteeism as major factors, which give rise to cost of construction. The process of quality control in the construction industry should begin with making quality.

Management programs that are based on construction documents (Chen & Luo, 2014). Chen and Luo (2014) state that these programs should explicitly state the quality of material and equipment, the acceptance standards of work and tests to be performed. Simpeh and Shakantu (2020) explore quality in terms of functionality of construction facilities. The study reported inadequacies in facilities in higher institutions of learning. Some of the required facility are missing, while some were found to be underperforming (Simpeh et al., 2014). These documents are arguably available but the industry players still grapple with implementation problem. Viable quality management system in construction will contribute to improving the performance of PPIs in the industry (Kazaz et al., 2008). Low quality materials engenders higher construction cost (Memon et al., 2011). Chen and Luo (2014) state that one of the difficulties in quality management is that the current focus of quality control is the final component with less attention given to quality control during the process of construction. Chen and Luo (2014) expound that the inadequate understanding of quality codes contributes.

**Time Indicator:** Delays in construction can be reduced by identifying the underlying causes and appropriating preventive measures against the identified causes. Khoshgoftar et al. (2010) state that site investigations is a necessary measure needed in order to better manage delays and to mitigate its resulting consequences. Lead time should be well managed from the beginning to the delivery of construction work. Typically, a project is broken down into activities to which resources can be assigned, durations and costs estimated. The activities are linked according to work sequences to form a network. Critical path method (CPM) is used to analyze the network to identify critical path(s) and project duration (Choudhury, 2009). Shorter lead times are aimed at reducing construction time and increase competitiveness. Josephson and Chao (2014) state that sufficient time is needed to avoid future problems. Completing projects on time is a pointer to efficiency; however, the construction process is subject to several variables and capricious factors. There are different categories of delays attributed to construction project delivery. Many researchers have identified the forms of delay in construction project execution process as; excusable delays, non-excusable delays and concurrent delay (Abdul-Rahman et al., 2008, Enshassi et al., 2010). Excusable delays result from unforeseen factors outside the control of contractor and are not attributed to contractors' negligence (Akinsiku & Akinsulire, 2012). Such delays stem from force majeure, extremely inclement weather, civil commotion, industrial unrest (Ameh & Osegbo, 2011). Contractor is not responsible for this type of delay (Arditi & Pattanakitchamroon, 2006, Enshassi et al., 2010).

To quality problems in the construction sector unfortunately, construction organizations, workers, and the general public have lost billions of dollars to the bad quality of work and unsafe work conditions (Loushine et al., 2006). Therefore, this necessitates the need for improvement in product quality, business results and customers' satisfaction (Aichouni et al., 2014). Ameh and Osegbo (2011) state that project contractors are responsible for the risk associated with schedule overruns on matters related to low labour productivity stemming from inadequate scheduling or mismanagement, construction mistakes, equipment breakdowns and staffing problems. Delay is said to be concurrent when two or more delay events arise concurrently, while the effects of the delays are felt at the same time (Enshassi et al., 2010). A delay may occur simultaneously with other delays, which sometimes contribute to the formation of other delays (Arditi & Pattanakitchamroon, 2006). Borse and Khare (2016) attribute the occurrence of time overruns on construction projects to factors such as design errors, unexpected site conditions, increases in project scope, weather conditions, and other project changes. Abisuga et al. (2014) differ that the underlying causes of delay can be associated with project stakeholders (clients, contractors, subcontractors, consultants) and external factors such as statutory agencies. Aibinu and Jagboro (2002) posit that contractors and clients jointly or severally contribute to the inability to complete a construction project within the stipulated contract period. Khoshgoftar et al. (2010) expound that delays occur between the clients and contractors due to problems arising from contractual arrangements. According to Memon et al. (2011), the number of change order, financial constraints and owners' lack of experience in construction are the main causes of delays.

**Construction Productivity:** Construction organizations operate within an environment that consistently changes (Enshassi et al., 2010). There is no single definition that can entirely describe productivity in a complex sector like the construction industry (Rane et al., 2017). Nasir et al. (2014) opine that the reason for this is because different inputs and outputs are involved in different projects and organizations. For equipment-intensive construction operations, productivity is defined as output / input (i.e. $m^3$ / h for excavation works). Conversely, the subject is defined as input / output (i.e. 0.50h / $m^2$ for wall formwork operations) for labour intensive construction operations (Panas & Pantouvakis, 2010). Both output and input usually have cost implications (Rivas et al., 2011). The construction industry is usually characterized by poor productivity (Adebowale & Fapohunda, 2015).

The industry is complex in its nature as it comprises large numbers of stakeholders such as clients, contractors, consultants, and regulators (Enshassi et al., 2010). Management of these diverse construction stakeholders is challenging as they are usually from different disciplines and organizations, which can constitute a major obstacle to projects success. The general emphasis on the need for construction productivity improvement is widely centered on its contributions to nations' economy and satisfaction of construction projects' stakeholders (Odesola & Idoro, 2014). A number of factors have been identified to militate against productivity growth in construction. Adebowale and Smallwood (2020) determined that inadequate workers' skills represent the most critical factor that influence productivity growth in construction. The pursuit of stakeholders' satisfaction and economic growth has therefore increase the interest of academics and industry practitioners on the need for construction productivity improvement.

## 3. Research Methodology

A quantitative research method was used to achieve the objectives of the study. 523 questionnaires were distributed to contractors in the Eastern Cape, Gauteng, Kwazulu-Natal, and Western Cape provinces of South Africa. These provinces were chosen because of their high construction capital outlay. Contractors from these provinces were drawn and the sample size was determined. First, a pilot study was conducted to enhance the validity of the questionnaire. The pilot survey conducted preceded the primary study and spanned over a period of one month. Through a convenient sampling technique, site managers and site engineers were selected on construction sites in Port Elizabeth, Eastern Cape province. After the pilot survey, the research questionnaire was modified to accommodate the input of participants. The modification improves the instrument for the primary survey. Respondents were informed about the study and their consent was sought before the questionnaires were distributed. The scale adopted was 1 (minor) to 5 (major), while an option of selecting 'unsure' was provided should respondents be uncertain with respect to a question. From the 523 questionnaires distributed, 96 questionnaires were retrieved and were captured for analysis.

0.70 reliability value was obtained after a Cronbach alpha coefficient reliability tests was conducted. According to Dane (2011), a correlation value of 0.70 is considered sufficient. The data collected was analyzed using the statistical package SPSS version 21 and a measure of central tendency in the form of a mean scores (MSs) was used to rank and identify significant perceptions of factors influencing the PPIs in South African construction. With respect to percentage representation of respondents on province basis, 33.3%, 28.2%, 20.8%, and 17.7% of the respondents were from the Eastern Cape, Gauteng, Western Cape, and KwaZulu-Natal respectively. 18 of the respondents were site engineers, 27 were site managers and 51 were site supervisors. Participants' organizations had an average of 22 years in the construction industry, and respondents had an average of 16 years work experience in the construction industry and an age range of 26-45 years. This suggests that respondents are adults and experienced to respond to the questionnaire. 83.3% of the respondents were male and 16.7% were females, this showed that respondents were dominated by males. The research considered contractors' perceptions because they are the key driver of production on construction sites and proficient with respect to the subject under investigation.

Contractors that are registered with the CIDB within grades 5-9 are established construction organizations and would have delivered several construction projects, therefore, contractors in this category are considered in this study. Construction site engineers, site managers, and site supervisors working for these contractors were surveyed and deemed to be capable of providing useful insights into factors that influence the PPIs in South African construction. The study population was obtained from the official page of the CIDB, and was randomly drawn except for a few conveniently sampled contractors. Microsoft Excel was used to draw the sample and a number was allotted to each of the participants contracting organizations, which enables the organizations to be sorted on a random value. The sample size of each province was obtained as randomly generated in Microsoft Excel. The research questionnaires were distributed to participant organizations through the internet, while completed questionnaires were retrieved through the same medium. Anonymity of respondents was assured through a duly signed consent and an introduction letter. The letter documented the purpose of the research and was distributed to participants' organizations together with the research questionnaires.

## 4. Discussion of Results

**Respondents' Information:** Tables 1-3 present the information of construction workers who participated in the study. Table 1 presents the qualifications of study respondents. The table reveals that 6.2% of surveyed respondents have a Master degree, 7.5% a Honors degree, 36.3% a Bachelor degree, 37.5% a Diploma certificate, 7.5% a Matric certificate, and 5% have a Trade certificate. The table suggests that majority of survey respondents have Barchelor degrees and Diploma certificates.

**Table 1: Qualifications of Respondents**

| **Qualification** | **No** | **%** |
|---|---|---|
| Master degree | 5 | 6.2 |
| Honours | 6 | 7.5 |
| Bachelor degree | 29 | 36.3 |
| Diploma | 30 | 37.5 |
| Matric | 6 | 7.5 |
| Trade certificate | 4 | 5.0 |
| **Total** | 80 | 100.0 |

Table 2 reveals the three categories of construction workers that participated in the study. They include: site engineers, site managers and site supervisors. 21.2% of the respondents were` site engineers, 48.8% were site managers, and 30% were site supervisors. Site managers predominate with regards response rate, follow by site supervisors, while the study record the least response from site engineers.

**Table 2: Occupations of Respondents**

| **Respondents** | **No** | **%** |
|---|---|---|
| Site engineer | 17 | 21.2 |
| Site manager | 39 | 48.8 |
| Site supervisor | 24 | 30.0 |
| **Total** | 80 | 100.0 |

Table 3 presents the range of years that respondents have worked in the construction industry. 20.0% of respondents have experience ranging from 0-5 years, 18.8% respondents have 6-10 years of construction experience, 15.0% have worked in construction for 11-15 years, respondent that have worked in construction for 16-20 years constitute 18.8%, then 21-26 years (3.27%), followed by 26-30 years (3.7%) while 20.0% respondents have more than 30 years of construction experience. These suggest that the respondents have the required site experience to understand the factors affecting the PPIs in South African construction.

**Table 3: Experience of Respondents**

| **Years** | **No** | **%** |
|---|---|---|
| 0-5 | 16 | 20.0 |
| 6-10 | 15 | 18.8 |
| 11-15 | 12 | 15.0 |
| 16-20 | 15 | 18.8 |
| 21-26 | 3 | 3.7 |
| 26-30 | 3 | 3.7 |
| >30 | 16 | 20.0 |
| **Total** | 80 | 100.0 |

Table 4 reveals the extent to which PESTEL factors influence the PPIs identified in the study. With respect to the PPIs, the results revealed that rework, poor planning, non-achievement of production targets, inadequate training, shortage of construction resources, disputes in construction, poor constructability of designs, and political related factors were the order of major factors, which influence cost performance in South African construction. Some studies determined that the occurrence of cost overruns is usually as a result of the misunderstanding between project team members, improper planning and budgeting, poor coordination and monitoring of the projects (Borse & Khare, 2016; Doloi et al., 2012). Respondents perceived the order of factors that exert negative influence on the quality of construction projects as inadequate training, rework, poor constructability of designs, and poor planning. Chen and Luo (2014) note that one of the difficulties in quality management is that the current focus of quality control is the final component with less attention given to quality control during the process of construction.

Chen and Luo (2014) further maintain that the inadequate understanding of quality codes contributes to quality problems in the construction sector. In terms of time performance, rework, poor planning, shortage of construction resources, inadequate training, non-achievement of production targets poor constructability of designs, political related factors, and disputes in construction were the order of major time influencing factors. Abisuga et al. (2014) note that the factors that affect time performance can be associated with project stakeholders (clients, contractors, subcontractors, consultants) and external factors such as statutory agencies. Khoshgoftar et al. (2010) state that delays occur between the clients and contractors due to problems arising from contractual arrangements. Relative to the mean scores (MS) of the PESTEL related factors in table 4, it can, therefore, be construed that the factors were very important to the PPIs. The results revealed a considerable relationship between productivity, cost and time as opposed to the relationship between productivity and quality.

In relation to the MSs, the four most significant quality influencing factors are highly rated as essential to productivity, cost and time. This suggests that quality is only related to productivity to some extent, while cost and time are related to productivity to a very large extent. The average MSs of the extent to which the identified factors influence PPIs are computed. Based on the results obtained, half of the factors have mean MSs > 3.40 ≤ 4.20, and the other half have mean MSs > 2.60 ≤ 3.40. These suggest that some of the factors have a major influence on the PPIs. These factors include: rework, poor planning, inadequate training, non-achievement of production targets, poor constructability of designs, and shortage of construction resources. It can further be construed that the remaining factors have a lesser influence on the PPIs. These factors include: disputes in construction, political related factors congestions on sites, unfavorable social economic conditions, poor working environments, and unfavorable welfare conditions. Considering the mean value of the PESTEL factors, it is deemed that all the factors are relevant to the PPIs.

**Table 4: Influence of PESTEL Factors on the PPIs**

| **Factor** | **PPIs (MS)** | | | | **Average** | **Rank** |
|---|---|---|---|---|---|---|
| | **Productivity** | **Cost** | **Quality** | **Time** | **MSs** | |
| Rework | 3.89 | 4.14 | 3.73 | 4.28 | 4.01 | 1 |
| Planning | 3.77 | 3.81 | 3.56 | 3.98 | 3.78 | 2 |
| Inadequate training | 3.69 | 3.53 | 3.76 | 3.77 | 3.69 | 3 |
| Non-achievement of production targets | 3.54 | 3.59 | 3.38 | 3.65 | 3.54 | 4 |
| Poor constructability of designs | 3.43 | 3.42 | 3.61 | 3.63 | 3.52 | 5 |
| Shortage of construction resources | 3.46 | 3.52 | 2.95 | 3.93 | 3.47 | 6 |
| Disputes in construction | 3.43 | 3.46 | 3.09 | 3.47 | 3.36 | 7 |
| Political related factors | 3.53 | 3.41 | 2.84 | 3.54 | 3.33 | 8 |
| Unfavorable socio-economic conditions | 3.39 | 3.15 | 2.8 | 3.09 | 3.11 | 9 |
| Poor working environments | 3.14 | 3.18 | 3 | 3.11 | 3.11 | 10 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Congestion | 3.04 | 3.15 | 2.97 | 3.28 | 3.11 | 11 |
| Unfavorable welfare conditions | 3.01 | 3.19 | 2.89 | 2.95 | 3.01 | 12 |

An analysis of variance (ANOVA) test was conducted to obtain possible statistically significant difference of respondents' perceptions relative to the influence of PESTEL-related factors on the PPIs. As three (3) occupation means were involved, ANOVA was deemed appropriate to reduce the chances of Type 1 error, since ANOVA analyses differences between all conditions means simultaneously. The mean difference for each factor was deemed significant at the 0.05 level. Based on the p-values obtained in table 5, respondents largely differ in their perceptions of factors that influence the PPIs. The result suggests that respondents' perceptions of factors influencing the PPIs differ with respect to construction productivity, cost, and quality, which have p-values of 0.514, 0.204, and 0.219 respectively. However, the perceptions of respondents with respect to construction time are statistically significant at the 0.049 level, which implies that respondents' perceptions relative to factors impacting on construction time are largely consistent.

**Table 5: ANOVA of PESTEL Influence on PPIs**

| PPIs | | Sum of Squares | Mean Square | F | p-Value |
|---|---|---|---|---|---|
| Productivity | Between Groups | 1.072 | 0.536 | 0.670 | 0.514 |
| | Within Groups | 73.644 | 0.800 | | |
| | Total | 74.716 | | | |
| Cost | Between Groups | 3.033 | 1.516 | 1.620 | 0.204 |
| | Within Groups | 86.132 | 0.936 | | |
| | Total | 89.165 | | | |
| Quality | Between Groups | 3.037 | 1.518 | 1.544 | 0.219 |
| | Within Groups | 90.459 | 0.983 | | |
| | Total | 93.496 | | | |
| Time | Between Groups | 5.417 | 2.709 | 3.121 | **0.049** |
| | Within Groups | 79.854 | 0.868 | | |
| | Total | 85.271 | | | |

* The mean difference is significant at the 0.05 level

Further analysis in the form of Tukey HSD test was conducted for multiple comparisons of respondents' perceptions on PESTEL-related factors influences on the PPIs. The results obtained relative to productivity, cost, and quality imply that the influence of PESTEL-related factors on these PPIs is not statistically significant. This result is consistent with the one obtained in the ANOVA test. However, time, has earlier proven to be statistically significant at the 0.049 level with the interpretation that PESTEL-related factors significantly influence construction time. Table 6 reveals that site supervisors and site mangers have largely contributed to the p-value of construction time achieving statistical significance.

**Table 6: Tukey HSD Multiple Comparisons of Respondents' Perceptions**

| PPIs | Dependent Variables | | Mean | Standard Error | p-Value |
|---|---|---|---|---|---|
| Productivity | Site supervisor | Site manager | 0.19669 | 0.21195 | 0.624 |
| | | Site engineer | -0.03680 | 0.27030 | 0.990 |
| | Site manager | Site supervisor | -0.19669 | 0.21195 | 0.624 |
| | | Site engineer | -0.23349 | 0.24659 | 0.612 |

| | | | | | |
|---|---|---|---|---|---|
| | Site engineer | Site supervisor | 0.03680 | 0.27030 | 0.990 |
| | | Site manager | 0.23349 | 0.24659 | 0.612 |
| | Site supervisor | Site manager | 0.41251 | 0.22922 | 0.175 |
| | | Site engineer | 0.25573 | 0.29232 | 0.657 |
| Cost | Site manager | Site supervisor | -0.41251 | 0.22922 | 0.175 |
| | | Site engineer | -0.15678 | 0.26668 | 0.827 |
| | Site engineer | Site supervisor | -0.25573 | 0.29232 | 0.657 |
| | | Site manager | 0.15678 | 0.26668 | 0.827 |
| | Site supervisor | Site manager | 0.33175 | 0.23491 | 0.339 |
| | | Site engineer | -0.06043 | 0.29957 | 0.978 |
| Quality | Site manager | Site supervisor | -0.33175 | 0.23491 | 0.339 |
| | | Site engineer | -0.39218 | 0.27330 | 0.327 |
| | Site engineer | Site supervisor | 0.06043 | 0.29957 | 0.978 |
| | | Site manager | 0.39218 | 0.27330 | 0.327 |
| | Site supervisor | Site manager | .53188* | 0.22071 | **0.047** |
| | | Site engineer | 0.17785 | 0.28146 | 0.803 |
| Time | Site manager | Site supervisor | -.53188* | 0.22071 | **0.047** |
| | | Site engineer | -0.35403 | 0.25678 | 0.356 |
| | Site engineer | Site supervisor | -0.17785 | 0.28146 | 0.803 |
| | | Site manager | 0.35403 | 0.25678 | 0.356 |

* The mean difference is significant at the 0.05 level.

## 5. Conclusion and Recommendations

During the delivery of construction projects, the significance of the PPIs identified in this study cannot be overemphasized. While the PPIs are different, improved or poor performance of one of the indicators would influence the performance of others. Based on the findings of this study, the major factors that influence the PPIs in South African construction are rework, poor planning, and inadequate training. The study further determined that respondents' perceptions of factors influencing the PPIs differ with respect to construction productivity, cost, and quality. However, their perceptions are largely consistent with respect to factors impacting on construction time. Consequently, the study recommends adequate supervision and effective training of construction employees. This will mitigate the rate of construction rework and also helps to improve the skills of construction workers.

As long as the construction sector remains labor-intensive, development and monitoring of human capital is essential for modern construction projects. Adequately trained workers would demonstrate high competence in projects execution, which would further reduce rework in construction. Furthermore, construction organizations should consider evolving effective planning programs. Based on the nature, type, and complexity of construction projects, some of what should be considered in the planning programs include; appropriate planning tools, accessibility of resources required for project implementation, selection of appropriate technology, weather conditions, duration and relationship between activities, health and safety measures, and other intrinsic and extrinsic project performance influences in construction.

**References**

Abdul-Rahman, H., Yahya, I. A., Berawi, M. A. & Wah, L. W. (2008). Conceptual delay mitigation model using a project learning approach in practice. *Construction Management and Economics*, 26(1), 15-27.

Abisuga, A. O., Amusu, O. R. & Salvador, K. A. (2014). Construction Delay in Nigeria: A Perception of Indigenous and Multinational Construction Firms. *Journal of Emerging Trends in Economics and Management Sciences,* 5(3), 371-378.

Adebowale, O. J. & Fapohunda, J. A. (2015). Analysis of construction-related factors affecting the efficiency of construction labour, *Journal of Construction Project Management and Innovation*, 5(1), 1115-1130.

Adebowale, O. J. & Smallwood, J. J. (2020). Qualitative model of factors influencing construction labour productivity in South Africa. *Journal of Construction*, 13(1), 19-30.

Ahiaga-Dagbui, D. D. & Smith, S. D. (2014). Rethinking construction cost overruns: cognition, learning and estimation. *Journal of Financial Management of Property and Construction*, 19(1), 38-54.

Aibinu, A. A. & Jagboro, G. O. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, 20(8), 593-599.

Aichouni, M., Ait Messaoudene, N., Al-Ghonamy, A. & Touahmia, M. (2014). An empirical study of quality management systems in the Saudi construction industry. *International Journal of Construction Management*, 14(3), 181-190.

Akinsiku, O. E. & Akinsulire, A. (2012). Stakeholders' Perception of the Causes and Effects of Construction Delays on Project Delivery. *Journal of Construction Engineering and Project Management*, 2(4), 25-31.

Akogbe, R. K., Feng, X. & Zhou, J. (2015). Construction Projects Productivity in West African country of Benin: Case of Ground Earthworks. *Journal of Construction Engineering and Project Management*, 5(2), 16-23.

Alinaitwe, H. M., Mwakali, J. A. & Hansson, B. (2007). Factors affecting the productivity of building craftsmen-studies of Uganda. *Journal of Civil Engineering and Management*, 13(3), 169-176.

Ameh, O. J. & Osegbo, E. E. (2011). Study of relationship between time overrun and productivity on construction sites. *International Journal of Construction Supply Chain Management*, 1(1), 56-67.

Arditi, D. & Pattanakitchamroon, T. (2006). Selecting a delay analysis method in resolving construction claims. *International Journal of Project Management*, 24(2), 145-155.

Assaf, S. A. & Al-Hejji, S. (2006). Causes of delay in large construction projects. *International Journal of Project Management*, 24(4), 349-357.

Bierman, M., Marnewick, A. & Pretorius, J. H. C. (2016). Productivity management in the South African civil construction industry-factors affecting construction productivity. *Journal of the South African Institution of Civil Engineering,* 58(3), 37-44.

Borse, M. & Khare, P. (2016). Analysis of Cost and Schedule Overrun in Construction Projects, *International Journal of Innovative Science, Engineering & Technology,* 3(1), 383-386.

Chan, A. P. & Chan, A. P. (2004). Key performance indicators for measuring construction success. *Benchmarking: An International Journal*, 11(2), 203-221.

Chen, L. & Luo, H. (2014). A BIM-based construction quality management model and its applications. *Automation in construction*, 46, 64-73.

Chingara, B. & Moyo, T. (2014). Factors affecting labour productivity on building projects in Zimbabwe. *International Journal of Architecture, Engineering and Construction,* 3(1), 57-65.

Choudhury, I. (2009). The effect of political unrest on construction time for food grain warehouses in Bangladesh. *Construction Management and Economics*, 27(7), 619-624.

Coka, E. (2013). Construction sector productivity needs closer scrutiny to unlock its vast growth potential productivity SA.

Construction Industry Development Board (CIDB). (2012). The construction industry indicator summary results. Pretoria: CIDB, 1-10.

Cottle, E. (2014). Bargaining indicators, twenty years – A labour perspectives twenty years of transformation of the construction sector in South Africa since the end of Apartheid, labour research service, 139-150.

Dane, F. C. (2011). Evaluating research – methodology for people who need to read research, Sage publication ltd, Boston, United State.

Dai, J., Goodrum, P. M. & Maloney, W. F. (2009). Construction craft workers' perceptions of the factors affecting their productivity. *Journal of Construction Engineering and Management*, 135(3), 217-226.

Delgado-Hernandez, D. J., Bampton, K. E. & Aspinwall, E. (2007). Quality function deployment in construction. *Construction Management and Economics*, 25(6), 597-609.

Doloi, H., Sawhney, A., Iyer, K. C. & Rentala, S. (2012). Analyzing factors affecting delays in Indian construction projects. *International Journal of Project Management*, 30(4), 479-489.

Dudek-Burlikowska, M. (2011). Application of estimation method of customer's satisfaction in enterprise focused on quality. *Journal of Achievements in Materials and Manufacturing Engineering*, 47(1), 83-96.

Enshassi, A., Arain, F. & Al-Raee, S. (2010). Causes of variation orders in construction projects in the Gaza Strip. *Journal of Civil Engineering and Management*, 16(4), 540-551.

Forsythe, P. (2015). Monitoring customer perceived service quality and satisfaction during the construction process. *Construction Economics and Building*, 15(1), 19-42.

Hossain, M. A. & Chua, D. K. H. (2014). Overlapping design and construction activities and an optimization approach to minimize rework. *International Journal of Project Management*, 32(6), 983-994.

Hogg, R. & Tannis, E. (2009). Probability and statistical inferences. 8th ed. Upper Saddle River (NJ): *Prentice Hall*, New York, United States.

Iyer, K. C. & Jha, K. N. (2005). Factors affecting cost performance: evidence from Indian construction projects. *International Journal of Project Management*, 23(4), 283-295.

Jarkas, A. M. (2015). Factors influencing labour productivity in Bahrain's construction industry. *International Journal of Construction Management*, 15(1), 94-108.

Josephson, P. E. & Chao, M. (2014). Use and non-use of time in construction of new multi-dwelling buildings in Sweden. *International Journal of Construction Management*, 14(1), 28-35.

Kaliba, C., Muya, M. & Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*, 27(5), 522-531.

Kazaz, A., Manisali, E. & Ulubeyli, S. (2008). Effect of basic motivational factors on construction workforce productivity in Turkey. *Journal of Civil Engineering and Management*, 14(2), 95-106.

Khoshgoftar, M., Bakar, A. H. A. & Osman, O. (2010). Causes of delays in Iranian construction projects. *International Journal of Construction Management*, 10(2), 53-69.

Kukoyi, P. O., Osuizugbo, I. C., Yohanna, H. S., Edike, U. E. & Ohiseghame, I. E. (2020). Pre-Qualification of Selecting Construction Project Contractors Using Health and Safety Criteria. *Journal of Engineering, Project, and Production Management*, 1-7.

Kukoyi, P. O. & Smallwood, J. J. (2017). A qualitative study of Health and Safety (H&S) construction practices in Lagos. *Journal of Construction Business and Management*, 1(1), 1-7.

Loushine, T. W., Hoonakker, P. L., Carayon, P. & Smith, M. J. (2006). Quality and safety management in construction. *Total Quality Management and Business Excellence*, 17(9), 1171-1212.

Memon, A. H., Rahman, I. A., Abdullah, M. R. & Azis, A. A. A. (2011). Factors affecting construction cost in Mara large construction project: perspective of project management consultant. *International Journal of Sustainable Construction Engineering and Technology*, 1(2), 41-54.

Nasir, H., Ahmed, H., Haas, C. & Goodrum, P. M. (2014). An analysis of construction productivity differences between Canada and the United States. *Construction Management and Economics*, 32(6), 595-607.

Ng, S. T. & Zhang, Y. (2008). Optimizing construction time and cost using ant colony optimization approach. *Journal of construction engineering and management*, 134(9), 721-728.

Odesola, I. A. & Idoro, G. I. (2014). Influence of Labour-Related Factors on Construction Labour Productivity in the South-South Geo-Political Zone of Nigeria. *Journal of Construction in Developing Countries*, 19(1), 93-109.

Ofori, G., Hindle, R. & Hugo, F. (1996). Improving the construction industry of South Africa: a strategy. *Habitat International*, 20(2), 203-220.

Panas, A. & Pantouvakis, J. P. (2010). Evaluating research methodology in construction productivity studies. *The Built and Human Environment Review*, 3(1), 63-85.

Rane, N., Lopes, M. S., Raval, M. A., Rumao, M. D. & Thakur, M. P. (2017). Study of effects of labour productivity on construction projects. *International Journal of Engineering Sciences and Research Technology*, 6(6), 15-20.

Rivas, R. A., Borcherding, J. D., González, V. & Alarcón, L. F. (2011). Analysis of factors influencing productivity using craftsmen questionnaires: Case study in a Chilean construction company. *Journal of Construction Engineering and Management*, 137(4), 312-320.

SA, construction. (2013). Highlighting trends in the South African construction industry, Pwc 1st edition, 1-56.

SA, construction. (2015). Highlighting trends in the South African construction industry, Pwc 3st edition, 1-44.

Sambasivan, M. & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, 25(5), 517-526.

Sezer, A. A. & Brochner, J. (2014). The construction productivity debate and the measurement of service qualities. *Construction Management and Economics*, 32(6), 565-574.

Simpeh, F., Mohamed, Z. & Hartmann, A. (2014). Importance-performance analysis for modeling maintenance prioritization in higher institutions. *Journal of Construction Project Management and Innovation*, 4(2), 976-989.

Simpeh, F. & Shakantu, W. (2020). An on-campus university student accommodation model. *Journal of Facilities Management*, *Emerald Publishing Limited,* 1-17.

The construction sector. (2010). World cup building and wood workers international, campaign for decent work, 1-62.

Ugwu, O. O. & Haupt, T. C. (2007). Key performance indicators and assessment methods for infrastructure sustainability—a South African construction industry perspective. *Building and Environment*, 42(2), 665-680.

Windapo, A. O. & Cattell, K. (2013). The South African Construction Industry: Perceptions of Key Challenges Facing Its Performance, Development and Growth. *Journal of Construction in Developing Countries*, 18(2), 65.

Zimina, D., Ballard, G. & Pasquire, C. (2012). Target value design: using collaboration and a lean approach to reduce construction cost. *Construction Management and Economics*, 30(5), 383-398.