INFLUENCES OF TIME BUFFER USAGE IN THE CONSTRUCTION INDUSTRY

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One of the issues confronting the construction industry is the continuous inability to deliver construction projects to contract at agreed time. In view of this, various techniques and innovations have been introduced by concerned stakeholders in the quest of delivering projects to the satisfaction of clients and customers, and one of them is the adoption of time buffer. This study therefore examine various factors influencing the adoption of time buffer in construction projects with a view to promoting and maximizing the benefits of the practice in architecture, engineering and construction industry. From existing literature materials, 12 major factors influencing the usage of time buffer for construction projects were identified and adopted. Using purposive sampling, primary data were collected from architects, construction manager, quantity surveyors, engineers and project managers with emphasis on their knowledge and understanding of construction process and the concept of time buffer. Out of the 50 questionnaires administered to these professionals practicing in government, contracting, consulting and client establishment, 48 were completed and analysed accordingly. The most important factors influencing the adoption of time buffer in the South African construction are the availability of necessary equipment and tools as well as various work and jobsite conditions. Other factors include level of details of the design or adopted working method, type and strength of labour force as well as level of coordination, management and supervision of construction activities. It is therefore necessary that contractors make available necessary and adequate equipment, tools and machines while also ensuring favourable working conditions for employees, site workers and other individuals on the construction site. This study will be useful for construction educators, scholars, practitioners, professionals as well as bodies shouldered with the responsibilities of managing and regulating construction process and activities in the quest of adopting time butter to improve project performance.

Keywords: Buffering, Construction process, Project performance, Productivity.

INTRODUCTION

Construction projects have some type and amount of uncertainty as a result of the complex and intrinsic nature of the construction industry. This uncertainty are most likely to end up to variation in the project duties and tasks from what was originally scheduled. Subsequently, construction workers should adjust for the uncertainty by adding time by means of hours and days to get rid of variations in the work plan (Russell, et al., 2013). Time buffer is defined as the amount of time included in the task durations to compensate for uncertainty and to protect against variations (Miller

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et al., 2000). Variation can be described as any change to the works, which is instructed or approved as a variation under a section between the planned and actual task duration of the physical work whether quantity or quality required to be carried out under the contract (Russell et al., 2013).

Buffering is common practice in project planning, it protects the planned project schedule from uncertainty irrespective of how complex the construction process and project may be (Lee, et al., 2006). Ballard and Howell (1995) outlined such things as absence of multiple participants, constraining and standardization as factors that makes construction projects more difficult to complete their goal. However having to include this complexity is the high mark of interdependency intrinsic to the construction process. According to Poshdar et al. (2016), time buffer on construction project reduces the improbability caused by changes and errors particularly when a similar design of construction is applied to an infrastructure project, however buffering is an active tool used to protect the planned performance of construction projects. Lee, et al. (2006) stated that applying time buffer on construction projects will help to evaluate the time effectiveness and the amount of hidden errors, therefore latent changes will be reduced and the flexibly located time buffer will help to identify the errors and changes in parallel to the design and construction. This study examines the factors influencing the adoption and usage of time buffer in the construction industry with a view to promoting the application of the concept for improve project performance.

CONCEPT OF TIME BUFFER IN CONSTRUCTION

Ballard and Howell (1995) highlighted that the usual custom in construction projects is to add time buffer on each projects to ensure stability and reduce variability. Buffers in production such as deliberate delays, excess inventory and added capacity, are commonly utilised to protect against instability. Poshdar et al. (2016) stated that possibly and essentially, buffers cover the bases of instability that make them needed. However there are numerous types of buffers, but the emphasis and focus of this research study is the examination of administration of time buffer which can be extra hours or days added to individual construction project duties within the planned period by construction personnel to adjust for instability and probable variation. Furthermore, Russell et al. (2013) highlighted that addressing and understanding the foundation of time buffer will assist to assign them where they are needed most and therefore reduce project duration and cost of the project.

The effectiveness of buffer time in a construction project acts as a cushion that protect the planned project schedule from uncertainty, but there is no rule as to how much time should be added, and how to manage them (Rogalska and Hejducki, 2007). Therefore to estimate without hidden safety margins the following must be assumed; people have everything they need to perform a task; the task is completed without unforeseen problems; and work is focused on the task, without interruption or multi-tasking. Russell et al., (2014) noted buffer time can be most effective when the location of the buffer time is naturally at the beginning of the activity in the executing process, it is much more critical to give successor a reliable precedence than to worry about delays that still do not arise however in the executing phase, it means that the location of buffer time has to move from the end of the project in the contract buffer time to the front of each activity.

According to Wambeke, et al., (2010), variability in construction projects usually leads to schedule delays, cost overruns and productivity losses therefore, the use of buffer time is a common approach to handle variability and to protect production processes from its negative impact. Rogalska and Hejducki (2006) further elaborated that when projects are delayed, they are either accelerated or have their duration extended beyond the scheduled completion date and these are not without some cost consequences therefore the conventional approach to manage the extra cost is to include a percentage of the project cost as contingency in the pre-contract budget. Wambeke et al., (2011) also concluded that project size and its complexity have a huge effect when dealing with buffer time on projects because the time added on project task on a large project can mislead the planner by adding a smaller time that will be less than the expect time to finish the task and this will result a delay in a project.

Rogalska and Hejducki (2007) highlighted that the preparation of projects when time buffers are involved and the continuity of construction processes is most definitely maintained therefore the least time is adopted as the benchmark for selecting an organisational design. The following risk factors were also highlighted amongst numerous factors affecting the project buffer size; errors on design; weather change; equipment failures; disorganized contractors; irregular financing; administrative-legal disturbances; and disturbances in the supply of materials and equipment.

Yang (2007) stated that making use of linear scheduling with time buffer on construction projects speed up and fast track the project duration. Ryu et al. (2007) identifies that linear scheduling has its roots in the manufacturing industry while Russell et al. (2013) suggested that scheduling technique is particularly well suited for projects where the activities are of a similar nature. They are also suitable for types of construction projects that lend themselves to linear scheduling because of the physically horizontal type of project such as railroads, pipelines, highways, rather than vertical projects, even though some components and processes of high-rise buildings and even residential construction could be scheduled with linear scheduling methods due to the similar nature of some of those project components. Therefore, the main objective of linear scheduling is to help project managers better envisage time and space conflicts between activities.

FACTORS NECESSITATING THE USE OF TIME BUFFER

In the construction industry, buffers are used to accommodate variation and delays produced by the essential difficulty and uncertainty present in construction projects (Russell et al., 2013). Factors that have impact on construction productivity are equally imperative in a developed detailed list of factors for examination and inspection, however construction projects are complex actions, as nearly every single project is unique. Unforeseen consequences result from the interaction of multiple variables that can reduce project performance and the standard practice is to try to build as much buffer as possible into the duration of the project in consideration (Yang, 2007). The complex nature of construction is combined with the ever growing economic demand to deliver projects more speedily while decreasing costs, resulting in uncertainty as a characteristic component of construction (Russell et al., 2014). According to Lee et al. (2006), uncertainty here is a consequence of changeability, lack of assurance or reliability or doubt. Construction personnel involved with project planning have a natural tendency to compensate for the uncertainty in the construction

environment by adding buffer to project duration to absorb the resulting variations in the work plan. Influences of buffer time on construction projects are further explained in subsequent sub-sections.

Project characteristics

Project characteristics include such things as contract duration, size of project and complication of the project, that is, interdependency of activities. Hammad et al. (2011) also noted that project characteristics and complexity are basic factors that necessitate the use of time buffer because complexity of the task for a trade which can be a point of struggle or nature of the work in the project. It is the instability about characteristics specific to a project and a given skill (Poshdar et al., 2016).

Prerequisite works

These are tasks that must be accomplished before other activities. If there is an instability that the item permits, prerequisite work, or rework on a prerequisite task will not be finished on time, then contemplate the extent to which one's duration estimate is affected. This can also be thought of as confidence in the schedule or work plan (Poshdar et al., 2016).

Detailed design or working method

This is related to the concerns or doubt about having precise and obtainable design and a possible working technique to finish the required task (Poshdar et al., 2016). Furthermore, Russell et al., (2013) explained working method or detailed design as the quality of documents that indicates design errors and omissions in the project, different conditions on site and issues requiring additional time as the factor that necessitate the use of time buffer

Labour force

Poshdar et al. (2016) explained labour force as a factor that concerns or gives doubt about capability, availability and reliability of the labourers to complete the required job in the project. However, Yank (2007) stated that reliability of labour force becomes an issue only when labourers' absenteeism is too high, people arriving late and/or leaving early at work, lack of motivation, low confidence as well as language barrier among workforces and managers.

Equipment and tools

According to Poshdar et al., (2016), equipment and tools are the factors that necessitate the use of time buffer in construction industry because it is the concerns or uncertainty about the availability of the tools and equipment in the project and reliability in terms of whether the tools and equipment can be reliable to perform the task in the project. According to Russell et al., (2013), equipment and tools have the tendency to breakdown or wear out when they are old, hence a suggestion was made that a register of equipment and tools must be made for maintenance that will be done by the construction company owning the tools and equipment. Furthermore, time must be allocated to accommodate the repair of equipment if a breakdown occurs as well as time to change equipment if failure occurs.

Materials and components

According to Hopp and Spearman (2008), material and components are the factors that necessitate the use of time buffer because this factors concerns about getting the

correct and needed materials from service providers when and where you need them as well as receiving materials for task not later than scheduled. This can be said as trust or confidence in one's service provider. However, Poshdar et al. (2016) stated that getting or receiving incorrect quantity and quality of materials, receiving inappropriate material or receiving broken materials necessitate the use of time buffer in the project to avoid delays that can lead to extension of time from the original contract period.

Work or jobsite conditions

According to Poshdar et al. (2016), working condition is a factor that necessitate the use of time buffer due to fear of the physical space available to accomplish one's duty and overcrowded or disorderly work area which is usually delay progress of construction projects. Therefore, Omran et al. (2011) stated that difficult access to work area delays the project and suggested the ways which material transfer on site is required from receiving area to task location is through the crane, construction elevator or hand carry, therefore the space of material transfer required from getting site area to undertake a duty must be permissible.

Management, supervision and information flow

Omran et al. (2011) highlighted management and supervision as factors that necessitate the use of time buffer, they are concerns about the supervision system issues related in getting questions answered when they arise, they can include such issues as changes, trust, and communication,. However, Russelle et al. (2013) stated that preparing for duration negotiation with management with the knowledge that will request the task to be done in shorter time during the course of the project leads to buffer time and trust in supervisor which is based on their reputation, knowledge, and experience you have had with them and lastly the changes in scope of work by clients leads to buffer time.

Weather

According to Hopp and Spearman (2008), weather is the factor that necessitate the use of time buffer in the construction industry because it is the indecision about the climate at the site of the project and the predominant weather circumstances, such as wind, rain and temperature can cause the delay in the projects. Poshdar et al. (2016) highlighted that typical weather conditions such as temperature, rain, and wind associated with the location of the project necessitate the use of time buffer to compensate for the time lost during the bad weather which delayed the project duration as planned.

RESEARCH METHODOLOGY

A descriptive survey design and quantitative approach was adopted in the research thus, questionnaires were designed and distributed to appropriate respondents. This study was carried out in North West province, South Africa, targeting construction professionals that have been involved in not less than five construction projects and are presently involved in at least one of such. The respondents for the study included Engineers, Contractors, Quantity Surveyors, Architects, Construction Managers and Project Managers that are registered with their various professional bodies in the

country. They were classified into two categories, those practicing with clients, government and consultants in one group while professionals from the contracting firms formed the other group. Mean item score (MIS) and standard deviation (SD) were adopted in the analysis and ranking of various factors influencing time buffer in the construction industry.

FINDINGS AND DISCUSSION

Table 1 shows the importance of various factors that necessitate the use of time buffer in the construction industry. The respondents were grouped into two, the first include Government, client and consultants (GCC) while the other group are contractors. Therefore, the first factors that necessitate the use of time buffer are equipment and tools as well as work/jobsite conditions both with the MIS=4.65 and SD=9.90 (GCC with MIS=4.72 and SD=7.88 and the contractors with MIS= 4.57 and SD=2.12). The second important factor are detailed designs or working method with MIS of 4.52 and SD= 13.23, this is followed by labour force with MIS=4.46 and SD=2.83, management or supervision or information flow with MIS=4.44 and SD=4.24. The table further reveal other factors that necessitate the use of time buffer and they are as follows; material and components, weather, prerequisite work and size of project. The less important ones include such factors as work area access with MIS=4.10 and SD= 6.00, quality of documents was with MIS of 4.04 and SD=1.00 and project characteristics with MIS=4.00 and SD= 2.59.

According to the rankings (R), together with the calculated standard deviation (SD) and mean item score (MIS), it was found out that the most important factors that necessitate the use of time buffer in South African construction industry are Equipment and tools as well as work/jobsite condition which were ranked as the first factors that necessitate the use of time buffer. The combined MIS of both factors was 4.65 and SD=9.90. These findings are in agreement with the study of Poshdar et al., (2016) where project characteristics, prerequisite work and Work condition were the major factors that necessitate the use of time buffer on construction projects. However, the study of Wambeke et al. (2011) as well as that of Rogalska and Hejducki (2007) identified project complexity as the first major factor that necessitate the use of time buffer in the construction industry followed by quality of documents, weather and size of project. In addition, Russel et al. (2013) highlighted that the most important factor is communication and labour force capabilities because the individual causes loaded on this factor pertained to either the labour force in terms of the reliability, availability and skill morale as well as communication between construction personnel in the project. But these were not the case of the South African Construction Industry. The findings implies that these factors have positive impact in necessitating the use of time buffer in order for a project to be delivered and handed over on the scheduled date.

Table 1: Factors that necessitate the use of time buffer

Factors	Overall			GCC		Contractor		MIS Gap
	MIS	SD	R	MIS	SD	MIS	SD	
Equipment and tools	4.65	9.90	1	4.72	7.78	4.57	2.12	0.15
Work/jobsite conditions	4.65	9.90	1	4.72	7.78	4.57	2.12	0.15
Detailed design or working method	4.52	1.33	2	4.42	6.08	4.58	7.15	0.16
Labour force	4.46	2.83	3	4.35	0.83	4.56	2.00	0.21
Management/supervision/information flow	4.44	4.24	4	4.48	0.70	4.39	3.54	0.09

Material and components	4.33	1.13	5	4.36	4.95	4.30	6.36	0.06
Weather	4.31	1.04	6	4.33	6.00	4.29	4.44	0.11
Prerequisite work	4.21	1.47	7	4.24	5.00	4.19	9.85	0.05
Size of Project	4.13	3.00	8	4.07	1.00	4.19	2.00	0.12
Work Area Access	4.10	6.00	9	4.08	3.51	4.13	3.85	0.05
Quality of Documents	4.04	1.00	10	4.11	0.6	3.95	0.40	0.16
Project Characteristics	4.00	2.59	11	3.97	2.16	4.11	4.36	0.14

GCC=Government, Client & Consultant, MIS=Mean Item Score, SD=Standard Deviation, R=Rank

CONCLUSION AND RECOMMENDATION

Existing literature materials indicated a number of factors that necessitate the use of time buffer and they include such things as project characteristics, detailed design or working method, labour force, equipment and tools, materials and components, weather and size of projects. From the findings of the survey from this study, project characteristics, prerequisite work, detailed design or working method, labour force, equipment and tools, material and components, work or jobsite conditions were the major factors that necessitate the use of time buffer in the study area. Therefore, it can be concluded that the project characteristics, prerequisite and detailed design of the projects are major factors that necessitate the use of time buffer. In view of this, construction projects should be adequately planned and scheduled according to the given duration. More so, material, equipment, labour force and human resources should be available when required and to the correct specification and quantity. Risk management must be conducted to ensure the successful implementation of a construction project, as risk can lead to delays and cost overruns. Further research should be conducted on how to identify and formulate the location of time buffer on individual projects, to allow for better benchmarking and progress measurement, resulting in improved project delivery.

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