



Re-imagining the Factors Influencing the Choice of Project Management Tools and Techniques in Tanzanian Infrastructure Projects: Elicitation of Practitioners' Perspectives

¹Nyamagere Gladys Sospeter, ²Anthony Chang'ah and ³Pantaleo Rwelamila

^{1&2}School of Architecture, Construction Economics and Management, Ardhi University, Dar es Salaam, Tanzania.

³Graduate School of Business Leadership, University of South Africa, South Africa.

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Abstract

Construction project Management tools and techniques (CPMTT) are vital for the success of construction projects. Nonetheless, there is a paucity of studies that examined the factors influencing the choice of CPMTT in developing countries, particularly, Tanzania. The objective of the study was to analyze the factors influencing the choice of CPMTT in Tanzanian public infrastructure projects, with the aim to fill the knowledge gap. The study was descriptive in nature and employed a mixed method approach. Using purposive and snowball sampling techniques, data was collected from 60 out of 70 Project management practitioners including Consultants and project Coordinators within Dar-es-salaam Metropolitan Development Projects (DMDP) and similar infrastructure projects. Fifty valid responses were received equivalent to 83% response rate and interviews were done. Quantitative data from respondents was analyzed using IBM SPSS v25. Directed content analysis method was employed for qualitative data from 10 Resident Engineers to supplement the quantitative results. Using factor analysis, four groups of organization support, ease of access and usefulness of tools, fulfillment of project objectives, and project environment and idea generation were determined to influence the choice of CPMTT. Project managers frequently chose tools which could be easily accessible without considering organization project objectives as well as resource commitment. The findings could be used as a guide for project practitioners to critically assess the areas of weakness and select CPMTT that help to address those weaknesses hence improve project delivery in Tanzania, un-explored context. Project managers are called to re-imagine project needs based on priority and select the CPMTT that satisfy the needs based on experience, skills and project objectives as crucial factors in selection of CPMTT rather than using their discretion. This would improve delivery of infrastructure projects hence performance outcomes in the construction sector in Tanzania and other emerging countries. This study was limited to DMDP public infrastructure projects in Tanzania.

Keywords: Construction Project Management Tools and Techniques (CPMTT), Decision analysis, mixed-methods, Tanzania

1. Introduction

Globally, the selection of construction project management tools and techniques (CPMTT) to achieve desired quality and time of the key project stakeholders is becoming increasingly crucial as projects are becoming progressively larger and more complex (Sospeter et al., 2022; Mtanga & Rwelamila, 2019). According to a Chinese Proverb, "to do good work, one must first have good tools." It is also true for project managers, who if they want to deliver good project results, must first have good CPMTT (Milosevic, 2004). Researchers globally acknowledge the relationship of CPMTT with project success (Thawatchai et al., 2019; Dorskocil, 2015). Despite the contribution and advancements in CPMTT,

project success in the workplace has not improved significantly. Due to projects uniqueness and differences in contexts, CPM frameworks are not generic, they are specifically designed to introduce project management methodologies and tools that ensure the completion of a specific project. The selection and use of CPMTT in achieving the desired project objectives is dependent on crucial factors such as which specific tool is to be used, when is to be chosen and how they are selected. Research studies mention the main risks in executing projects in developing countries as; lack of construction CPM skills and improper selection and use of project tools and techniques (Ogbonna et al., 2018; Al Rawi et al., 2021).

¹ Corresponding Author

Email address: nyamagere@yahoo.com

Inappropriate selection and use of CPMTT has been attributed to cause numerous challenges in projects from disruption of project schedules thus impacting the project performance and delivery (Kikwasi and Escalante, 2020; Chemuturi, 2013; Nguyen, 2020). This is evident as infrastructure development projects have been plagued by project stalling, cost overruns and premature deterioration prior to end-of-life cycle, worse abandoned and unfinished requiring huge amount of money and time to revive (Kikwasi, 2013; Mallewo, 2014). With the increase in the size of projects as a result of greater infrastructure demands for socio-economic development, project managers require appropriate choice and use of CPMTT at each stage as they facilitate enhanced project planning, monitoring, and, control over the various project phases from design, construction, operation to decommissioning. At a conceptual phase, tools used include; WBS, Scope statement, Gantt chart, CPM, PERT, decision tree and analytical tools to assist in project selection, at project planning phase tools include: cost estimating and resource list for cost planning and cost-benefit analysis while EVM, change request, progress reports and inspections are commonly used at execution phase. Milestone chart has been referenced as crucial for any schedule driven objective organization in successful time management of a project (Milosevic et al. 2010; Petro, 2016). The construction industry is at the forefront as it converts resources into physical assets including the much needed physical infrastructure. This has been partly attributed to the failure in proper choice of CPMTT as per project phases.

The Tanzanian construction industry with specific reference to infrastructure projects has emerged to be a major sector for economic growth (Kikwasi and Sospeter, 2023). The United Republic of Tanzania (URT) (2022) reveals the construction sector growth of 4.3% from 14.1% in 2020 which results from ongoing construction works including construction and rehabilitation of roads, bridges and airports as part of DMDP projects. DMDP is a multi-facet infrastructure project within Dar es Salaam metropolitan area, whose main goal is to increase urban services and institutional capacity. The projects main focus was in infrastructure improvements and construction for priority roads including local and feeder roads to reduce congestion, and facilitate public transit and connectivity to low-income communities (World Bank, 2021).

While construction works differ in context, complexity, construction method and nature, DMDP projects come with a new direction of civil works which present the need for an advanced technology in terms of technical and its management. Despite the immense contribution of CPMTT to project success, there is limited empirical studies on the factors influencing the choice of CPMTT in infrastructure projects. With ever increasing new CPMTT as a result of fast development of the project management practice in developed nations, the variability in awareness of what tools project managers in developing countries actually apply and their perceived factors influencing their choices in realizing the iron triangle objectives of cost, time and quality is still a question.

Numerous factors driving selection and application of PMTT have been identified in developed nations in various sectors of economy including IT, business, manufacturing, and construction. For example, it was concluded that, the use of modelling tools and techniques in the area of project management is not widespread in practice (Dorskocil, 2015); stakeholders' engagement, knowledge and skills set are critical success factors affecting project performance (Thawatchai et al., 2019), guidelines of using PMTT to mitigate delays (Alotabi et al., 2016). Furthermore, most of these studies have focused on the use of PMTT in building projects. Studies by Ismael et al. (2019) and Pellerin et al. (2018) have categorised factors affecting the choice and use of PMTT as internal and external factors. Each study adds up new factors depending on their contexts. They have focused on the development projects generally and others on the aftermath of PMTT application as a reactive approach to address project delivery issues. However, the uniform application of PMTT to all projects at all times has been highlighted by authors as a problem since each project is a unique endeavor, with its own constraints and limitations. Kerzner (2000) argued that lack of focus on the application of project management and project managers' discretion is among weaknesses in selection and use of CPMTT. Since project delivery fairly depends on appropriate choice of CPMTT and that government policies influence project practitioner's execution of infrastructure projects, they can only best apply CPMTT when critical factors are clearly understood and considered. It was therefore important to analyze the various factors influencing the choice of CPMTT in public infrastructure projects so as to improve project performance and delivery within the Tanzanian context.

2. Literature review

2.1 Project management in the construction industry

Project management tools and techniques have been described as a way to project success (Milosevic 2001; Sospeter and Awuzie, 2023). The Tanzania construction industry generated USD 6.7 billion in the year 2018 approximately 14% of the GDP compared to USD 4 billion in the year 2014, representing an increase of 68% (Tanzania Invest, 2023). According to Petro (2016) the number of project management tools exceeds 70 by far since the publication of the first few editions of the project management book of knowledge (PMBOK) Guide and numerous tools are developed and used as time goes. Henceforth, there was a need for adequate literature review to identify and include the most relevant tools for investigation based on previous studies. Time management tools selected for the study such as and not limited to Gantt charts, Bar charts and were drawn from literal sources notably Milosevic et al., (2010); PMI (2013) and Besner et al. (2008). Cost management tools such as cost estimating techniques, earned value management, cost change control system and performance measurement Petro (2016) and Fortune et al. (2011). Quality management tools such as Pareto diagram and control charts were drawn from a study by Besner et al. (2008). For the purpose of this study, the investigated

tools and techniques used in Time, cost and quality management of a project were evaluated as the most relevant and commonly used tools associated with construction project success. Various factors such as; size and duration of the project (Al Rawi et al., 2021; Thawatchai et al., 2019), the construction method, the nature of the project, the ability and knowledge of the Project Manager, involvement of stakeholders (Ponnappa, 2014), availability and accessibility of the appropriate tools (Sospeter et al., 2020) acknowledged as factors affecting CPMTT.

2.2 Factors affecting selection of Construction Project management tools and techniques

Factors influencing selection of PMTT have been identified by researchers. These factors are identified internal and external factors. Internal factors include; the type of project and the phase of the project lifecycle (PMI, 2013; Besner et al., 2008; Love et al., 2005), concept of success and strategic importance of the project (Dvir et al., 2004; Memon and Mohammed, 2011), level of experience of the project team (Besner et al., 2004; Petro, 2016; Ayodele et al., 2015; Milosevic et al., 2010), the implementing organization (Xuana et al., 2021; Besner et al., 2008; Milosevic et al., 2010), the number of project stakeholders and their involvement (Diallo et al., 2005; Ponnappa, 2014), and the nature of project tools in the business or industry sector (Milosevic et al., 2001; Kerzner, 2000). Whereas, external environment factors include; political intervention (Ika et al., 2011, 2012; Akande et al., 2018; Nyangwara et al., 2015) and the technological and managerial capabilities have also been among the notable factors (Ofori, 2000; Xuana et al., 2021). Most of these studies are not specific to CPM Studies as have been carried out all around the world (Xuana et al., 2021; Al Rawi et al., 2021; Sospeter et al., 2020; Thawatchai et al., 2019 and Ponnappa 2014).

Numerous authors have endeavored to elaborate on the subject of PM tools and techniques application. For instance, Milosevic et al., (2010) argued that practitioners need to pay closer attention on which tools to use depending on the project phase cycle. The author emphasized that construction project management is directly related to project life cycle phases with each phase requiring unique and specific tools and techniques of implementation (PMI, 2013; Dvir et al., 1998; Besner et al., 2004). The experience of the project manager is also a key issue in effective application of PM tools and techniques. Proponents of this argument (Besner et al., 2004; Petro, 2016; Ayodele et al., 2015; Milosevic et al., 2010) stressed that experienced project managers have been observed to use project management tools at a higher frequency than inexperienced project managers. The nature of the tool has also been exposed as a defining factor in the application of PM tools, in their study of PM tools practice across UK, Australia, and Canada, (Fortune et al., 2011) concluded that the use of bar charts, Gantt charts is substantially higher across projects due to their simplicity nature. (Besner et al., 2004; Ika et al., 2011) had similar conclusion that the lack of specific training

and resource support influenced many practitioners to use simple traditional methods in managing projects.

Stakeholders' involvement has been highlighted by (Diallo et al., 2005; Ponnappa, 2014) to influence the use of PM tools and techniques as a result of contradicting interest of stakeholders involved in development projects. Not only that, the effects of involvement of stakeholders especially in development projects in developing nations can be exacerbated by the state of political environment (Ika et al., 2012; Akande et al., 2018; Nyangwara et al., 2015). Stakeholders in the Australian construction project sector have a crucial role to play in cost management and their failure to execute their responsibilities adds to the chronic problem of cost overruns (Doloi, 2013). According to Ika et al. (2011) considering the fact that many tools such Gantt chart are rationally and efficiency-driven and that NPCs have to cope with political and social demands on project resources which can significantly hinder the project management. Nature of the organization influenced the selection and use of project management tools through the governance and decision making process (Prieto, 2017). Research studies undertaken by Xuana et al. (2021), Milosevic et al. (2010) and Besner et al. (2004) concluded that practitioners require the support of the organization in the selection and use of PMTT especially tools which require significant resource commitment and training. Table 1 summarizes factors influencing selection and application of CPMTT across the world.

Despite the available literature mainly focusing on PM tools application in various developed nations, where the context is different, procurement systems and even construction methods are different from the developing countries, none of them highlighted the criticality by analyzing the factors influencing the choice of CPM tools and techniques. For example, in the context of the Tanzanian industry, Mallewo (2014) expounded on the concept of Project management practice in building projects in Tanzania, the study significantly highlighted the planning, coordination and execution aspects of Project management using findings from questionnaire survey. Nonetheless, the study was limited as it did not explore the various project management tools and relevant factors influencing their selection and application. Similarly, Kikwasi (2013) elaborated on the various causes of project disruption and delays in Tanzanian construction projects. Among the findings, the poor application of project management was stated. The study was rather limited as it did not elaborate the factors leading to poor application of project management tools. Henceforth, it is important for this study to analyze the various factors that influence the choice of CPM tools and techniques in the unexplored developing context such as Tanzania industry.

3. Methodology

3.1 Research design, population and sample size

A cross-sectional research design attempts to gather information from practitioners on factors influencing the choice of CPMTT.

Table 1: Factors influencing selection and application of PMTT

S/No.	Factors influencing selection and application of CPMTT	Author/s
1.	Nature of the tool and easily accessible	Fortune <i>et al.</i> , 2011; Ponnappa, 2014
2.	Easy to use	Milosevic <i>et al.</i> 2010; Love 2005
3.	Organization provision of training	Diallo <i>et al.</i> , 2005; Prieto, 2017
4.	Organization provision of resource commitment	Besner <i>et al.</i> , 2008; Diallo <i>et al.</i> , 2005
5.	The tool commonly used	Besner <i>et al.</i> , 2008 ; Fortune <i>et al.</i> , 2011
6.	Number of people in the project	Milosevic <i>et al.</i> (2010); Ssenyange and Kudakwashe (2023)
7.	Stakeholders engagement	Doloi, 2013; Akande <i>et al.</i> , 2018
8.	External environment	Ika <i>et al.</i> , 2011; Akande <i>et al.</i> , 2018
9.	Nature of organization in training	Ismael <i>et al.</i> , 2019; Al Rawi <i>et al.</i> , 2021)
10.	Number of activities in a project	Garland, 2009; Nyangwara <i>et al.</i> , 2015
11.	Organization norm in use of specific tools	Xuana <i>et al.</i> , 2021; Ponnappa, 2014
12.	Organization provision of resources	Xuana <i>et al.</i> , 2021; Al Rawi <i>et al.</i> , 2021)
13.	Organization provision of guidance	Xuana <i>et al.</i> , 2021; Prieto 2017
14.	Use of tool based on availability	Besner <i>et al.</i> , 2008 ; Fortune <i>et al.</i> , 2011
15.	To assist in planning a project	Akande <i>et al.</i> , 2018; Sospeter <i>et al.</i> , 2020
16.	To assist in execution and controlling	Besner <i>et al.</i> , 2008 ; Fortune <i>et al.</i> , 2011
17.	Use of tool to complete project within budget	Ismael <i>et al.</i> , 2019; Ayodele <i>et al.</i> , 2015
18.	Use of tool to complete project within quality	Ayodele <i>et al.</i> , 2015
19.	Closure and orderly ending of a project	Besner <i>et al.</i> , 2004; Al Rawi <i>et al.</i> , 2021)
20.	Use of tool based on usefulness	Ismael <i>et al.</i> , 2019; Sospeter <i>et al.</i> , 2020
21.	Use of tool based on familiarity of past project	Fortune <i>et al.</i> , 2011
22.	Monetary value of the project	Ponnappa, 2014
23.	Use of tool based on education and training	Ponnappa, 2014; Ika <i>et al.</i> , 2011
24.	To assist in idea generation and inception of the project	Sospeter <i>et al.</i> , 2020; Al Rawi <i>et al.</i> , 2021

Descriptive survey research design using the sequential explanatory mixed research approach was adopted (Rowley, 2014; Saunders et al., 2016). This approach was used as it provides the quantitative advantage of analyzing the factors while generating more detailed information from the interviewee views on several attitudinal aspects from a qualitative approach (Yin, 2018; Kothari, 2014). Henceforth, the case study for the DMDP projects employing a mixed method was expected to provide a more in-depth description on the numerous factors in the context of Tanzanian public projects and the perception of stakeholders' role on the factors as observed by practitioners. Since there was no official list of practitioners involved in infrastructure projects, the population size could not be easily determined. The study population was composed of two groups, the first

population included the project managers and project coordinators within the Dar es Salaam Metropolitan Development Project. The second intended population involved managers with experience in infrastructure projects. The study targeted 10 respondents for interview and 60 respondents from DMDP public infrastructure projects which were completed or ongoing at the time of the study. Due to a small population size, the overall population of 60 practitioners was used as a sample. In the project management study, Ismael and Pardon (2019) stated that total population sampling is a type of purposive sampling technique whereby the overall population is used as a sample because the population is small and manageable. This is done to increase response rates from the population and to obtain conclusive results.

3.2 Sampling techniques and sample size

Purposive sampling technique was employed in order to obtain valid and relevant information for the study (Saunders et al., 2016). The basis for selection of a respondent was due to the qualities the respondent possesses and the ability to provide relevant information (Yin, 2018). This method was crucial for the research to study sample of population with certain knowledge pertaining to the research. Snowballing sampling approach was used where suggestions of the most relevant people to participate in the study was through chain referral from DMDP project practitioners. According to DMDP, there are three municipalities of Kinondoni, Ilala and Temeke undertaking the DMDP projects with various work packages. Therefore, the DMDP participants in project management were the main focus of the study. Furthermore, since the study aimed at infrastructure public projects, the rationale for choosing respondents from such projects for the study was to obtain the most relevant data pertaining to the study objective. The interview and questionnaire data were collected from Dar es Salaam region whereby the DMDP project is being executed. This allowed to get first-hand information directly from practitioners in the project through face to face interviews. Furthermore, the region as the financial and economic capital of Tanzania has been a focal point of rapid infrastructural projects thus respondents with experience in role of project managers are highly concentrated in the region.

Data Collection was through questionnaire survey administered as the first step in the sequential explanatory approach to obtain descriptive data from respondents. The sample selected for the interviews was a total of 10 participants. The interview was administered to the three Chief Resident Engineers and seven assistant resident Engineers from DMDP. The selected members were relevant to the study since they are directly linked/involved in the management of the DMDP projects which is the focus case study of this research (Rowley, 2018). The involvement of project managers to the project was the main criteria in selecting the sample size for the interviews. According to Patton (2002) and Yin (2018) meaningful qualitative research using interviews is adequate between the thresholds of 5-50 interviews in relation to the specified study, hence the chosen sample is adequate. A similar sample size of 10 interviews was used by Ssenyange and Kudakwashe (2023) in their study on identification of project management practices in Tanzanian PPP building projects.

3.3 Data collection and questionnaire

A literature search was conducted in order to uncover the knowledge and identify factors influencing selection and application of CPMTT (Xuana et al., 2021; Al Rawi et al., 2021; Sospeter et al., 2020; Thawatchai et al., 2019 and Ponnappa 2014; Nguyen et al., 2016 and Ayodele et al., 2015). The information obtained from the reviewed studies related to the current study, guided the design of the structured questionnaire (Saunders et al., 2016). The questionnaire as a data collection instrument was

developed to assess the factors influencing selection and application of CPMTT in Tanzania's public infrastructure projects. In total, 24 factors were extracted from literature of various countries and as illustrated in Table 1 formed the basis of the questionnaire design. The main reason for using previous factors is to provide an opportunity of comparing the findings with those from other studies (Sospeter, 2023). The 24 factors were listed and sent to 60 project management practitioners to rank those which are relevant to be adopted for the study.

The questionnaire was divided into two distinct sections: (1) Section 1 composed of the general demographic information on participating practitioner such as gender, educational background, and project management experience. To enable comparability of the information, the questions were arranged uniformly with prepared categories with various options for practitioner's selection. (2) Section 2 comprised of the rating and ranking of the 24 factors influencing the selection of construction project management tools and techniques. The questionnaire composed active and attribute variables. Twenty-four factors extracted from the literature formed a list of factors in the questionnaire for respondents to rate using active variables with the weighting of 5 for Most Agreed (MA), 4= Agreed (A); 3= Moderate (M); 2= Disagreed (DA); 1= Most Disagreed (MD).

Questionnaires were administered physically through face-to-face and 50 valid responses were received equivalent to 83% response rate as indicated in Table 2. Quantitative data collected from the questionnaire was coded, amended and analyzed by using IBM Statistical Package for Social Sciences (SPSS) version 25 and factor analysis was used to categorize the factors influencing selection and application of CPMTT into smaller groups or set of variables (factors) as suggested by Akande et al., (2018). Directed content analysis was used to analyze audio and written records from interviews in correlation with literature to attain comprehensive results. The method was suitable for the study as it helped to compare and contrast the compiled data resulting from interviews with concepts and theories from previous studies.

4.0 Data presentation and Analysis

4.1 Respondents response rate

From the 60 questionnaires administered to respondents in capacity of project manager and 10 to Resident Engineers and Assistant Engineers in similar infrastructure projects, 40 questionnaires from Project Managers and 10 from the Engineers were returned equivalent to 83% of total response as indicated in Table 2. In the second step, Oral interview was conducted with DMDP project respondents composed of Resident engineers, Assistant resident engineers and project coordinators (PIU), a total of 10 interviews were successfully conducted in a period of 7 weeks.

4.2 Profile of respondents

Table 3 provides the profile of the questionnaire respondents, while Table 4 provides the interviewee's

profile according to the following individual attributes: Interviewees position as held, education and experience levels. The experience and education level of practitioners is an important factor in ascertaining the reliability of their response in relationship to Project management practice and specifically tools application. Examination of Table 3 shows that majority respondents had a strong education background, varying ranges of experience and designation backgrounds. Education-wise, the majority (64%) of the respondents had a Bachelor degree. While the remaining 36% have a Master's degree which is much higher than the first degree, implying that respondents

have adequate educational background. Generally, 58% of respondents have experience of over 10 years, 22% have experience of between 6 to 10 years, whereas only 20% have experience of 1 to 5 years in the construction industry. Furthermore, respondents indicated to be well experienced in terms of the roles and responsibilities relating to their individual current positions with 38% stating to have an experience of more than ten years in the role of project manager. 32% of respondents have between 6 and 10 years of experience in project management roles.

Table 2: Distribution and attained Questionnaire responses

Respondents	Distributed	Returned	Percentage of success
Resident Engineer (DMDP)	3	3	100%
Assistant Resident Engineer (DMDP)	7	7	100%
Project managers in DMDP and similar projects	50	40	80%
Total (respondents outside DMDP)	60	50	83%

In addition, only 30% have an experience of below 5 years in the role of project manager. Furthermore, 67% of Project coordinators in the DMDP equivalent to 2 out of 3 from PIU have experience of 1 to 5 years in their role of project coordination, whereas 33% equivalent to 1 out of 3 has experience of 6 to 10 years. These results indicate the practitioners are well experienced in their individual roles and associated issues that come with the roles thus viable respondents for the study. The composition of

respondents was divided into foreign and local practitioners firm whereby 14% of respondents were foreign firms while 86% were local practitioners. The presence of foreign practitioners' firm in the respondents' composition indicate the potential of the findings to compare and contrast the practical application of project management tools and techniques between the foreign and local practitioners.

Table 3: Profile of questionnaire respondents

Variables	Categories	Frequencies	Percentages
Experience in the Construction industry	Less than 5 years	10	20%
	6-10 years	11	22%
	Over 10 years	29	58%
	Total	50	100%
Experience in position of Project manager	Less than 5 years	15	30%
	6-10 years	16	32%
	Over 10 years	19	38%
	Total	50	100%
Educational qualification	Diploma	0	0%
	Bachelor's degree	32	64%
	Master's degree	18	36%
	Ph.D	0	0%
Total	13	100%	
Professional background	Civil engineer	35	70%
	Quantity surveyor	9	18%
	Construction Manager	4	8%
	Architect	2	4%
	Civil technician	0	0%
Total	50	100%	
Nature of firm	Local	43	86%
	Foreign	7	14%
	Total	50	100%

Table 4: Profile of interviewees

Interviewee	Designation of Respondents	Nationality Status	General experience	Experience in current position	Education level
A	ARE-Temeke	Local	Over 10 yrs	6 to 10 years	Master's
B	RE-Kinondoni	Local	over 10 yrs	over 10 years	Master's
C	ARE-Kinondoni	Local	Over 10 yrs	6 to 10 years	Bachelor
D	ARE-Ilala	Local	Over 10 yrs	Over 10	Bachelor
E	PIU-Kinondoni	Local	Over 10 yrs	6-10 years	Master's
F	ARE-Ilala	Local	Over 10 yrs	6-10 years	Master's
G	ARE-Temeke	Local	Over 10yrs	Over 10 years	Bachelor
H	RE-Temeke	Foreign	Over 10 yrs	Over 10 years	Master's
I	ARE-Temeke	Local	Over 10 yrs	Over 10 years	Master's
J	ARE-Kinondoni	Local	Over 10 yrs	1-5 years	Bachelor
K	PIU-Temeke	Local	Over 10 yrs	1-5 years	Master's
L	PIU-Ilala	Local	Over 10 yrs	1-5 years	Bachelor
M	RE-Ilala	Foreign	Over 10 yrs	Over 10 years	Master's

Key: RE: Resident engineer. ARE: Assistant Resident engineer. PIU: Project Implementation Unite coordinator

4.4 Results of Factor Analysis – Components 1 to 4

Table 5 presents result on factor analysis. Rotated component matrix of all combined components is

84.106% which is above 50%. The higher the variance in percentage the higher the influencing factor.

Table 5: Results of Factor Analysis

	Rotated Component Matrix ^a			
	1	2	3	4
Fulfillment of project objectives (37.454% Variance)				
Use of tools to complete projects with quality	.903			
To assist in the execution and controlling of the project	.903			
Use of tools to complete the project within budget	.903			
To assist in the planning of the project	.903			
Use of tools to complete project within time	.789			
The tool is easily accessible (i.e does not require substantial resources commitment)	.777			
The number of people in the project	.763			
The tool is traditional (i.e commonly used across projects)	.756			
Use of tool based on Education and training	.718			
To assist in closure and orderly ending of the project	.709			
Organization support (21.435% Variance)				
The tool is relatively easy to use (i.e does not require any particular training, skills or substantial inputs)		.871		
Organization provision of training on use of tool		.865		
Organizations provision of guidance/manual on use of tools		.848		
The involvement of stakeholders		.816		
Organizations provision of resources for ease access of tools		.783		
The monetary value of the project		.726		
Project environment and idea generation (15.394% Variance)				
The external environment aspects of the project (i.e political influence)			.812	
To assist in idea generation and inception of the project			.686	
The number of activities in a project			.684	
The duration of project			.674	
Ease of access and usefulness of tool (9.823% Variance)				
Organizations norm in use of specific tools and techniques				.579
Use of tools based on availability and ease of access				.732
Use of tools based on usefulness				.576
Extraction Method: Principal Component Analysis.				
Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 8 iterations.				

5. Discussion of the Factors influencing the choice of CPMTT

5.1 Fulfilment of Project Objective Factors

Component 1: fulfillment of project objective factor was determined to influence the choice of CPMTT in Tanzania public infrastructure projects as a category explained by 37.454% total variance based on the dataset in Table 5. The component has 10 items; Use of tools to complete the project within quality, to assist in execution and controlling of the project, Use of tools to complete the project within budget, to assist in the planning of the project, Use of tools to complete the project within time, the tool is easily accessible, the number of people in the project, the tool is commonly used across projects, use of tool based on education and training and to assist in closure and orderly ending of the project with factor loadings of 0.903, 0.903, 0.903, 0.903, 0.789, 0.777, 0.763, 0.756, 0.718 and 0.709) respectively.

Time, cost, and quality form an iron triangle of elements that have been appreciated by many researchers to contribute to project success (Dorskocil, 2015; Thawatchai et al., 2019). The use of tools to complete the project within quality, budget, and time is evidenced in literature as a factor influencing selection of CPMTT (Ismael et al., 2019; Fortune et al., 2011; Adoyele et al., 2015). The tools aim to assist in executing the project by speeding it up and enhancing project output. Assist in the planning of the project is a factor influencing the choice of CPMTT. Planning is an important aspect of that influence the choice of CPMTT because of fast-tracking features and is likely to be preferred.

5.2 Organization Support and Training Factors

Component 2: organization support and training was determined to influence the choice of CPMTT in Tanzania's public infrastructure projects as a category explained by 21.425% total variance based on the dataset. The component has 6 items: The tool is relatively easy to use (i.e does not require any particular training, skills, or substantial inputs), the Organization provides training on the use of the tool, the organization provision of guidance/policy/manual on the use of tools, the involvement of stakeholders, Organizations provision of resources for ease access of tools and the monetary value of the project with factor loadings of 0.871, 0.865, 0.848, 0.816, 0.783 and 0.726 respectively.

Organizations' provision of resources for ease of access to tools implies that project managers in organizations that have policies to foster project management tools for productivity tend to influence support in the accessibility and use of various project management tools. This includes software tools that tend to require financial support to acquire as a result of the high costs involved. Notable literature such as Besner et al. (2008) and Fortune et al. (2004) concluded with similar findings that resources required to access PM tools can greatly affect the ability and frequency of choosing the PM tools. Furthermore, Besner et al., (2008) established in their

investigation on PM practice that tools such as Gantt charts display a significantly higher use among practitioners because individuals can use such tools without any organizational investment or support. However, the use of database tools such as Monte Carlo simulation does require significant organizational resources and support. Interviewee G stated;

"The company needs to assist the project manager especially when using tools that do not come with the computer (Microsoft Office package). In our firm, we prefer to use Merlin for project scheduling hence we have office desktop computers for our engineers to use since the program is not readily available in other platforms."

The emergent implication of the finding is that project managers tend to frequently choose tools that can be easily accessible without significant resource commitment, especially when the company does not provide resources for ease of access. This fact complements findings from the survey whereby tools such as Microsoft Office project display a significantly higher use than others such as CCPM, Primavera, and Monet Carlo simulation. The reason behind this is that the former can be easily accessed as it comes in the Microsoft Office package compared to the latter tools which would require resource commitment in not only the purchase of the tools but also the provision of training in use.

Organization provision of training on the use of tools is identified in the literature as a factor influencing the choice of tools as similarly asserted in studies such as Xuana et al. (2021) and Fortune et al. (2011). Training includes a range of continuous development programs initiated by the firm or other professional organizations that assist project managers in not only the selection of compatible tools in line with project demands but also training and guidance for project managers in the appropriate application of various tools (Milosevic et al., 2010). Project management training offers lots of benefits and companies that are well-structured have taken advantage of this (Sospeter et al., 2022). For instance, in their study on the importance of project management training asserted that training tailored to the organization's goal contributed to the organization through the provision of an improved level of project risks and also offered resource control (Ponnappa, 2014). The significance of training is further noted as Al Rawi et al. (2021) opined that a well-organized and effective professional development program is one of the most important assets of a company, directly impacting its fruitfulness and long-term viability as a company.

Interviewee C stated:

"Yes, the organization provides support and training, but I have to show them why I need the tool and how it can help to accomplish my tasks because support in training or purchasing of these software involves costs incurred by the firm, they must see value for money."

The respondent further highlighted the process of how the organization supports and influences the use of tools as follows:

“The user will go to the management of the firm and tell them we think a certain software is useful for our project, then they will sit together to see if there is an alternative or if this is the best tool to be used. But it begins with the user knowing which tool he needs to accomplish his tasks to get the assistance (support) he needs from the firm management.”

The findings highlight the immense role of training in improving the performance of project managers specifically tool applications. Training is also significant in ensuring continuous improvement in the management process as practitioners have access to workshops and learning programmes. This leads to a better understanding and use of project management tools, catering to the construction environment.

Involvement of stakeholders

Involvement of stakeholders refers to the influence that various stakeholders have as a factor influencing the application of Project management tools. Ponnappa, (2014) argued that stakeholder management will also be a challenge when the organization has to adopt new tools and techniques. Due to differing interests, backgrounds, and experiences between stakeholders in a project, convincing each stakeholder of the relevance of certain tools and techniques can become a challenge. The findings of this study agree with those of Diallo et al. (2005), Ponnappa (2014), and Ocharo et al. (2018) which highlighted the influence of multiple stakeholders in development projects executed in developing nations, whereby the varying degree of interest between the NPC (National project coordinators), financier, technical advisors, and client can hinder the role of Project managers. According to the findings, the client has the major influence in the project management process, this extends from the conception stage about the term of reference and extends to the design and execution phase with the choice of tools.

Interviewee H stated that;

“I proposed to use PRIMAVERA during the first kick-off meeting to manage project progress but it was declined by the client due to the lack of awareness by the client and the Contractor. The client instructed that the Microsoft project is to be used.”

The aforementioned project manager who is a foreigner has an extensive background in project management in developed nations such as Korea and Saudi Arabia. From the practice, PRIMAVERA was the most widely used tool based on its extensive functions, nonetheless, the proposal to adopt the tool for management in the DMDP project was declined by the client. The implication of this is the Client has considerable influence on the manner of managing the project, hence a consensus between the client and project management team needs to be reached on the best set of tools for managing the project based not only on the client’s preference but the effectiveness of the tools.

Organizations' provision of guidance/policy/manual on the use of tools is noted in the literature as one of the factors influencing the application of CMPTT (Prieto, 2017). Organizations with policies and guidance ensure that practitioners in the firm are aware of the basic tools approved by the management to acquire the desired output in each task. In addition, the presence of policy and guidelines for project management tools application improves productivity as it creates uniformity in the application of tools among practitioners, reduces the erroneous application of tools among recruits, and provides a baseline of output expected from each operation. For instance, Alrajhi et al. (2020) in their study on the role of policy in project management in Saudi Arabia concluded that policy is important in project management because it not only protects the company through a proactive policy but also provides a framework that defines the rules of operation for the users of project management tools.

Interviewee B stated that;

“We have a company guideline (policy) that every recruit (employee) will be informed of during the first few months (probation period) showing the software tools we expect them to use and the formats required for doing their tasks. This helps us to have uniformity in our final output and also facilitates quick learning for the new staff.”

The finding implies that policy development is crucial for firms in ensuring recruits possess the required level of guidance in the choice of effective tools to produce the desired outputs in the management of the project.

5.3 Project environment and idea generation of the project factors

Component 3: The project environment and idea generation of the project factor was determined to influence the choice of CPMTT in Tanzania public infrastructure projects as a category explained by 15.394% total variance based on the dataset. The component has 4 items; the project environment, to assist in idea generation and inception of the project, the number of activities in a project, and the duration of the project with factor loadings of 0.812, 0.686, 0.684, and 0.674 respectively. Idea generation is a process used to generate options whether they are tangible or not hence a factor influencing the choice of CPMTT. It involves gathering ideas among various project teams before implementing the plan. Appropriate tools are needed to provide support, simplification, and consolidation of stakeholders' ideas towards the agreed plan of the project. An interviewee attested that “at the very early stage of the project, lots of ideas with more alternatives are expected to meet clients’ expectations”. The idea generation aids in informing project-related decisions (Dorskocil, 2015; Mtanga and Rwelamila, 2019). Therefore, the tools are used as decision support during the design stage as they encourage thinking, joint efforts, and generation of options around issues. While external environment factors always affect the project externally, it provides room for challenges in infrastructure project management as a result of differing socio-cultural backgrounds and practices (Kikwasi and Escalante, 2020; Diallo et al., 2005). In addition, the significantly different political

climate may influence the choice of CPMTT in Tanzania public projects compared to other developing nations such as Kenya and Nigeria where similar studies such as (Akande et al., 2018; Nyangwara and Datche 2015) have been conducted. The results imply that, the environment in which the project is in and the ability to assist in providing alternatives influence the choice of CPMTT.

5.4 Easy access and usefulness of tools factor

Component 4: easy access to tools and usefulness was determined to influence the choice of CPMTT in Tanzanian public infrastructure projects as a category explained by 9.832% total variance based on the dataset. The component has three items: use of tools based on availability and ease of access, organizations norm in use of specific tools and techniques, and use of tools based on usefulness with factor loadings of 0.732, 0.579, and 0.576 respectively. The tool is relatively easy to use and is among the factors influencing the choice of CPMTT as it does not require any particular training, skills, or substantial inputs. Tools' relative ease of use implies the inherent character of the project management tool to cater to various users, some with the most basic tool of operation (Mtanga and Rwelamila, 2019). This can be observed in the contrasting level of use between bar chart tools like Gantt charts and database tools such as Montecarlo. In the case of the former, both project managers and intended clients prefer the tool as it is simple to understand and use compared to the other work programming tools.

The results of the study are aligned with various studies on PM tools, notably (James 2003; Ogbonna et al., 2018). The authors stressed that project managers prefer to use tools that can be easily grasped and applied to produce desired output, but also provide easy presentation for understanding of other stakeholders. Ponnappa (2014) asserted in their findings regarding scheduling management tools that the Gantt chart provides easy and convenient monitoring of job progress and has become a veritable tool in representing project activities for easy assimilation by a wider audience. Xuana et al. (2021) similarly concluded that the Gantt chart is immediately intelligible to people with no knowledge of network diagrams. The results imply that the simplicity of the tools and the ease with which users can apply them to achieve desired deliverables is a crucial factor influencing the selection and use of a tool.

6. Conclusion and implications

The purpose of this research was to analyze factors influencing the choice of PM tools and techniques in

Tanzania's public infrastructure projects. Using factor analysis of the factors influencing the choice of CPMTT, four groups of organization support, ease of access and usefulness of tools, fulfillment of project objectives, and project environment and idea generation were determined. The results of the four groups obtained were highly influenced by: the use of tools to complete the project within quality, the use of tools to complete the project within budget, to assist in execution and controlling of the project, assisting in planning of the project (component 1), the tool is relatively easy to use, organization provision of training on use of tools, organization provision of guidance on use of tools, involvement of stakeholders (component 2), project environment, to assist in idea generation and inception of the project (component 3) and use of tools based on availability and ease of access (component 4).

The contribution of this study is through the synthesis of the 24 factors identified from the literature into groups of four components (a factor analysis approach). This taxonomy provides more insights on the understanding of the factors influencing the choice of CPMTT and critical assessment of various stakeholders' role in projects. Further, project managers tend to frequently choose tools which can be easily accessible without organization significant resource commitment. The findings could be used as a guide for project practitioners to critically assess the areas of weakness and select CPMTT that will help to address those weaknesses hence improved project delivery. Project managers are called to re-imagine the project needs based on priority and select the CPMTT that satisfy the needs such as time, cost, quality (project objectives) and innovation (idea generation) rather than using their discretion based on experience, skills and perceptions as crucial factors influencing the choice of CPMTT.

Limitations and areas for further study

First, the study was restricted to practitioners within the DMDP infrastructure projects within Tanzania. Therefore, the findings may not be generalized to different countries with contradicting political settings and practices. Second, the study did not study the extent of influencing factors and their effect on project performance nor the differences on registration status of respondents between Local or foreign firms. Future study should focus on assessment of project stakeholders' roles and how they influence CPM tools selection in in public-infrastructure projects.

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