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Assessment of the Role of Project Management Technical and Behavioral Competencies in the Success of Construction Projects

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Abstract: ***Technical and behavioral competencies influence the successful completion of a construction project and lack thereof can lead to poor project performance. Grade 1 contractors operating in Ethiopia were surveyed to find the prevalence of selected competencies and the associated impact they have on a project's duration, cost and quality. The correlation analysis results showed that there is a positive relationship among all competencies and project performance. A stronger correlation was observed between the prevalence and impact of behavioral competencies implying greater alignment as compared to technical competencies allowed for the identification of areas to target during competency development.***
Keywords: Project Management; Competency; Technical and Behavior Competency; Ethiopia

I. INTRODUCTION

A project is defined as a temporary endeavor that is undertaken to create a unique product, service or result according to the Project Management Institute's Project Management Body of Knowledge (Project Management Institute 2017a). The success of a construction project is dependent on a range of internal and external factors, but it is generally agreed that the competency of the project management team is highly influential on the project's success (Project Management Institute 2017a).

Competency is generally defined as the ability to independently execute a role or a task such as completion of a construction project according to a prescribed standard. The competency of the project management team is seen as one of the most important factors which determines the success or failure of a construction project. The success and performance of a construction project is generally measured using a Project Triangle, which related the project cost, duration and quality. Success in terms of time and cost is based upon the contract documents, which set out the contractual cost and completion date of projects. The measurement of quality is the most complex and difficult of the three but generally national or international standards in combination with specific requirements set out in the design and contractual documents can be used to check if the quality dimension has been met. Beyond the negative impacts unsuccessful projects have on the clients, other there is are financial penalties and reputational damages associated with missing project success benchmarks that contractors are keen to avoid (Lester 2014; Project Management Institute 2016).

Ethiopian construction projects often suffer from cost overruns, delays, quality defects or in some cases a combination of all three. As seen in the Construction Sector Transparency Initiative's (CoST) report, out of the 52 projects which were surveyed, a 76.2% cost overrun and 124.4% delay was observed (Tadesse et al. 2017). Since it is generally accepted that there is a link between project managers competency and chances of project success, understanding this relationship is essential to improving construction project performance in Ethiopia.

II. ROLE OF PROJECT MANAGERS

A project manager is an individual that is responsible for the operation of a project. A project manager's prime responsibility is "to ensure that the project produces the required products with the specified tolerances of time, cost, quality, scope, risk and benefits." (Office of Government Commerce 2017).

Considerable thought has been put into what abilities a manager needs in order to successfully execute a project. A good manager must be able to manage six areas: scope, schedule, finance, risk, quality and resource. Beyond these, the manager must also possess "Well-developed interpersonal skills such as leadership, communication and conflict management" (Association for Project Management 2012; Lester 2014; Office of Government Commerce 2017).

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Alternatively, the construction extension to the PMBoK states that a project manager must have the necessary knowledge, experience and competence to understand the complex relationships among the different stakeholders (Project Management Institute 2016). The complex and dynamic nature of the construction industry means seemingly small problems can lead to delays, cost overruns and defects. Therefore, ensuring the competency of the project manager matches the project's needs is critical (Arain 2010).

III. PROJECT MANAGEMENT COMPETENCIES

As defined previously, competency is defined as the ability of an individual to independently execute a role or tasks according to a given standard. It is a combination of knowledge, skills, and behavior that a person needs to possess for the role in question (Association for Project Management 2012).

The Project Manager Competency Development Framework (PMCDF), developed by PMI views competency as having three dimensions:

1) Knowledge Competence, which can be demonstrated by having the proper credentials and qualifications. This is often developed through education and training. For construction project managers, the Project Management Professional (PMP) certification (or other equivalents), and an engineering education are some of the ways knowledge competency are measured.

2) Performance Competence refers to how the manager applies his project management knowledge to deliver a successful project; and

3) Personal Competence which is the behavior, attitudes, and personality characteristics which managers must exhibit during the project (Project Management Institute 2017b).

An alternative definition of competency is as a combination of technical and behavioral competencies, which are each made up of various elements. Technical competencies are made up of knowledge about methods, processes and techniques required to conduct a specialized activity. Behavioral competencies refer to how individuals act in specific situations (Association for Project Management 2012; Nordhaug 1998).

The diagram below presents a breakdown of general and technical competencies.

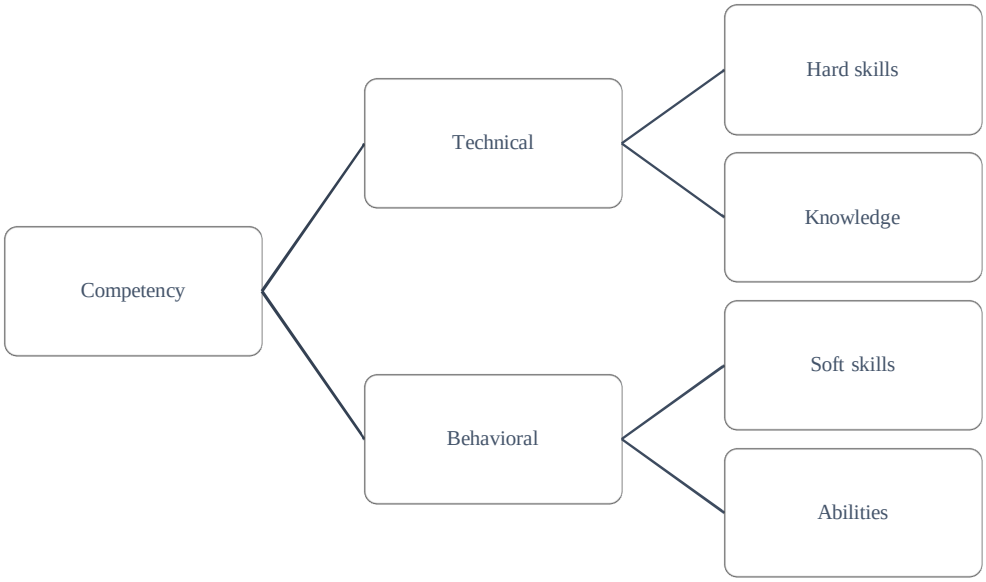


Figure 1. Breakdown of Competencies

Hard Skills refer to the knowledge about a specific topic which managers generally gain through education. In construction projects, such skills can come from education in civil engineering, construction management, architecture or related field. Knowledge while similar to hard skills encompasses information which individuals gain through education and practical experience (Lester 2014).

Soft Skills include interpersonal and intrapersonal skills which ensure that managers can interact and deal with different stakeholders effectively. Construction projects typically involve numerous stakeholders in addition to staff involved in the execution of the project, therefore its important to emphasize such skills. Abilities are skills and competencies which are gained through either natural skill, training, or a combination of both (Lester 2014).

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While the needs of projects, including construction projects vary from one project to the next, PRINCE2 defines key competencies which a manager must always possess:

- Planning;
- Time Management;
- People Management;
- Problem solving;
- Attention to detail;
- Communication;
- Negotiation; and
- Conflict management (Office of Government Commerce 2017).

A quick inspection of their recommendations shows that the key competencies are a combination of both technical and behavioral competencies.

A. Competency Development

So far, the discussion of competency has focused on what it is, and what engineers need in order to become successful managers. However, another topic of interest is how engineers can gain such skills.

Typically, the process of competency development begins during a manager's undergraduate education and is a continuous process throughout their professional career (Ahn et al. 2012). Once engineers graduate, there are multiple competency development opportunities but the experience they gain on construction projects is one of the most common.

While on the job training might be one of the common ways engineers gain competencies, including behavioral ones, there are other alternatives through which they could gain various competencies. Examples of possible avenues for competency training include: mentoring, coaching, peer-to-peer, role playing, group training, in-house training, computer-based training, individual training, and conferences (Project Management Institute 2017b).

Engineers tend to gain technical competencies quite well through their education. However, engineering education rarely introduces the soft skills necessary to manage a diverse group of people, which sometime leads to engineers making poor managers. Such behavioral competencies are often gained through their time on construction sites (Ahn et al. 2012).

While there are a wide variety of topics in which engineers have shortcomings in competency, Turk (2007) identified 3 areas in which improvements need to be made:

- People Skills, with a focus on dealing with staff throughout the project's hierarchy and stakeholders;
- Financial Management, which is included as a separate knowledge area in the Construction Extension to the PMBoK; and
- Scheduling of a project (Turk 2007).

IV. METHODOLOGY

The purpose of the research is to study the relationship between competency and construction project success, and in order to reveal the relationship, a questionnaire and correlation analysis was performed.

The process of competence development begins with the assessment of the current level of performance before the competence development plan can be created. The outputs of this research can therefore be seen as the first step in fixing the performance problems the Ethiopian construction faces.

A. Population and Sample Size

The target population for the research were Grade 1 contractors operating in Ethiopia. The population is defined as all contractors that have maintained a valid license with the Construction Works Regulatory Authority of the Federal Ministry of Urban Development and Construction as of June 2019. A total of 133 contractors were found to meet the criteria.

In order to calculate the sample size, a 95% confidence interval with a 5% margin of error was use. The response rate used was 0.5. In a finite sample size, it is possible to reduce the sample size (Cochran 1977). Based on these parameters, the sample size was calculated to be 56.

Using a stratified sampling approach, which requires all members of the population to have an equal probability of selection, the 56 contractors were selected.

B. Questionnaire Design

The purpose of the questionnaire was to gauge the prevalence of selected technical and behavioral project management competencies among contractors and measure their impact on the time, cost and quality of the project.

The questionnaire was divided into the following 5 sections:

1) *Section 1:* Respondent Background, including demographics, education, experience and the type of contractor in which they are employed.
2) *Section 2:* Competencies in Construction Projects, which asked respondents to describe how competency is addressed at their firm, and what they perceive the relationship between competency and success is.
3) *Section 3:* Relationship between Project Management Competency and Success. The purpose of this section is to evaluate the relationship between the prevalence and influence of selected competencies. Each competency was ranked on a scale of 1 to 5 in terms of its existence/prevalence followed by its impact on the project performance measures. This was then used to calculate the correlation between the prevalence of different competencies and project success.
4) *Section 4:* Measures of Project Management's Efficiency, where the development of competencies and management methodologies implemented at the respondent's firm.
5) *Section 5:* Project Success Criteria, and how the respondents believe project success is measured.

C. Correlation Analysis

As shown in the literature review, there is a relationship between the success of a project and project management competencies. To quantify the strength of the relationship between the existence the selected competencies and their impact on project success, the following correlation coefficients were computed.

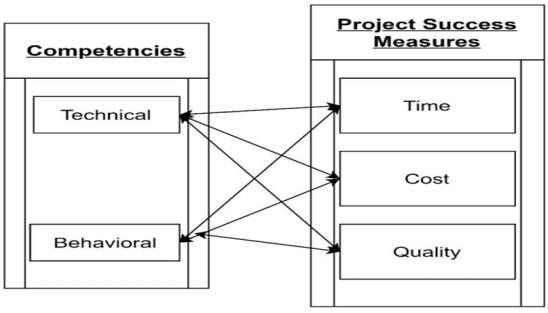


Figure 2. Relationship Between Competencies and Project Performance Measures

V. RESULTS AND DISCUSSION

The results of the questionnaire and correlation analysis is presented in this section. From the 56 questionnaires that were distributed, 48 were returned. However, 1 of the questionnaires were filled incorrectly. The valid response rate was therefore 84%.

As the sole target of the questionnaire were contractors, all respondents came from contractors. The table below summarizes the breakdown of the contractor's classification, and project management methodology that is used at the responding firms.

The most common management methodology was PMBoK based, followed by an in-house methodology while 19% had no response which is problematic because managers aren't aware of the management methodology their firm uses.

TABLE I. CONTRACTOR TYPE AND MANAGEMENT METHODOLOGY

Question	Categories	%
Contractor's Classification	General	53.19
	Building	42.55
	Road	0
	Special	4.26
Project Management Methodology Used	PMBOK Based	51
	PRINCE2	2
	In-House	28
	Other	0
	No Response	19

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A. *Respondent Demographics and Background*

The table below summarizes the gender, and age of the respondents. The respondents skew heavily towards men while a majority of the respondents were also in the 30 to 39 age group.

TABLE II. RESPONDENT'S DEMOGRAPHICS

Question	Categories	%
Gender	Male	72
	Female	28
Age	25-29	19.5
	30-39	53.19
	40-49	21.28
	>50	6.38

B. *Respondents Education and Experience*

With the exception of 2.13% of respondents who held diplomas or certificates, the remainder held either a bachelor or master's degree, with 89.36% possessing a background in Civil Engineering. A high proportion of degree holders improves the likelihood they have been exposed to technical competency through their education, and combines with their experience in the industry, they would have also gained soft skills and abilities which constitute behavioral competencies.

Since the aim of the research is to study the effects of project manager's competency, the respondents must be in positions of management. Project managers made up 42.55% of respondents, while office engineers made up 40.43% of respondents. This suggests a good balance among the respondents between different positions of management.

TABLE III. RESPONDENT'S EDUCATIONAL AND WORK BACKGROUND

Question	**Categories**	**%**
Respondent's Qualification	Diploma/Certificate	2.13
	Bachelor's Degree	59.57
	Master's Degree	38.3
	Other	0
Area of Specialization	Civil Engineering	89.36
	Architecture	10.64
Official Title	Project Manager	42.55
	Office Engineer	40.43
	General Foreman	2.13
	Other	15
Years of Experience	< 5 Years	12.77
	5 to 10 Years	42.55
	10 o 15 Years	25.53
	> 15 Years	19.15

C. *Project Managers Competency*

When hiring managers, contractors must be able to define the required competencies and identify what competencies and characteristics are important.

To examine this important topic, the questionnaire asked the respondents whether their firm defined the necessary qualifications during the hiring process. It was found that 97.87% of respondents agreed there was a definition of required competencies.

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Next, the respondents were asked to gauge which competencies were of greatest importance to the contractor. The responses are summarized below.

TABLE IV. IMPORTANT CHARACTERISTICS FOR PROJECT MANAGERS

Question	**Categories**	**%**
Important characteristics for project managers	Project management competencies	41
	Formal education and qualifications	4
	A combination of both	55
	Other	0

The results show that formal education on its own is of little significance to the contractors. Instead, a combination of formal education and project management competencies was found to be the majority's preference. However, 41% also appear to prioritize project management competencies alone, which indicates their importance to firms.

The level of impact technical and behavioral competencies on project success was examined by asking the respondents to see which competencies are of greatest importance. The results showed that 72.34% believed technical competencies, while the remainder (27.66%) believed behavioral competencies had the greatest impact.

As previously discussed, project management competencies have a significant on impact the performance of construction projects (Association for Project Management 2012; Lester 2014; Project Management Institute 2017a). The respondent's belief on the impact of competencies on project success showed that 85.11% though it had significant impact, while 14.89% believed it has a moderate impact. No respondents thought it had low or no impact, which means that contractors understood the importance of project management competencies.

With regards to the relationship between project management success and the project's overall success, 63.83% responded that projects are generally successful when there is successful project management, while 25.53% responded that it was always successful. Therefore, there are external factors which can influence the success of a project even with a highly competent project manager.

The following table summarizes the results.

TABLE V. Respondent's Belief Regarding Competencies

Question	Categories	%
Level of impact of competencies on project success	Significant Impact	85.11
	Moderate Impact	14.89
	Low Impact	0
	No Impact	0
Relationship between successful project management and project success	Always Successful	25.53
	Generally Successful	63.83
	Sometimes Successful	6.38
	Rarely Successful	4.26
	No Relationship	0
Most important competency	Technical	72.34
	Behavioral	27.66

The results summarized in the table above, project management is critical to the successful of a project, and technical competencies were found to be the most important competency according to the respondents.

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D. Competency Development

Engineers generally gain technical competencies through their formal education, while behavioral competencies are gained through other avenues. The respondents were asked how competencies are developed and the results are presented below.

TABLE VI. AVENUES FOR COMPETENCY DEVELOPMENT

Question	Categories	%
Competency Development Routes	Experience on Site	93.62
	Mentorship	0
	External Courses	4.26
	Internal Courses	2.13
	Trial and Error	0

As expected, experience on construction sites was the most common path for competency development. More formal courses which have greater potential to impart the necessary qualifications were rare.

E. Ranking of Competencies by Prevalence

A total of 21 technical competencies, and 15 behavioral competencies were presented to the respondents in the questionnaire. The following two tables present the technical and behavioral competencies, ranked by prevalence along with their influence on time, cost and quality.

TABLE VII. TECHNICAL COMPETENCIES, RANKED BY PREVALENCE

Technical Competencies	**Ranking**			
	P	**T**	**C**	**Q**
Structuring, sequencing, duration estimation, and scheduling of activities	1	2	9	10
Identification, definition and agreement of the client's demand and project objectives	2	5	10	9
Effective exchange and understanding of information between different parties	3	10	14	3
Defining the deliverables and ensuring they meet the scope of the project	4	12	7	8
Ensuring the inherent characteristics of the project satisfy quality requirements	5	20	10	1
Design of organizational structures based on capabilities and the needs of the project	5	5	4	2
Planning, and assigning of resources with the appropriate standard	7	3	4	16
Integrated control of the project	8	3	6	5
Creating a summary of the project/system performance	9	12	13	11
Mandatory planning, monitoring, and controlling of costs	10	18	1	14
Root cause analysis and problem-solving skills	11	1	2	4
Understanding objectives and constraints for overall project success	12	7	7	5
Creating hierarchical organizations to ensure nothing is omitted from the project	13	17	20	18
Establishing project milestones based on major deliverables	14	14	16	17
Stakeholder analysis and understanding the interests of all parties	15	15	19	13
Identifying lessons learnt from previous projects	15	21	10	5
Completion of the project	17	11	14	19
Modelling, gathering, selecting, storing and retrieving project data	18	16	17	14
Receiving improved value from suppliers of goods or services to the project	19	8	3	11
Providing the basis for a successful project	20	8	21	20
Monitoring and comparing of unanticipated occurrences against original objectives	21	18	18	21

Note: P = Prevalence; T = Impact on Time; C = Impact on Cost; Q = Impact on Quality

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A quick analysis of the technical competencies shows that some of the highly ranked competencies have low impact on project success and vice-versa. This lack of alignment between impact and prevalence will be discussed further.

TABLE VIII. BEHAVIORAL COMPETENCIES, RANKED BY PREVALENCE

Behavioral Competencies	Ranking			
	P	T	C	Q
The ability to utilize available resources to bring about the agreed upon outcomes	1	2	1	1
Negotiation skills	2	3	5	3
The ability to focus the team's attention on key objectives to obtain the optimum outcome for the parties	3	1	2	2
Directing and motivating others to fulfil the project's objectives	4	3	3	4
Conflict management skills	5	3	3	10
The ability to think and behave in an inventive and original manner	6	7	6	6
Morally recognized conduct or behavior of an individual	7	10	7	6
Delivering things according to the agreed upon time and quality	8	8	9	4
The ability to state one's views persuasively and authoritatively	9	11	11	13
Making peoples believe in the project and feel engaged	10	6	8	6
Perceiving intrinsic qualities of different people and understanding their standpoint	11	12	15	11
Systematic and disciplined approach to cope with daily tasks, changing requirements and to deal with stressful situations	12	9	9	9
Reasoning, presenting strong arguments, listening to others, and finding solutions	12	15	12	12
Listening to other's experience and allow them to express themselves	14	13	13	14
The ability to relieve tension in difficult situations	15	14	13	15

Note: P = Prevalence; T = Impact on Time; C = Impact on Cost; Q = Impact on Quality

Among the behavioral competencies, the lack of alignment previously observed wasn't seen. The highly prevalent competencies were the most influential, while the least prevalent also happened to be the least influential.

F. Correlation Analysis

Finally, the results from the correlation analysis between various technical and behavioral competencies and measures of project success. Overall, it should be noted that there was a positive correlation between the competencies and project success. The correlation between technical competencies and all measures of project success were higher compared to technical competencies. The table below presents the results, and they are further discussed in the following sections.

TABLE IX. Correlation Coefficients For Prevalence And Influence On Project Performance

		Measures of Project Performance		
		Time	Cost	Quality
Prevalence of Competency	Technical	0.3869	0.4407	0.6160
	Behavioral	0.8942	0.9015	0.8509

A high correlation is indicative of greater alignment between the most influential and most prevalent competencies. This means that competencies which the respondents believe to have the greatest influence on project performance were the most prevalent competencies. This increased alignment was observed in the behavioral competencies only. In the next section, the technical and behavioral competencies which have the most significant impact on the project's performance are presented and discussed. Areas of strength and deficiencies which should be fixed to improve project performance are also identified.

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G. Technical Competency and Project Duration

The technical competency with the most significant impact on project duration was root cause analysis and the ability to develop solutions to problems. The dynamic nature of construction projects means problems will inevitably arise, requiring managers to find the root causes and their solutions. However, this option was ranked 12th in terms of prevalence, which indicates that this is an area where competency training can be focused on. In the PMBoK, root cause analysis is one of the tools which managers must use in the "Monitor and Control Project Work" process, as well as the "Manage Quality" process, which shows it's a critical technique to address departures from the project baseline (Project Management Institute 2017a).

The second highest ranked option was the structuring, sequencing, duration estimation and scheduling of activities. Logically, this competency and its influence on project duration is clear, since poor scheduling can lead to misestimation of project durations and affect how subcontractors participate in the project among other factors. Fortunately, it was the most prevalent competency.

The third highest ranked option was planning and appropriate designation of resources to an acceptable standard. This is an important step in project planning since construction projects require a myriad of resources to be brought together based upon a schedule. However, this was ranked only 8th in terms of prevalence.

The fact that the first and third most influential competencies weren't in the top 3 most prevalent competencies indicates that there is a gap in the technical competency development of project managers that needs to be addressed.

H. Technical Competency and Project Cost

The most influential competency on cost was the planning, monitoring, and controlling of costs throughout the project life cycle. This competency allows managers to see activities which consuming resources beyond their allocation are and adjust accordingly in order to maintain the cost baseline set (Project Management Institute 2017a). However, it was only ranked 11th in terms of prevalence. The second highest ranking option was root cause analysis and the ability to develop solutions to problems. Despite this competency being highly influential on project duration as well, it was only ranked 12th, which is further evidence of the importance of developing this competency. The third highest competency was incurring improved value from suppliers of goods and services. Outsourcing activities to sub-contractors can allow specialized contractors to perform certain activities which have the potential to improve productivity and introduce cost savings. Extracting value from such relationships can allow the main contractor to make savings. This competency was ranked 20th from the 22 available options, which is indicative of an important area where contractor's competency can be improved.

I. Technical Competency and Project Quality

The most influential competency on quality was found to be ensuring the inherent project characteristics meet the project's requirements. An element of quality is ensuring that the client's needs are met in accordance with national and international codes. This competency was also tied for 5th in terms prevalence. The second most influential competency was designation of appropriate roles, organizational structures, and capabilities for the project. Since construction involves many individuals with specific skills sets coming together, matching them to their tasks and ensuring they possess the necessary skills is important to ensure quality work. This competency also tied for 5th in terms of prevalence among contractors.

Effective exchange and understanding of information between different parties was ranked 3rd, which ensures that different stakeholders in the construction are operating from the same playbook since miscommunication and misunderstanding have the potential to lead to quality defects. This was also the third highest ranking competency.

J. Behavioral Competency and Project Time

The most influential behavioral competency on project time was found to be the ability to concentrate the team's attention on key objectives to achieve the optimum outcome. This competency was also found to be the 2nd most influential on both cost and quality. The second most influential competency was the ability to effectively utilize time and other resources to bring about the desired outcome. Again, this was found to be the most influential competency on both cost and quality. This was the most prevalent behavioral competency.

A three-way tie was found for the third most influential competency. The competencies were:

1) Negotiation skills;
2) Providing direction and motivating others into fulfilling their tasks; and
3) Conflict management.

The three competencies were ranked 2nd, 4th, and 5th respectively in terms of prevalence among the surveyed contractors.

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K. Behavioral Competency and Project Cost

The most influential competency on cost was the ability to effectively utilize time and other resources to bring about the desired outcome. Organizational skills and the ability to coordinate various inputs and processes is fundamental to a project's success, and this competency is important in this regard. It was also the highest ranked behavioral competency in terms of prevalence.

The second most influential behavioral competency on cost was the ability to concentrate the team's attention on key objectives to achieve the optimum outcome. It was also the third highest ranked competency in terms of prevalence.

The third most influential competency was providing direction and motivating others into fulfilling their tasks. It was the 4th most prevalent competency. The second and third most influential competencies are elements of leadership which have been identified as critical to project success by PMBoK, PRINCE2, and APMBoK.

L. Behavioral Competency and Project Quality

The highest and second highest competencies were the ability to effectively utilize time and other resources to bring about the desired outcome and the ability to concentrate the team's attention on key objectives to achieve the optimum outcome. Both were discussed in the preceding section and won't be repeated here.

The third highest ranked competency was negotiation, which was the second most prevalent competency.

VI. CONCLUSION

As the discussion in the previous section showed, there is a clear correlation between the prevalence of the selected competencies and their impact on project performance measured in terms of time, cost, and quality.

A higher correlation between the prevalence of the most influential behavioral competencies and the most impactful on project performance indicates that there was better alignment among behavioral competencies. As the discussion of the results showed, the three most prevalent behavioral competencies were also the most influential on time, cost, and quality.

The lower correlation for the technical competencies meant that some highly influential competencies weren't prevalent among the contractors, which is a possible cause of poor project performance among contractors. The only technical competency which was ranked in the top 3 in terms of prevalence and was among the top 3 most influential on project success was scheduling.

To resolve this problem, the authors suggest a competency development program which includes the following three topics:

1) Root cause analysis and problem-solving skills;
2) Planning, monitoring, and controlling of project costs; and
3) Incurring improved value from suppliers of goods and services.

The development of competencies should be encouraged during engineers' higher education and through formal competency development programs since 93.62% of respondents said that the most common competency development option was experience on site. Since PMBoK was the most common project management methodology, it is recommended that the Project Management Institute's Project Management Competency Development Framework is used.

Finally, the results showed that the assumption engineers gain the technical competencies they need for the job through their education is flawed in the Ethiopian context. In addition to a competency development program for contractors, the needs of the industry should be evaluated and higher education syllabi should be modified accordingly.

VII. ACKNOWLEDGMENT

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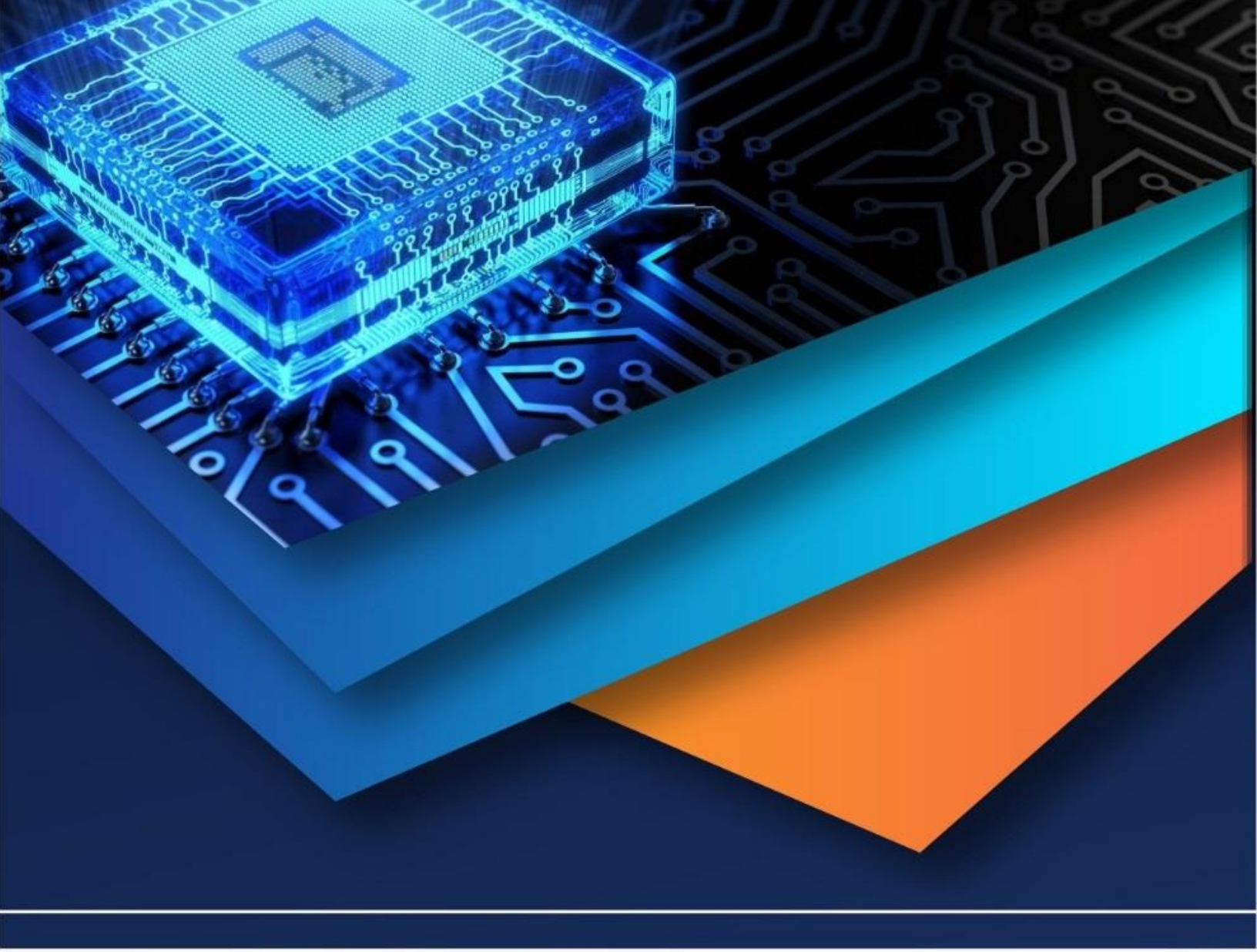
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