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Stakeholder`s Relationship and Influence Level in Integrating the Industrial Construction Technology in Tanzania-The Structural Model

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Abstract
The prevailing sustainable approach for improving the performance of the construction sector is the use of industrialized construction technology, or ICT that has drawn much attention of several international construction community researchers. The objective of this paper was to examine the stakeholder's relationship and influence level towards integration of industrial construction Technologies in Tanzania. One-hundred fifty-nine (159) structured questionnaires were completely administered via online media to experienced construction sector professionals. The findings documented eight influential stakeholders including developer, manufacturer, government, consultant, contractors, supplier, public institutions and education institutes who plays a significant role towards integration the industrialized construction technology. Also, the findings have recognized the structural model showing the correlation between the stakeholders. This study offers the essential insights for future research in this field aimed at informing the construction industry about the fundamental stakeholders and their influence power towards industrialized construction technology integration in the Tanzania construction industry.

Keywords: *Construction Project, Technology, Construction Technology, Industrial Construction Technology*

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1.0 INTRODUCTION

The construction industry plays a vital role in the economic and social development of developing countries, serving as a cornerstone for infrastructure growth, job creation, and poverty reduction. By building essential structures such as roads, bridges, schools, hospitals, and housing, the industry directly improves living standards and facilitates access to basic services. It stimulates local economies by creating employment opportunities across various skill levels and drives demand for materials and services from related sectors. Ultimately, the construction industry is a key driver of progress, fostering sustainable development and improving the quality of life for communities. Despite the crucial contribution of the construction industry in Tanzania to the national development, yet the industry still faces with overwhelmed challenges that impact its

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general productivity and performance. Challenges includes poor or inadequate project management skills, construction project delays, health and safety problems, disputes, malpractices and late payments (Mwemezi et al., 2023). Additionally, very low profit to contractors, limited training, and inadequate integration of industrialized construction technology to mention a few. poor quality of the competed project, occupational injuries and illnesses that has ultimately led to the negative image of the industry. Understanding the stakeholder's influence level on integrating industrialized construction technology in Tanzania's construction sector is necessary to recognize the gaps and propose the potential stakeholder's necessary for integrating industrialized construction technology. This study intends to assess the stakeholder`s relationship and influence level in integrating the industrial construction technology in Tanzania's construction industry. The study will contribute to a offer a deeper understanding of the potential stakeholder's, their influence level and relationship towards integrating industrialized construction technology that will eventually enhance efficiency and performance improvement of the construction industry.

2.0 MATERIALS AND METHODS

1.1 The industrialized construction technology paradigm

The two paradigm of industrialization and digitalization forming the Industrial Construction Technology (ICT) has offered additional benefits to the construction activities. They have considerably changing the construction sector resulted from a combined pair than when applied separately (Guangbin, W.*et al.,* 2020). Despite an extensive research undertaken, a knowledge gap still persists concerning the present state and the forthcoming trajectory of this integration (Jiawang, F., 2024). The two has driven and necessitated the construction industry to undergo a tremendous transformation. Recently, the Industrialized Construction technology (ICT) have received much attention in the global construction community and recognized as a promising strategy for enhancing the performance improvement of the construction project in particular and construction industry in general (Fakhira, K. *et al.,* 2023).

Industrialized Construction Technology denotes the use of automated methods, modern, advanced processes, and equipment in construction industry activities. It comprises the application of modern techniques including prefabrication, modular construction, robotics and digitalization to increase productivity and quality in construction projects (Meng, Q. *et al.,* 2020). ICT have made a chance to enhance efficiency, reductions in construction cost, time and safety risks, environmental impact, enhancing design flexibility, visualization, easing collaborative efforts and hence profitability escalations (Jiawang, F., 2024). Numerous synonymously terms are used to signify industrialized construction technology including Offsite construction (Mao, C. *et al.*, 2016), Prefabricated construction (Hong, J.,et al., 2018), Offsite production, Modular construction (Kamali, M., and Hewage, K, 2016), and Industrialized Building Systems (Bari, N; Abdullah, NA; Yusuff, R; Ismail, N; and Jaapar, A, 2012). Although the term "industrialized construction technology" has been used consistently in literature, the preference terms differ from country to country and involves multiple stakeholders.

1.2 Stakeholder's in Integrating ICT

Unlike other sectors, the construction industry is a project-based industry, encompassing several stakeholders, with each party operating while chasing its interests and playing different functional roles in the inventive and innovative processes. Several stakeholders including manufacturers, contractors, consultants, developers, supplier, government as client and training institutes needs to work together towards ICT integration within the construction project. Xue et al. (2018) recognized that Stakeholders long-term expertise, understanding on ICT and resources utilization, network's power (partnership or alliance) entailing good communication and

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collaboration have a great impact on construction project performance (Xue, H, 2018). The stakeholder's collaborative efforts are compulsory to solve tangible ICT problem which eventually stimulate the adoption, integration and hence promote ICT development. Boroto and Shepherd (2024) further opined that among the most cost-effective way to promote the ICT integration is to enforce the obligatory responsibilities for every stakeholder (Boroto,H. and Shepherd, P., 2024). Despite the extensiveness of scholarly discourse and initiatives undertaken to maximize the adoption and integration of ICT, the study on stakeholder involvement, challenges and influences is of paramount important (Shojaei, S. and Burgess, G, 2022; Klaus-RA.; Iwko, J., 2021). Thus, this study intends to assess the stakeholder's influence on ICT integration.

3.0 METHODOLOGY

1.1. Study Respondents

This study identified and evaluated the stakeholder influences required for the successful integ ration of industrialized Construction technology using a quantitative research design.The targe ted professionals in the construction industry were chosen based on two criteria: (1) they had t o have theoretical and research experience working on construction projects, and (2) they had t o have gained sufficient practical skills over a minimum of five years of experience.A sample fra me consisting of 250 seasoned construction project specialists was employed.Respondents wer e given a standardized questionnaire with three sections to collect their opinions for the study. The purpose of the first section of the questionnaire was to collect the respondent's demographi c information.Part two aimed to gather feedback on stakeholders' ICT awareness, Part three intended to collect an opinion on the relationship between the stakeholders when integrating ICT.

1.2. Data Collection Instruments

The English-language questionnaire translated into Swahili language set in a 5-point Likert scale, chosen to convey the numerical ranks only as: 1=not critical, 2=fairly critical, 3=critical, 4=very critical and 5=extremely critical was circulated on 9th,11th and 14th May 2024. The distribution was made through a combination of personal emails by attaching the QR-code and Web link and WhatsApp social network. After numerous reminders, 159 completed questionnaires were collected from respondents within three weeks allocated to accomplish the survey. The study acknowledges that issues with data quality and reliability are key disadvantages for online questionnaire surveys; thus, the risk was considerably reduced by enlisting more registered professionals with extensive practical experience within the construction industry.

1.3. Quantitative Data Analysis

The collected sample data were coded, edited and descriptive analyzed. A number of statistical tests, including construct validity, reliability analysis test, mean score analysis, relative importance index was performed using SPSS. To determine the degree to which every item on a scale measures the same construct, construct validity was used. The 5-point Likert scale's internal reliability was tested by closely examining data reliability. The goal of the study was to determine whether the questionnaire survey instrument yielded comparable findings across various test sets. Additionally, confirmatory component analysis (CFA) was conducted using AMOS, and the results made it easier to assess for both discriminant and convergent validity. However, to build the link between stakeholders toward ICT integration, a structural equation modeling (SEM) approach was employed with SPSS-AMOS.

4.0 RESULTS AND DISCUSSIONS

1.1. Respondent's Demographic Information

The survey's descriptive statistics of the respondents' demographic are shown in Table 1. Age, education level, work experience, career path, and leadership role were among the fundamental

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data gathered for this study. The results indicate that most respondents (120, or 75.4%) were between the ages of 35 and 45, followed by respondents (26, or 16.4%) who were between the ages of 26 and 34, and minor respondents (13, or 8.2%) who were between the ages of 18 and 25. This suggests that the vast majority of respondents were old enough to comprehend and deal with the problems being studied. The majority of responders (139, or 87.42%) have master's degrees. This shows that knowledgeable people answered the questionnaires. It also demonstrates that those with sufficient experience, expertise, and comprehension of the difficulties facing the construction sector provided their comments for the study.

Item	Class	Frequency	Percentage (%)
Respondent's Age (Years)	18-25	13	8.2
	26-35	26	16.4
	35-45	60	37.7
	Above 45	60	37.7
Educational Level	Diploma	11	6.9
	Degree	97	61.0
	Masters	42	26.4
	PhD	9	5.7
Working Experience (Years)	0-10	28	17.6
	10-20.	76	47.8
	21-30	29	18.2
	Above 30	26	16.4
Profession	Engineer	65	40.9
	Architects	42	26.4
	Quantity Surveyor	26	16.4
	Surveyor	13	8.2
	Procurement officer	8	5.0
	HR officer	5	3.1
Leadership	Director General /GM	19	11.9
	Project Managers	31	19.5
	Departmental managers	50	31.4
	Foremen/Supervisor	59	37.1

Table 1: Respondent's Demographic Information

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Over three quarters (131=82.39%) of the respondents had worked in the construction industry for more than ten years, which gave them sufficient knowledge of the many operations and difficulties the sector faces. Additionally, the majority of the sample (50=31.4%) is made up of top management executives, such as directors and project managers. This implies that most of the opinions gathered were from individuals who most likely have a significant influence on the management and operations of their companies. Moreover, departments were also well-represented; engineers (65=40.9%) are the most common, followed by architects (42=26.4%) and quantity surveyors (26=16.4%).

1.2. Stakeholders' Awareness On ICT Integration

One of the major obstacles to ICT adoption and integration has been identified as a lack of or insufficient awareness about ICT. To analyze the awareness level, a relative importance index (RII) formula (equation 1) was used to compute the mean and rank the stakeholder's in ascending order.

$$RII = \frac{\sum w}{A * N} \qquad \text{Eqn. 1}$$

Where RII= Relative Importance Index
W = is the weighting given to each factor by the respondents (ranging from 1 to 5),
A= is the highest weight (i.e. 5 in this case),
N = is the total number of respondents.

An investigation on stakeholder's awareness level on ICT in Tanzania was conducted in this study. It was found that 39.9% of respondents have little awareness followed by 37.7% who have no knowledge on Industrial Construction technology. 9.5% were found to have a neutral opinion. However, the majority 37.7% and 39.9% had no very little to know knowledge respectively. The conclusion of the findings indicates that, majority of stakeholders are not aware of ICT and thus make it difficult to be implemented in construction industry.

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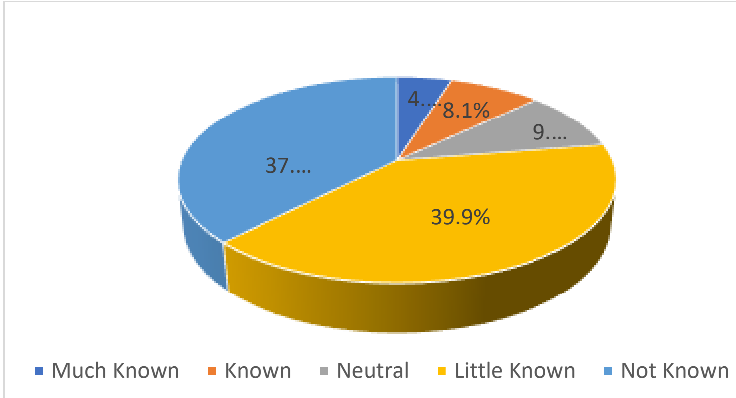

Figure1: Stakeholder's Awareness level on ICT

Furthermore, the relative importance formula was opted in order to study the awareness level and rank the stakeholder's participating in adoption and integration of ICT in order of their awareness level. the findings acknowledged that, manufacturers were ranked number one in terms of mean score with mean score 3.745, followed by contractors recording the mean score of 3.571. the developer became the third scoring the mean score of 3.486 followed by engineers with mean score of 3.340; architect/quantity surveyors (mean score=3.260) and policy maker being the last scoring the mean score of 2.235. Thus, the policy maker needs to invest much to understand and prioritize adoption of ICT. Generally, the overall awareness was recognized to be low with an average mean score of 3.273. The finding recommended the government and other potential stakeholders to conduct several awareness programs, and advise the practitioners to use their platform to propagate ICT.

Table 2: The ICT awareness Level in Tanzania

Item	Business type	Mean	RII	Rank
1	Engineers	3.340	0.743	4
2	Architect/Quantity surveyors	3.260	0.719	5
3	Policy Maker	2.235	0.423	6
4	Contractor	3.571	0.152	2
5	Manufacturer/Supplier	3.745	0.118	1
6	Developer	3.486	0.087	3

1.3. Stakeholder's Influence on ICT Integration

The integration of Industrialized Construction Technology (ICT) in Tanzania is significantly shaped by various aspects including priorities, and collaboration of various stakeholders. The stakeholders always influence the policy frameworks, resource mobilization, skills development, and adoption of advanced construction methods to modernize the industry and improve efficiency, sustainability, and economic growth. To assess the stakeholder's Influence on ICT Integration in Tanzania, a Relative importance index (RII) was used to rank the stakeholder's influence level. The finding (Table 3). documented that the government`s influence level was highly ranked with RII of 0.773. The public institutions' influence on ITC integration as a technology provider was secondly ranked with RII of 0.751, and the third top ranked was education institute' level scoring the RII of 0.742, figure 2 refers

Table 3: Stakeholder`s Influence in Integrating ICT

Stakeholder Type	Likert Scale					Relative Importance Index	Rank
	5	4	3	2	1		
Government	17	16	19	43	64	0.773	1

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Public Institutions	15	19	21	47	57	0.751	2
Education Institutes	13	18	23	46	59	0.742	3
Manufacturer	14	19	27	43	56	0.736	4
Contractor	17	22	24	40	56	0.721	5
Consultant	19	19	18	57	46	0.716	6
Developer	18	29	17	35	60	0.713	7
Supplier	25	21	34	29	50	0.673	8
Local Community	39	39	39	19	24	0.540	9

The first and second top ranked was likely to occur because of various collaborations signed between private firms and the government (PPP) help to implement large-scale projects using industrialized techniques. The findings associate with what is occurring in various countries where ICT is efficiently experienced. The Tanzania government's high influence level is traced from its role and motive in integrating ICT and likely contributed by its investments initiatives played by its agencies or institutions eagerly to promote the construction technology. The local community was ranked the last attaining a very low RII=0.54 succeeded by supplier counting the RII of 0.673.

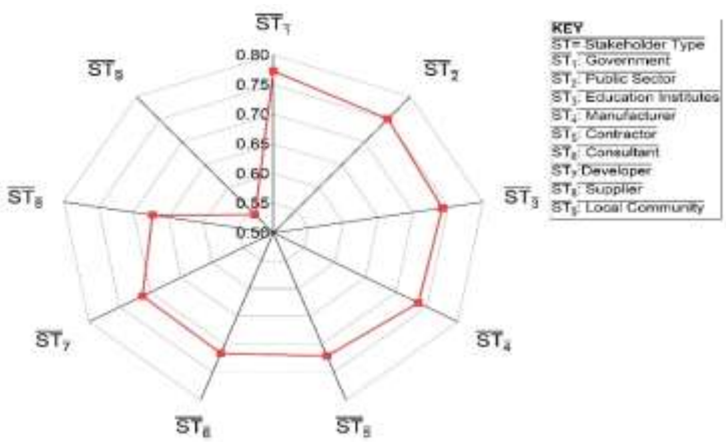

Figure 2: **Stakeholder`s Influence in Integrating ICT**

1.4. Institutional Influences in Integrating ICT

Through education, research, policy setting and implementation, creating infrastructure, and providing oversight; several key Tanzanian institutions were recognised to play a significant role in facilitating the integration of Industrialized Construction Technology (ICT) to support the country's industrialization goals, improve the efficiency and sustainability of its construction sector.

Table 4: Institutional Influence in Integrating ICT

Institutions	*Remarks*	*Frequency*	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Relative Importance Index	Ranking
	Remarks		***5***	4	3	2	1	$\sum W$ RII	

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Ministry of Works &Transport	MoWT	*f*	73	59	21	4	2	674	0.8478	2
		%	45.91	37.11	13.21	2.52	1.26			
Local Government Authorities	LGA	*f*	57	69	13	12	8	632	0.7950	10
		%	35.85	43.40	8.18	7.55	5.03			
Tanzania Bureau of Standards	TBS	*f*	59	65	19	9	7	637	0.8013	8
		%	37.11	40.88	11.95	5.66	4.40			
National Construction Council	NCC	*f*	82	57	7	5	8	677	0.8516	1
		%	51.57	35.85	4.40	3.14	5.03			
Tanzania Building Agency	TBA	*f*	63	69	14	8	5	654	0.8226	6
		%	39.62	43.40	8.81	5.03	3.14			
Universities	UN	*f*	63	69	16	7	4	657	0.8264	5
		%	39.62	43.40	10.06	4.40	2.52			
TARURA	TAR	*f*	68	51	24	11	5	643	0.8088	9
		%	42.77	32.08	15.09	6.92	3.14			
TANROADS	TANR	*f*	58	73	15	6	7	646	0.8126	7
		%	36.48	45.91	9.43	3.77	4.40			
Construction Boards	CB	*f*	79	58	6	5	11	666	0.8377	3
		%	49.69	36.48	3.77	3.14	6.92			
National Housing Cooperation	NHC	*f*	69	59	19	8	4	658	0.8277	4
		%	43.40	37.11	11.95	5.03	2.52			

The finding of this study have documented NCC to possess the highest influence level on stimulating ICT integration with RII=0.8516 scoring 51.57% strongly agree, 35.85% agree, 4.4% neutral, 3.14% disagree and 5.03% strongly disagree. The second-third score were taken by Ministry of Works &Transport and Construction Boards recording the RII of 0.8478 and 0.8377 respectively. The last three lowest institutions (in ascending order) were Tanzania Bureau of Standards concurring the RII of 0.8013, followed by TARURA and Local Government Authorities earning the RII of 0.8126 and 0.7950 respectively Table 4: Ranking of Institutional Influences on Integrating ICT.

1.5. The Relationship Between Stakeholder's on ICT Integration

The relationship between stakeholders in integrating ICT was represented by the structural model created using SPSS-AMOS. The structural relation model (SEM) indicates the statistical relationship between variables and their relational estimates that depicts the percentage of influence between construct or latent variables. In this study, the structural model includes nine latent variables: government, Public Institutions, Education Institutes, Manufacturer, Contractor, consultant and developer. The generated SEM (Figure 1) have provided a data comparison that generated a statistical-model-fit helped to assess the relationship between the model variables. Nonetheless, the associations between variables were deemed to be supported by the data if the model fit (Table 2) was within the suggested model fit indices (Sathyanarayana,S; Mohanasundaram, T., 2024). The interpretation of the model was based on the ranges stated as: (≥0.7 to 1.0; indicating a strong positive relationship); (0.4 to 0.7; suggesting a moderate association); (0.1-0.4; implying a weak connection) and from (-0.1 to 1.0; indicating an inverse relationship).

The correlation analysis on stakeholder's ICT integration was conducted on the scale comprising nine construct variables. The findings have revealed the correlations ranging from 0.35 to 0.76. Over 32 identified correlations, 8 (25%) have attained the threshold value below 0.5, while all remaining have conquered exceedingly the minimum correlation threshold value of 0.5 (Hair, J.,

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2014). However, the findings have acknowledged high regression weight estimates portraying a strong level of correlation among the construct variables and hence indicating their critical role in influencing the integration of industrial construction technology. The overall analysis of the final structural model's regression weight estimates provided a substantial evidence supporting the relationship among stakeholder's in facilitating the integration of industrialized construction technology.

The assessment of the produced final structural model involved a complete investigation of the inter-relationships among constructs and the overall model fit (Hair, J., 2014), including structural parameter estimates and path coefficients. Numerous goodness-of-fit indices were considered to assess the adequacy of the model and its ability to represent the underlying data. The findings (Table 5) have recognized that all correlations involving local community and other construct have yielded the lowest threshold estimate values. However, some of the correlation between constructs have recognized high estimates over above 0.7 suggesting the strong positive relationship.

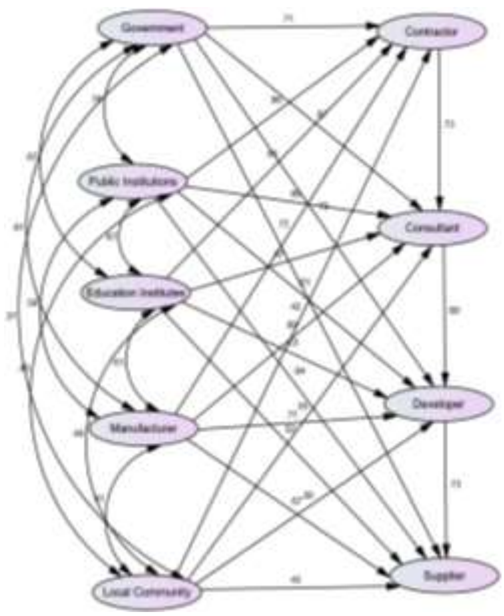

Figure 1: stakeholder's Relation on ICT integration

Table 5: The Standardized Correlations Model Estimate

Construct Code and Relationship			**Correlations Estimate**
LC	<-->	S	0.43
LC	<-->	D	0.39
LC	<-->	CONS	0.35
LC	<-->	CONT	0.42
LC	<-->	M	0.41
LC	<-->	EI	0.40
LC	<-->	PI	0.43
LC	<-->	G	0.37
G	<-->	PI	0.76
G	<-->	CONT	0.71
D	<-->	S	.73
M	<-->	D	0.71

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M	<-->	CONT	0.72
G	<-->	D	0.73
CONT	<-->	CONS	0.73

Manifest variables: LC=Local Community; S=Supplier; D=Developer; M=Manufacturer; G=Government; Cons=Consultant; Cont=Contractors; PI= Public Institutions; EI= Education Institutes.

1.6. The Structural Model fit Assessment

The structural model fit indices have recognized the x2 goodness-of-fit test scoring a p-value of 0.000, demonstrating a significant difference between the observed data and the model-implied covariance matrix. Moreover, the chi-square over degrees of freedom ratio (x2/df) was also evaluated and realized a value of 1.728, below the recommended threshold of 2 to 3; and the root mean square error of approximation (RMSEA) value of 0.049 was below their respective recommended thresholds of 0.05 to 0.07 (Kline R. , 2015), indicating a good fit of the model to the data and the model's accuracy in predicting the observed data. Furthermore, in assessing the relative improvement in fit over the model's overall comparative fit, the incremental fit measures TLI and CFI values assessed, surpassed the recommended threshold of 0.90 (Sahoo, 2019), scoring values of 0.917 and 0.921 respectively demonstrating to support the adequacy of the model. Equally, the findings on parsimonious fit measures encompassing PNFI and PCFI realized the score values beyond the recommended threshold value of 0.50, with values of 0.683 and 0.741 respectively signifying that the model balances parsimony and model fit.

Table 6: Model Goodness of fit indices values

Model Fit Type	**Fit Index**	**Criteria**	**Computed Value**	**Remarks**
Absolute fit measures	x^2 (at p-value)	0.000	0.000	Achieved
	x^2/df	< 2,3	1.728	Achieved
	RMSEA	< 0.07	0.049	Achieved
Incremental fit measures	TLI	>0.90	0.917	Achieved
	CFI	>0.90	0.921	Achieved
Parsimonious fit measures	PNFI	>0.50	0.683	Achieved
	PCFI	>0.50	0.741	Achieved

5.0 CONCLUSIONS

The final structural model indicates the achievement of adequate fit indices through several measures as compared to the recommended threshold values (Table 6) suggesting that if the relationships among the latent construct (construction industry stakeholders) is well observed and monitored can assist to ease an integration of the industrialized construction technology. Thus, the study findings have provided a comprehensive understanding of required potential stakeholders, their influence Level and relationship towards Integrating the Industrial Construction Technology in Tanzania construction industry.

Declaration of Conflict of Interest: The authors declare no conflict of interest.

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Data Availability: Data are available upon request from the corresponding author.

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