ORIGINAL RESEARCH ARTICLE

Organizational Culture's Influence on the Adoption of Information Management Technology in Construction Projects in Nairobi, Kenya

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ABSTRACT

The construction industry, being collaborative in nature, has over time grown to accommodate professionals from various backgrounds with varying degrees of human interaction that brings its own organizational culture. This increase in complex and ever-changing construction project activities during the life cycle of construction requires effective communication using appropriate information technology. Many studies have documented the slow uptake of this technology in the industry and have focused on processes and systems when researching the reasons behind it. Human factors, and particularly the unique project organizational culture in construction projects have not been vastly addressed in relation to uptake of information management technology. With reference to the Competing Values Framework the study sought to find out the effect of project organizational culture on information management technology adoption in construction projects in Nairobi, based on the Unified Theory of Acceptance and Use of Technology. It also described the characteristics of construction project organizational culture, and the perception of respondents on extent of adoption of information management technology and the relationship between the project organizational culture and information management technology adoption. A descriptive cross-sectional study design was used and primary data collected using questionnaires. Quantitative Data was analyzed SPSS v25. The findings were that all four components of the Competing Values Framework (collaboration, competition, creativity and control) were statistically significant in the uptake of information management technology. It was also found that the construction projects environment skews collaborative and control-based in nature, and this requires an enhancement of information management technology that ensures values and common goals of the Clan culture (collaboration) and Hierarchy culture (control), an atmosphere of collectivity, discipline and mutual help, and an emphasis on empowerment and project participant evolvement. Organizational culture therefore has an impact in the uptake of Information Management technology for construction projects.

Keywords: Construction Project Management, Information Management Technology, Competing Values Framework, Unified Theory of Acceptance and Use of Technology, Organizational Culture.

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1.0 Introduction

The collaboration between the different professionals working on projects in the construction industry results in the generation of massive amounts of information used for decision making (Coelho, Mojtahedi, Kabirifar, & Yazdani, 2022). The construction industry is heavily dependent on human capital dictated by the size of the project and requires effective ways of communication. Professionals have varying responsibilities and skillsets which if not effectively coordinated, can bring unique challenges in communication breakdown, fragmentation of information and low project information access between design team members and ground technical teams. (Adekunle, Aigbavboa, Akinradewo, Oke, & Aghimien, 2022; Waszkiewicz & Gumienny, 2021).

People who work on the same construction project eventually develop values that are shared based on the communication among team players in the specific environment (Zuo et al., 2014). These values and beliefs can be described as the 'project culture' or 'organizational culture' specific to the construction industry, and its projects. The competing values framework has been used in various studies to identify the internal and external organizational focus and the degree to which this provides stability to the project team (Awolesi & Fabi, 2019; Coelho et al., 2022). Various industries have documented the influence of organizational culture on different efficiencies, however, this has not been done within Construction Project Management (Arditi, Nayak, & Damci, 2016; Kim & Han, 2017).

The construction industry is heavily information-centric and requires effective management of this information for the efficient timely delivery of projects (Hua, Kang, Zhang, & Li, 2021; Patel & Patel, 2020). A number of studies have indicated that the use of information technology tools for communication in construction project management significantly improves efficiency and quality management and reduces turnaround time for on-site projects and the associated cost for clients (Serpell, Barai, & Oladapo, 2007; Szewczyk & Radziszewska-Zielina, 2020; Alsafouri & Ayer, 2017). Despite the importance and early adoption of communication technology by other industries, the adoption of collaborative communication technology in the construction industry has been slow across geographical locations and within countries (Manookian, Cheraghi, & Nasrabadi, 2014; Teräväinen, Junnonen, & Ali-Löytty, 2018).

There is a renewed focus on the people who deliver projects, not just the processes and systems as one way of addressing people driven inefficiencies for projects in construction (Kwatsima & Wanyona, 2014; Rotich et al., 2022; Muneer et al., 2022). This study therefore sought to apply the competing values framework to assess the construction project environment's organizational culture, in order to assess its effect on the uptake of information management technologies.

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2.0 Methodology

2.1 Frameworks Utilized

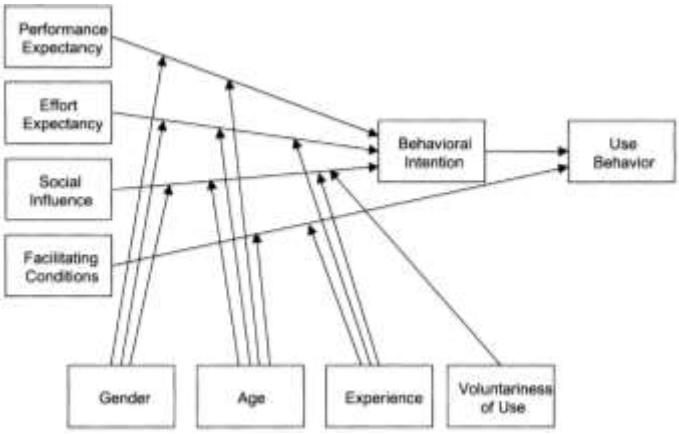

Fig. 1: Framework for the UTAUT. Source: Venkatesh et.al. (2003)

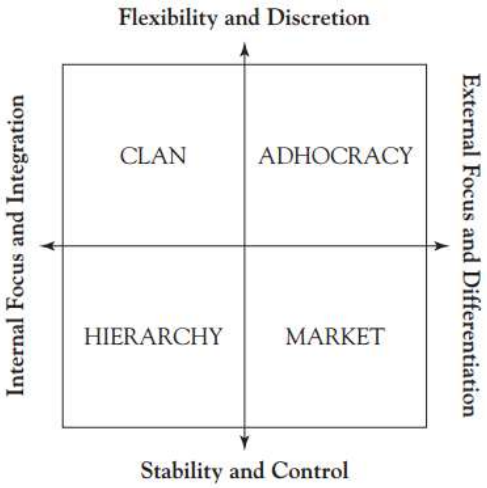

Fig. 2: The Competing Values Framework. Source: Cameron & Quinn, (2006).

A detailed review of the existing literature across various publications on both organizational culture and technology uptake was undertaken. The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, et.al. 2003) was selected as encompassing all elements needed to measure the drivers of adoption of information management technology in this study.

The Competing Values Framework, developed by Quinn & Rohrbaugh in 1981, emerged from research on the criteria that predict that if an organization performs effectively, two dimensions consistently appeared. One dimension has a continuum of flexibility, discretion, and dynamism on one end and stability, order, and control on the other. The second dimension differentiates an internal orientation with a focus on integration, collaboration, and unity from an external orientation with a focus on differentiation, competition, and rivalry (Cameron, 2015). The four effectiveness criteria models in the CVF are the four organizational culture types, termed as Clan, Adhocracy, Market, and Hierarchy and representing the values of Collaboration, Competition, Flexibility and Control, respectively (Cameron & Quinn, (2006).

A conceptual framework informed by the above frameworks was created. The key independent variables of the study were collaboration (clan culture), competition (market culture), creativity (adhocracy culture) and control (hierarchy culture), which are the markers of the different organizational cultures. The dependent variable was the adoption of information management technology. This was described by the behavioral intent of the project participants and the

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facilitating conditions, both which have been proved by UTAUT to be direct determinants of usage behavior, as well as the actual level and type of information management technology used.

2.2 Population, Sampling and Instruments

Data was collected from a cross-sectional study of the sample population. The data was sourced first-hand from construction industry professionals working within Nairobi County, who met the criteria of being situated in Nairobi County and having worked on housing or commercial construction projects of any size, and with a project team of at least three professionals in each of these projects.

As captured from membership data in the Architectural Association of Kenya, Board of Registration of Architects and Quantity Surveyors, and the Engineers Board of Kenya, 50% of all practicing architects in the country practice in Nairobi, as well as 65% of all practicing quantity surveyors, and 28% of all practicing engineers. The population of construction professionals in Nairobi was therefore 543 architects, 435 quantity surveyors and 676 engineers (440 civil, 107 mechanical and 129 electrical). In addition to this, based on an average of the percentage of the three professional groups practicing in Nairobi (48%), a sample population of construction project managers was calculated to be 95, bringing the total population to 1749.

To calculate the sample size, the Cochran formula was used (Cochran, 1977).

$$n_o = \frac{Z^2 pq}{e^2}$$

Where e is the margin of error, p is the estimated proportion of the population which has the attribute in question, q is 1 – p, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails and n_o is the sample size. (1 - α equals the desired confidence level, i.e., 95%). It is assumed that p = 0.5 for maximum variability, and that there is a 5% margin of error. Z = 1.96

$$n_o = \frac{1.96^2(0.5)(0.5)}{(0.5)^2} \qquad n_o = 384.16$$

Because the population under study was less than 10,000, the adjustments were calculated as follows, with N being the population size:

$$n = \frac{n_o}{1 + \frac{(n_o - 1)}{N}} \qquad n = \frac{384.16}{1 + \frac{(384.16 - 1)}{1749}} \qquad n = 316$$

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From this sample, there was a response rate of 78%, comprising of 67 architects, 69 engineers, 77 quantity surveyors and 33 project managers. Because of the specialist nature of the study i.e., technology related, purposive sampling was used to select respondents. The instrument chosen for this study was the questionnaire, which was administered in person and via email based on respondent preference. Validity and reliability were ensured by a pretest to assess internal consistency, ease of understanding, appropriateness of the questions and question sequence. The questionnaire's internal consistency was tested using Cronbach's Alpha, and returned a value of .848, showing that the questionnaire items had shared covariance.

2.3 Empirical Model

The data collected was quantitative in nature, and was cleaned, validated and value-labeled in SPSS version 24. The empirical model used was as follows:

Effects of collaboration on the adoption of information management technology

$Y= \beta 0\ \beta 1X1+e$ ..... (i)

Effects of competition on the adoption of information management technology

$Y= \beta 0 + \beta 2X2+e$ ..... (ii)

Effects of creativity on the adoption of information management technology

$Y= \beta 0 + \beta 3X3+e$ .....(iii)

Effects of control on the adoption of information management technology

$Y= \beta 0 + \beta 4X4+e$ ..... (iv)

Overall equation of the effects of the independent variables the adoption of information management technology

$Y= \beta 0 + \beta 1X1+ \beta 2X2+ \beta 3X3+ \beta 4X4+e$ ..... (v)

Where:
Y= adoption of information management technology
β0= intercept
β1X1 = linear effect of collaboration
β2X2 = linear effect of competition
β3X3 = linear effect of creativity
β4X4 = linear effect of control

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e = predictive error

3.0 Results and Discussion

3.1 The project organizational culture of construction projects in Nairobi

The first objective was to determine the project organizational culture prevalent in construction projects in Nairobi, based on the Competing Values Framework. The four main characteristics were collaboration, competition, creativity, and control, pointing to the clan, market, adhocracy, and hierarchy organizational cultures respectively.

The component of control (hierarchy culture) was found to be dominant followed by collaboration (clan culture) then creativity and competition, with scores of 0.83, 0.82, 0.81 and 0.74 respectively, out of a possible total of 1 for each.

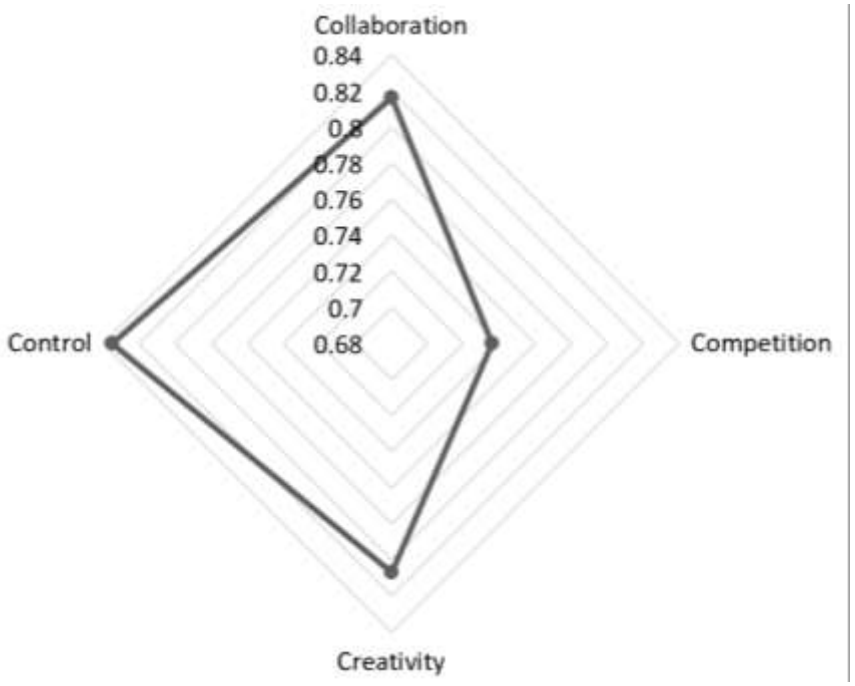

Fig 3: Visual representation of CVF scores for the construction industry in Nairobi

The component of control is dominant with the respondents followed by collaboration then creativity and competition, with scores of 0.83, 0.82, 0.81 and 0.74 respectively, out of a possible total of 1 for each. Respondents cited good organizational skills, and 90% said both that there were clear guidelines governing what they do, and there is hierarchy in communication with other participants. In comparison to this, in their study among contractors, Coelho, Mojtahedi, Kabirifar, & Yazdani, (2022); and Muneer et al., (2022), found that the collaborative (clan) culture scored the highest.

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Collaboration was second, with a majority of participants agreeing that there was harmony in workflow and that communication with other project participants was relatively easy (94%). This finding is similar to studies by (Jahanger et al., 2021). Mentorship and participation of all members rated high at 83% and 87% agreeing on these respectively. However, participants were divided on whether it was easy to communicate non-project matters with fellow construction professionals in the same project, with 20% disagreeing, 42% being neutral and 38% agreeing.

Creativity and competition scored the lowest, with competition coming in last. 90% and 87% of the respondents agreed that project participants were always trying to improve their workflow and that the leadership encouraged them to be creative in their approaches. Though 96% and 91% of respondents respectively said that their construction projects laid emphasis on the achieving of targets and that they were encouraged to solve problems that arose quickly, a high number (48%) agreed that they were not in competition with their fellow project participants to produce results.

3.2 The extent of adoption of information management technology in construction projects in Nairobi

The next objective was to find out the extent of adoption of information management technology in construction projects in Nairobi. It was found that construction professionals have a relatively higher preference to electronic means of information management over traditional physical means, which translates to a 73% use of completely electronic information management technology. 75% use email to communicate, while 65% and 59% respectively create and send documents electronically, and use the cloud for communication and collaboration. The industry was found to have a relatively good level of use of information management technology, at 84%. 99% and 97% of respondents respectively said that they had good computer skills and the knowledge necessary to utilize the system their construction project uses to disseminate documents. 78% said that the system they used made them more productive than traditional means, and 73% said that it fit well with their workflow methods. However, only 60% said that they had a specific person or group available to assist the project team members in case of system difficulties. Of the respondents 97.6% had a connection to the internet, while 2.4% did not.

3.3 The relationship between project organizational culture and information management technology adoption in construction projects in Nairobi, and creation of a model relating them

Table 1: A model relating organizational culture to information management technology adoption

Coefficients[a]							
	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	1.487	.375		3.967	.000		
Collaboration	.102	.093	.079	1.091	.276	.661	1.513

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Competition	.157	.073	.149	2.162	.032	.726	1.378
Creativity	.332	.088	.272	3.780	.001	.664	1.507
Control	.021	.092	.017	.224	.823	.614	1.630

a. Dependent Variable: Tech_uptake

Table 2: Regression Model

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.415[a]	.173	.159	.58904	1.289

a. Predictors: (Constant), Control, Competition, Collaboration, Creativity

b. Dependent Variable: Tech_uptake

The third and fourth specific objectives sought to establish the relationship between project organizational culture and information management technology adoption in construction projects in Nairobi, and to create a model relating them, respectively. The coefficient of correlation of collaboration ($r=0.265$, $p<0.01$), competition ($r=0.304$, $p<0.01$), creativity ($r=0.376$, $p<0.01$), and control ($r=0.258$, $p<0.01$) showed a positive relationship with technology uptake. The regression model specifies coefficient of determination R^2 as 0.159. The Variable Inflation Factors index was below 5 for all the variables indicating that there was no multicollinearity.

In a combined relationship Collaboration ($p<0.01$), Competition ($P<0.01$), Creativity ($p<0.01$), and Control ($P<0.01$), all had a significant influence on technology uptake. The study model was; therefore, $Y= 0.00 + 0.079X_1 + 0.149X_1 + 0.272X_1 + 0.017X_1 + \ldots$

4.0 Discussion

It is possible that the dominant hierarchical construction project environment in Kenya is inherited from ethnic culture where there is clear leadership hierarchy, and respect for leadership is observed (Hyden, 1972; Nyambegera et. al., 2000). This may be reflected in the project environment where clear guidelines which have been laid down by the project management are strictly to be followed. Collaboration scoring relatively high and coming in second resonates with the study by Oney-Yazic et. al (2006). Creativity and Competition scored the lowest, as they are values that are in competition with the first two high-scoring values, as explained in the Competing Values Framework. The industry has gained advantage from the hierarchical and clan cultures' distinct attributes, and typically construction project leaders should intentionally endeavor to create a culture that is in line with their project objectives. However, the construction industry would benefit from having construction project organizational cultures that are a healthy mix of the four typologies, and effort should be made to make sure the best quality of each culture is

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represented in the construction project. This is in line with the findings from other studies with homogenous cultures (Hua, Kang, Zhang, & Li, 2021).

The relatively high preference for electronic means of information management relatively good level of use of information management technology observed, together with the high level of internet connectivity can be attributed to the fact that the study was done in Nairobi. Thus, it may not be indicative of how the rest of the industry in the country operates, as Nairobi specifically has a higher internet penetration and use, as well as a higher number of construction professionals (Kenya National Bureau of Statistics, 2018), (Kenya National Bureau of Statistics, 2020). There is still much room for improvement, as the technology being used in the industry is at the most basic and general level (use of email, electronic document creation and storage using simple free cloud tools, etc.), and yet, more specialized technologies have existed for more than two decades (BIM, Construction ERPs, etc) that can make the construction professionals' communication and collaboration easier and more efficient. The next step for the industry would therefore be to take up the use of these technologies.

Correlation analysis showed a strong and positive relationship between the independent variables (collaboration, competition, creativity, and control) and the dependent variable (technology uptake). The coefficient of determination specified from the regression model means that variables in this study explained about 15.9% of variations in technology uptake. The lack of multicollinearity in the VIF index shows that there is no correlation between the independent variables, and that information management technology will improve if the variables in this study were taken into consideration in addition to other variables not in this study.

Further, the findings on collaboration (X1, B1= 0.079, P=0.276) implies that a unit change in collaboration will improve information management technology uptake by 7.9%, and the improvement is statistically significant at P<0.01. In addition, the findings on competition, (X2, B2= 0.149, P=0.032) implies that a unit change of X2, will improve information management technology uptake by 14.9%, and the improvement is statistically significant at P<0.01. The creativity model, (X3, B3=0.272, P=0.001) implies that a unit change of X3 creativity will improve information management technology uptake by 27.2%, and the improvement is statistically significant at P<0.01. Finally, (X4, B4=0.017, P=0.823 shows that a unit change of control X4, will improve information management technology uptake by 1.7 %, and the improvement is statistically significant at P<0.01. It therefore implies that if the results of this study were to apply creativity, competition and collaboration would be the point to start, followed by control.

5.0 Conclusion and recommendations

Organizational culture has been shown to influence the uptake of information management technology for construction projects. Based on these findings, and with the support of the Unified

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Theory of Acceptance and Use of Technology, the following should be done to improve the uptake of information management technology:

i. *Clear communication on the importance of technology by leadership*. Because there is a strong, controlled, Hierarchical project organizational culture in construction projects in Nairobi, project firms and their management need to lead by making clear intent to communicate the importance of utilizing this technology for timely delivery of projects.

ii. *Creation of policies and procedures by leadership*. The clear intent must be followed by policies and procedures, and resources being put in place in each project to make the transition from traditional to electronic means of information management seamless for project participants.

iii. *Collaboration and mutual help in technology use*. The naturally collaborative nature of construction projects and the presence of a strong Clan project organizational culture, with its atmosphere of collectivity and mutual help, will - once the necessary structures are put into place - then allow the project participants to easily work together to first learn and then use information management technology to better the communication and collaboration process throughout the project's life cycle.

6.0 Acknowledgements

6.1 Ethical Considerations

Ethical considerations for conduct of research on human subjects were adhered to. Ethical approval was obtained from the National Commission for Science, Technology and Innovation under License No. NACOSTI/P/20/7809. Consent was obtained from the respondents and confidentiality and anonymity maintained throughout the study.

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