

INFORMATION COMMUNICATION TECHNOLOGY DYNAMICS AND PERFORMANCE OF E-GOVERNMENT SYSTEMS. EMPIRICAL EVIDENCE FROM THE MINISTRY OF EDUCATION IN KENYA

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ABSTRACT

Kenya has heavily spent considerably in e-government systems with the aim of ensuring an efficient, transparent and accessible public services for full realization of vision 2030. Nevertheless, the performance of these systems have always been facing several challenges. Therefore, the study evaluated the influence of ICT dynamics on e-government performance within the Ministry of Education, concentrating on ICT infrastructure, security, and human capacity. The theoretical structures used comprised the Resource-Based View, Dynamic Capabilities, Diffusion of Innovations, Technology-Organization-Environment and stakeholder theories. A sum of 14 e-government systems used by the Ministry of Education were evaluated applying descriptive and explanatory research designs. The census approach comprised principal ICT officers, senior ICT officers, ICT officers 1 and 2, assistant ICT officers, and the individuals using e-government systems. A semi-structured questionnaire was used in gathering primary data, whereas quantitative data assessments included used of descriptive (mean and standard deviation) and inferential measurements (correlation and regression). The results were that ICT infrastructure ($\beta=0.0564$, $p=0.002$), ICT

security ($\beta=0.0498$, $p=0.002$), and ICT human capacity ($\beta=0.0317$, $p=0.001$) had contributed to significant positive improvement on the performance of e-government systems within the ministry. The study concludes that having a strong infrastructure can assist the Ministry in delivering services within the expected time and effective manner to students, teachers, and also the parents. The initiation of ICT safety actions guard sensitive data, consequently cultivating stakeholders' confidence. Improved quality ICT capacities of staff increase the administration of e-government schemes, resulting to progressive services such as registering and resource distribution. The recommendations are that the Ministry of Education ought to prioritize capitalizing in broadband connectivity for assured dependable internet availability to every institution of learning. Furthermore, the ministry must institute vulnerabilities in the present ICT infrastructures, measure risks related to e-government systems, and devise suitable approaches for handling such matters.

Keywords: ICT Infrastructure, Performance, ICT Security, ICT Human Capacity.

INTRODUCTION

The practicality of e-government systems is accepted as vital performance indicator for e-government frameworks. Studies point out that such systems improve the proficiency of services rendered by the government through promoting easy accessibility of information and nurturing an accountable and transparent process (Moon & Kim, 2019; Yildiz & Cerit, 2020).

The usefulness of these systems could be influenced by a number of issues like the quality of the system, information and service (Sahraoui et al., 2017). An e-government system provides its services using digital machineries, which incorporate mobile gadgets, internet, and several other digital platforms. Amongst methods used in assessing the e-government system performances is accessibility. It is expected that the operation of systems should 24/7 and accessible by any device connected to the internet.

The proficiency and effectiveness of e-government systems serves as ICT dynamics indicators, which improve the level of electronic government system performance by providing appropriate ICT assets and infrastructure (Gyaase, 2014), ICT human capacity (Abdalla, 2014; Sameer, Dwivedi, & Sherry, 2015), and corporate culture (Nkohkwo & Islam, 2015). ICT dynamics are important resources that permit efficient implementation of e-governments (Khanra & Joseph, 2020). The ICT infrastructure consist of several technologies, comprising operating systems, hardware, network, internet connectivity, servers, softwares, websites, and data centers with the framework of e-government systems (Alam & Hassan, 2014). A research done by Muraya (2015) focusing on factors influencing the performance of e-government systems adopted by the public sector pointed out that ICT infrastructure and computer systems contributed significantly. Dahiya and Mathew (2014) indicate that even though the government has invested heavily on government ICT, it still stands unclear how and what ICT investments strategies would result to better and sustainable performance of e-government.

Statement of the Problem

Education is fundamental for a nation's improvement goals. Vision 2030's education structure purposes to raise Kenya to middle-income position (RoK, 2017). Identifying the gains of e-government, the Ministry of Education (MoE) is improving delivery of services to the public (Corbitt & Oyaro Gekara, 2019). Session Paper No. 1 of 2005 seeks for achieving universal education by 2015, concentrating on convenience, fairness, and value (MOEST, 2005). Kenya's National ICT Strategy purposes to advance e-government and delivery of services. Nevertheless, its execution within the ministry has confronted difficulties like technical matters, lack of enough capacity, digital disparities, and opposition to transformations. Management of these difficulties is critical for successful use of e-government schemes to attain the policy's aims within education. Even though the strategy intends to nurture economic progression and maintainable expansion over technology, numerous electronic government schemes within the Ministry of Education are facing diverse achievement in attaining their objectives (Ministry of ICT, 2019).

The NEMIS system handles student data and educational records, helps in selecting those joining form ones, and assigns resources to schools (MOE 2016). To employ and equip the teachers with the required ICT skills, the objective was to guarantee smoother changeover for other teachers and students through NEMIS system, arming them with expertise in accessing KICD Cloud materials. Nevertheless, the approach did not meet the expectations (Riany, 2021). It was projected that giving laptops and accessories could allow registration of learners using NEMIS and KNEC-ERS at schools rather than using cyber cafes. Regrettably, teachers

could not have the capability of using digital learning devices for teaching, resulting to them being put away in storage, underlining the necessity for additional examination into the matter. The Teachers' Service Commission TMIS portal permits teachers to record, apprise their particulars, and get resources online (Bulimo, 2021). Formerly, this was done in cybercafés. Kabuto (2019) indicates that public sector in Kenya fights with ICT performance owing to higher rate of failing e-government system, stimulating examinations of these infrastructures, ICT security, policy structures, and training conducted. The Ministry of Education (MoE) has introduced several e-government changes to enhance delivery of services within education, comprising NEMIS, SDL, Online Recording and Examination Structures, Development of digital contents, TMIS, SIMS, and EMIS. Still, the correlation between ICT dynamics and system efficiency still stands inconsistent (Riany & Goga, 2021).

Objectives of the Study

- i. To assess the impact of ICT infrastructure on the performance of electronic government systems within the Ministry of Education in Kenya.
- ii. To investigate how ICT Security influences the effectiveness of electronic government systems in the Ministry of Education in Kenya.
- iii. To analyze the relationship between ICT Human capacity and the performance of electronic government systems in the Ministry of Education in Kenya.

LITERATURE REVIEW

Theoretical Review

There are two main theories adopted for this study; namely Resource based view (RBV) theory and diffusion of innovation theory.

According to Kraaijenbrink, Spender, and Groen (2014), Wernerfelt (1984) developed the Resource-Based View (RBV) Theory, which has made a significant contribution to Resource-Based View (RBV). There have been a number of contributors to Research Based Views (RBVs), including Barney (1986a, 1986b, 1991a), Peteraf (1993), and Teece (1997). The RBV Theory has thus been used in studies on E-Systems, strategic management, and other topics, according to Figueiredo, 2021. Peteraf and Barney (2018) assert that the RBV points out that organizational resources significantly contribute to competitive edge and Organizational performance. The RBV theory emphasizes that corporate possessions as the primary factors of competitive advantage and superior throughput. The theory argues that continuous improvement is vital to improving the performance of their firms. Nevertheless, Limited time and resources must be invested in making the modifications to improve the firm performance that the firms encounter. (William & Dettmer, 2018, Muithya & Muathe, 2020).

The Diffusion of Innovation (DOI) theory by Rogers (1983) explain the fundamental questions of how, why, and when new technologies spread. He describes diffusion as the intricate process of integrating innovations into a specific timeframe, engaging individuals within that space. Rogers (2003) indicate that a well-built ICT infrastructure is key for easing accessibility to government facilities. This theory proposes that the ICT infrastructures of the firm which is designed by its comparative benefit, technological configuration, complication,

experimentation prospective, and apparent impact. Moreover, it contends that technology's easiness of usage considerably affects user acceptance—available systems inspire commitment, whereas multifaceted ones might deter acceptance. So, ICT infrastructure used by the government for implementing e-government service has to be user friendly.

Empirical Review

ICT Infrastructure and Performance of E-government Systems

ICT's appearance in industrialized and emerging nations is considered by multifaceted dynamics, as discovered by Twiizeyimana, Larsson, and Grönlund (2016), specifies the continuing development of microelectronics, motivating the unceasing advancement of ICT and determining upcoming systems. Kabuto (2016) postulates that Kenya has not managed satisfactorily in performance of e-government performance credited to a substantial failure level of state-owned agencies. Egessa and Manyasi (2016) discovered a vital outcome: the growth of knowledge is powerfully connected with the distribution of ICT infrastructure within the country. Kibuku and Wausi (2020) shown that inadequate and unpredictable Internet bandwidth rests the main hindrance to operative e-learning within Kenya. Kibuku and Ochieng (2020) investigation show that owing to inadequate systems incorporation, inadequate practical infrastructure, and absence of bandwidth, Kenya fights to effectively execute e-government systems.

ICT Security and Performance of E-government Systems

Awad and Ghazawneh (2015) indicated that governments ought to guarantee that their systems are firmly sheltered from cyber penetration, ensuring the government information stands inviolate, trustworthy, and reachable. Bhatti and Khan (2016) perceived that safety procedures including firewalls, encryption, and interference detection schemes might impede efficiency of e-government systems, resulting to performance weakening. Alsharhan and Qaisi (2019) investigation establish that the performance of e-government system adversely effects safety and confidentiality fears. Similarly, Azam, Hussain, and Abbas (2021) surveyed how ICT security linked with performance of e-government systems within Pakistan, observing that improving safety procedures enhanced e-governance performance.

ICT Human Capacity and Performance of E-government Systems

Kashorda and Waema (2014) study based on universities within Kenya observed a substantial obstacle to e-learning employment in these institutions, revealing that E-learning is not economical for a middle-leveled university originally. Gyaase (2014) investigation recognized that regionalization, rules, e-governance, and efficiency altogether lacked efficacy. Tarus, Gichoya, and Muumbo (2015) did a research focusing on evaluation of factors limiting performance of China's e-learning, observing that designing e-learning courses grants substantial obstacles, particularly in relations to financial constrictions and e-content formation and application. The Moya, Nabafu, Maiga, and Mayoka (2017) study was based on looking at how effective the Uganda's e-government system was by applying an extended model. The investigation has determined that the model desires to comprise multiple features, integrating the social and political features, ICT infrastructure, and sensitization, proportions of financial features, training, confidence, and resource deployment.

RESEARCH METHODOLOGY

The study applied positivist philosophy. The research employed a combination of descriptive and explanatory designs. The population was 14 electronic government systems of Ministry of Education, whereas the respondents were Principal ICTOs, Senior ICTOs, ICT officers, Assistant ICT officers, and system operators. All the 14 e-government systems were sampled. Data was gathered using semi-structured questionnaires, whereas quantitative examination engaged descriptive and inferential measurements, comprising correlations and regressions assessments.

The regression model is expressed mathematically using the following equation:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \epsilon \dots \dots \dots \text{Model 1}$$

Where

- Y = Performance
- X₁ - ICT infrastructure
- X₂ - ICT human capacity
- X₃ - ICT security
- β₀ - Intersection point
- β Coefficients
- e - error term

RESEARCH FINDING AND DISCUSSIONS

Descriptive Statistics

The research did a comprehensive examination of quantitative data applying several descriptive statistical methods. This necessitated computation of necessary metrics like mean, which indicates the dataset average and functions as a central data spreading orientation. Also, the research adopted standard deviation to estimate the extent to which data varied or dispersed, underlining the level of individual's data points differed from the average. The subsequent subsections presents descriptive statistical outcomes, organized as per individual variable.

Table 1: ICT Infrastructure and Performance of E-government Systems

Statements	N	Mean	Standard Deviation
The Ministry of Education provides adequate hardware components to support e-government	277	3.75	1.007
At workplace the different e-government initiatives achieves the intended purposes.	277	3.81	1.017
The internet connectivity at work is of high speed ,reliable and provides a substantial up-time	277	3.58	1.203
Key hardware components are availed on demand to carry out various computer tasks	277	4.01	1.107
There is availability of necessary/required software components for use in e-government systems.	277	3.90	1.160
Software is updated frequently to meet the evolving needs of e-government.	277	4.65	0.587
A backup and recovery strategy for data is in place in case of loss.	277	2.60	1.669
Generally speaking, the workplace where you work has infrastructure in place to assist e-government projects.	277	4.54	0.683
There exist E-government standards in your organization	277	4.59	0.535
Aggregate mean and standard deviation score		3.94	0.996

From table 1 the aggregate mean and standard deviation of 3.94 and 0.996 respectively, is an indicator of respondents’ general agreement level on statements regarding the ICT infrastructure on performance on e-government system of the Ministry of education, Kenya. This implies that strong ICT infrastructure is vital to updating government processes and refining education provision within the Country. Also suggests that ongoing to emphasis and investment in this part could contribute substantial gains to the Ministry of Education and the stakeholders. Kibuku and Ochieng (2020) established that for e-governance strategies to prosper, an outstanding ICT infrastructure is essential.

Table 2: ICT Human Capacity and Performance of E-government Systems

Statements	N	Mean	Standard Deviation
Staff ICT qualifications leads to better performance of electronic government systems in your organization.	277	4.57	0.602
Staff professional experience leads to better output hence better performance of electronic government systems in your organization.	277	4.60	0.490
Staff training empowers them to boost electronic government performance in the organization.	277	4.53	0.667
Performance of e-government systems is dependent on Investment in ICT Research in your organization.	277	4.40	0.937
Performance of e-government systems rely on the adequacy of ICT officers in your organization.	277	4.50	0.684
Adequate acquaintance of ICT to use of electronic government systems by stakeholders/customers improves performance of electronic government services in your organization.	277	4.48	0.755
Aggregate mean and standard deviation score		4.51	0.689

The study observed that the respondents had commonly agreed on all the statements describing the influence of ICT human capacity on performance of e-government system performance within the Ministry of Education in Kenya (aggregate Mean=4.51; aggregate standard deviation = 0.689) as tabulated in table 2 above. The finding is a reflection of encouraging viewpoint for ICT expansion within ministry. Tarus, Gichoya, and Muumbo (2015) underscore the fundamental role of human capability within application and manipulation of ICT systems.

Table 3: ICT Security and Performance of E-government Systems

Statements	N	Mean	Standard Deviation
There is e-government systems security awareness conducted by the relevant ICT sectors to all the members of staff/citizens to uphold confidentiality and privacy.	277	4.54	0.645
There is a clear policy to Communicate the responsibilities for the protection of e-government systems.	277	4.14	1.073
ICT department facilitate the preservation of the integrity and privacy of e-government systems.	277	4.13	1.237
Employees are aware of e-government systems security threats and how they adversely affect their work.	277	4.58	0.594
Staff training and capacity building on security authentication/accessibility levels of e-government systems is conducted.	277	3.79	0.999
A high level of interdepartmental security awareness on e-government systems to boost trust is present.	277	3.84	1.003
Policies, protocols, and data management tools are present and necessary to strike a balance between protecting individuals' privacy and the effective and efficient use of that information by the government.	277	3.67	1.153
There exist a standard for managing storage of data.	277	3.92	0.966
Aggregate mean and standard deviation score		4.08	0.959

From table 3 respondents consistently agreed on all statements effectiveness of ICT security in improving the performance of e-government systems of the Ministry of Education, Kenya with an aggregate mean (4.08) and standard deviation (0.959). The findings reflect presence of rising recognition of technological progressions, with stakeholders progressively appreciating digital way out for improved efficiency, clearness, and convenience in governing educational systems. Alsharhan and Qaisi (2019) recognized the positive influence of digital structures on managerial competence and service provision within educational institutes.

Table 4: Performance of E-government Systems

Statements	N	Mean	Standard Deviation
Electronic government systems have brought about increased service delivery /fast execution of processes in the Ministry of Education	277	4.50	0.720
Electronic government systems have resulted in simplification of procedures in your organization	277	4.53	0.705
The Electronic government system has resulted in to reliable information delivery	277	4.17	0.962
The Electronic government system has resulted to comprehensive information delivery	277	4.23	0.990
The Electronic government system has resulted to easy access of information delivery	277	3.90	1.216
The Electronic government system has enhanced fairness among stakeholders	277	4.02	1.098
The Electronic government system has resulted in improved interaction	277	4.01	1.118
The Electronic government system has improved planning and decision making	277	3.86	1.191
The Electronic government system have resulted to better monitoring and control	277	3.96	1.176
Aggregate mean and standard deviation score		4.13	1.019

The aggregate mean value (4.13) and aggregate standard value (1.019) is a confirmation of general agreement from the respondents on all the statements that were used in describing performance of E-government Systems within the Ministry of education. The finding proves that the respondents had a positive perception of the level of performance of the Ministry's e-government systems. Founded on these outcomes, Yildiz and Cerit's (2020) investigation outcomes on e-government strategies usefulness and proficiency in improving provision of services to the public and transparency are reinforced.

Inferential Statistics

The examination of the level of relationship amongst variables was achieved through correlation examination, concentrating on the level association based on strength and direction. The study employed Pearson r correlation approaches to assess the amount of associations, thus cultivating the comprehension of essential shapes of data.

Table 5: Correlation Analysis

		ICT infrastructure	ICT human capacity	ICT security	Performance
ICT infrastructure	Pearson Correlation	1			
	Sig. (2-tailed)				
	N	277			
ICT human capacity	Pearson Correlation	0.364	1		
	Sig. (2-tailed)	0.214			
	N	277	277		
ICT security	Pearson Correlation	0.194	0.341	1	
	Sig. (2-tailed)	0.269	0.117		
	N	277	277	277	
Performance	Pearson Correlation	0.719	0.793	0.811	1
	Sig. (2-tailed)	0.003	0.002	0.001	
	N	277	277	277	277

The Pearson r value for ICT infrastructure is 0.719, 0.793 for human capacity and security had 0.811 revealing strong positive connections performance of e-government systems. The respective significance values were ICT infrastructure (0.003), human capacity (0.002) and security (0.001). The values were less than 0.05 which confirmed presence of statistical significance of all these variables on performance of e-government systems of the Ministry.

Table 6: Model Summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.891 ^a	.794	.751	1.0064
a. Predictors: (Constant), ICT dynamics (ICT infrastructure, ICT Security, ICT Human capacity)				

From table 6 above the adjusted R value was 0.751 which represents a variation of 75.1% of performance of performance of e-government systems is as a result of ICT infrastructure, human capacity and security influence. This means that the difference of 24.9% represents other ICT dynamics not considered by the study.

Table 7: Analysis of Variance

ANOVA ^a						
Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	512.6287	3	170.876	235.763	0.003
	Residual	197.8651	273	0.725		
	Total	710.4938	276			
. Dependent Variable: Performance						
b. Predictors: (Constant), ICT Dynamics (ICT infrastructure, ICT Security, ICT Human capacity)						

The results in table 7 indicate that the model had a significance value below 0.05 at 0.003 which was an evidence of statistical significance of the model.

Table 8: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
Constant	0.684	0.211		3.242	0.003
ICT infrastructure	0.778	0.169	0.0564	4.604	0.002
ICT Security	0.756	0.267	0.0498	2.831	0.002
ICT Human capacity	0.788	0.305	0.0317	2.584	0.001

Based on results obtained, the resultant regression is expressed as;

$$Y = 0.684 + 0.778X_1 + 0.756X_2 + 0.788X_3$$

The results indicate that ICT infrastructure was associated positively with improved e-government performance, with a statistically substantial value of 0.002, signifying that better-quality ICT infrastructure affected e-government performance significantly. The beta value for ICT security was 0.0498, designating a positive correlation between these variables. This was also supported by significance value of 0.002. In addition, the results imply that an improvement on ICT security would directly lead to improved e-government effectiveness. The beta value for ICT human capacity was 0.0317, representing a positive association with performance of e-government systems. Therefore, this signifies that a unit increment on of ICT capacity would lead to increased performance of these system at 0.0317. In the lack of an e-government efficiency enhancement, enhancing ICT human capacity could lead to significant improvements in efficiency. A 0.001 level of significance validates this statistical applicability.

Conclusions

A strong infrastructure lets the Ministry to distribute well-timed and effective provision of services to the relevant stakeholders. ICT infrastructure improves data administration practices of the Ministry of Education, permitting better decision-making process, policy progress, and resource delivery grounded on detailed and present information. The ICT security procedures guard delicate data, like the records of the students, examination marks, and individual teacher data and managers nurturing trust amongst all the stakeholders. Improved ICT expertise amongst staff guarantee that e-government systems are additionally user-friendly and available

resulting to faster reaction times for services like enrolling student, registering for examination and resource sharing.

Recommendations

The Ministry ought to prioritize enhancing accessibility of broadband to guarantee that every educational institution, especially those based in rural areas, have steady internet accessibility. The Ministry should identify susceptibilities within ICT infrastructure and measure possible risks to e-government systems. There is need for application of guidelines on ICT resource practice, data safety, and response to incidents. The Ministry should carry out consistent workshops and conferences dedicated on the newest ICT improvements, instruments, and paramount practices. Such actions could be conducted by industry experts and cover topics like data administration, cybersecurity, and software improvements.

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