

RESEARCH ARTICLE

A Digitization Model for Ugandan Technical, Vocational and Education Training Institutions: An Agency Theory Perspective

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ABSTRACT

The inconsistent effectiveness of digitization project implementation in Technical and Vocational Education and Training (TVET) institutions, often due to poor process quality and inadequate monitoring, presents a significant challenge. Grounded in Agency Theory as the foundational framework and supported by the DeLone & McLean Information Systems Success Model and the Dynamic Capabilities Framework, this study examines how process quality, goal conflict, and communication influence project outcomes in TVET institutions. Adopting a pragmatic stance, an abductive approach, and a design science methodology, the research provides a framework for stakeholders to optimize digitization projects. Data from 100 participants, analyzed using structural equation modeling, reveal that process quality significantly enhances communication, predicting project effectiveness. Monitoring plays a mediating role, while an inverse relationship is observed between digitization and goal conflict. The study shows high validity and reliability, with all variables having Cronbach's alpha above 0.7. Recommendations include addressing power struggles and reducing political influences while prioritizing process quality to improve project outcomes. The findings offer practical guidance for policymakers and practitioners in educational technology integration, particularly in developing economies.

1 | Introduction

Technical and Vocational Education and Training (TVET) plays a pivotal role in addressing global societal and economic challenges by equipping individuals with the skills needed for the labor market (Okolie et al. 2020; Amin et al. 2023). Recognized as a cornerstone of sustainable socio-economic development, TVET promotes entrepreneurship, enhances employability, and aligns education systems with the evolving needs of industries (Buli and Yesuf 2015). In Africa, TVET serves as a vital tool for preparing graduates for the workforce and driving economic

transformation in developing economies (Okolie et al. 2020; Tripney et al. 2013).

In Uganda, the government has prioritized TVET as a pathway for addressing unemployment and meeting labor market demands. Digitization of TVET operations, championed by the Ministry of Education and Sports, represents a critical initiative to enhance efficiency and effectiveness (MoES 2019; ILO 2021). Investments in ICT infrastructure, supported by partnerships such as the \$100 million World Bank funding, aim to modernize TVET delivery and bridge skill gaps in the workforce. However,

despite these investments, digitization efforts have been blemished by significant challenges, including high failure rates, resource misallocation, and inefficiencies in project implementation (Djurovic 2020; CHAOS 2020). Uganda's 70% digitization failure rate mirrors global trends, highlighting persistent obstacles in the adoption of digital systems in developing economies (Kituyi et al. 2024; Nabulongo et al. 2023).

Globally, digitization projects in developing economies face a failure rate of 70%, compared to 66% in developed economies, where established frameworks, models, and methods have improved project success rates (Djurovic 2020; CHAOS 2020). This plain difference emphasizes the contextual challenges in developing economies, revealing that a "one-size-fits-all" approach is ineffective. The persistence of high failure rates in developing contexts highlights the critical need for a tailored framework that addresses specific challenges unique to these regions. In Uganda's TVET sector, where digitization is essential for enhancing workforce readiness, the development of a contextual model became imperative.

This study responds to this gap by synthesizing constructs from Agency Theory, the DeLone and McLean Information Systems Success Model, and the Dynamic Capabilities Framework to design and develop a contextual model aimed at improving the success of TVET digitization projects. By addressing context-specific challenges such as conflicting goals, poor communication, and inadequate task clarity, the proposed model aims to promote the effectiveness of digitization projects in Ugandan TVET institutions and provide actionable insights for overcoming these persistent barriers.

1.1 | Digitization in Uganda

The digitization of Technical and Vocational Education and Training (TVET) in Uganda faces significant challenges, rooted in infrastructure limitations, financial constraints, and governance issues (Ismail et al. 2022; Oviawe 2017). These barriers complicate efforts to transition TVET graduates into the labor market and hinder the seamless integration of digital technologies into the educational framework. Governance and policy implementation gaps, in particular, exacerbate the struggle to achieve alignment between TVET curricula and labor market demands, further widening the skills gap (Kintu et al. 2019).

Despite these challenges, digitization offers transformative potential for Uganda's TVET sector by redefining learning experiences. By simplifying complex skilling processes and making education more accessible, digitization has the capacity to promote lifelong learning opportunities for Ugandans (ILO 2020). The integration of digital tools and technologies into teaching and learning processes can enhance both efficiency and effectiveness. However, achieving these goals requires a robust focus on equipping instructors with the necessary training and resources to use digital tools effectively (Holler et al. 2023; Teis and Christo 2021).

Digital literacy stands out as a critical factor in ensuring the success of digitization efforts. Both learners and instructors must possess the foundational skills to leverage digital tools, enabling

them to address barriers and improve outcomes in TVET. Without sufficient digital literacy, the potential benefits of digitization may remain unattainable, further entrenching disparities (Ismail et al. 2022). While the importance of digital literacy is widely acknowledged, it is conceptualized in this study as a foundational capacity-building measure that supports the effectiveness of governance- and organizational-level constructs included in the model, rather than as a standalone construct.

2 | Rationale for Using Agency Theory

Agency theory, originating from the challenges posed by the separation of ownership and control in organizations, addresses conflicts between principals (owners/shareholders) and agents (managers/executives) (Jensen and Meckling 1976). These conflicts often lead to inefficiencies and suboptimal performance of organizations, highlighting the need for effective frameworks to manage principal-agent relationships.

In Uganda, the high failure rates of digitization in TVET institutions stress the need for a more robust approach in implementing these projects. Our research builds on the foundational work of Mahaney and Lederer (2003) to develop a model inspired by successful frameworks from developed countries (Hanna 2020; Kimuli et al. 2021). By extending their insights on agency theory, we focus on improving communication, reducing shirking, and enhancing process quality to tackle the unique challenges faced in these digitization projects in the Ugandan context.

Agency theory is crucial for navigating the complexities and conflicts inherent in these projects (Djurovic 2020; CHAOS 2020). This study examines how these conflicts impact project outcomes, providing valuable insights to improve the implementation and management of digitization efforts within TVETs. By doing so, we aim to create a more effective and sustainable approach to digitization in Ugandan TVET institutions.

Key constructs within agency theory, such as goal conflict, communication, and task programmability, shape project dynamics (Eisenhardt 1989; Mahaney and Lederer 2003). Goal conflict emphasizes the need to align project goals, while effective communication promotes collaboration and lessens information gaps. Task programmability ensures clear task definitions for improved alignment, role (for both principle and agent) and goal clarity.

Moreover, integrating insights from DeLone and McLean's constructs on Use and User Satisfaction offers a comprehensive view of system usability and end-user perception (DeLone and McLean 1992, 2003). Dynamic capabilities theory further emphasizes adaptability and innovation, enhancing resilience in TVET digitization efforts (Teece 2010).

Strategies proposed by agency theory, such as contracts and governance structures, are relevant in the TVET context (Gwala and Mashau 2023; Macho-Stadler and Pérez-Castrillo 2021). Contracts align interests between principals and agents, while governance structures monitor and incentivize positive behavior.

As evidence shows, applying Agency Theory to a framework or model for understanding TVET digitization provides valuable

insights into governance and monitoring, ensuring alignment with IT governance frameworks (Young et al. 2019). In this study, Agency Theory was used as the foundational lens to address challenges such as process quality, task programmability, goal conflict, communication, and monitoring. Processes, relational mechanisms, and structures enforced by top management in government, acting as principals, promote goal alignment, enhance process quality, and improve task programmability, thereby reducing shirking and goal conflict. Effective communication and robust monitoring mechanisms further ensure that agents execute their responsibilities in alignment with project objectives.

The DeLone and McLean Information Systems Success Model was applied to evaluate use, user satisfaction, and the overall impact (net benefits) of the digitization project as key measures of success. Additionally, the Dynamic Capabilities Theory complemented these by enhancing adaptability and innovation, guiding TVET institutions to sense opportunities such as new technologies, process improvements, and stakeholder needs. It also supported their ability to seize resources effectively and transform the organization by embedding digitization into core operations, redesigning processes, and building digital capacity to align with long-term goals. Together, these theories and models were integrated into a comprehensive framework to address the complexities of digitization in Ugandan TVET institutions.

2.1 | IT Governance Models and Frameworks

This section provides an analysis of IT governance models and frameworks. It offers a clear examination of their strengths, limitations, and applicability to digitization projects in Uganda's TVET institutions in the context of Agency theory. In the realm of IT service management, various frameworks such as ITIL Version 4, COBIT, COSO, PRINCE2, and the National IT Project methodology offer diverse approaches for managing services and projects. However, when applied to the unique context of Uganda's Technical and Vocational Education and Training (TVET) institutions, these frameworks reveal certain limitations and gaps. This analysis examines how these frameworks align with TVET digitization projects and the specific challenges faced within this educational environment.

ITIL Version 4 provides a comprehensive range of management service practices that can be adapted to work with existing frameworks (José et al. 2013; Moudoubah et al. 2021). While its service categorization—covering areas such as service design and strategy, service operation, service transition, and continuous service improvement—is robust (Nyeko 2019), it lacks specific guidance on aligning processes, structures, and relational mechanisms essential for achieving optimal IT-business alignment in Uganda's TVET context (Wulandari and Buliali 2019).

COBIT, although a valuable framework, may not singularly meet the business and IT alignment needs of TVET institutions and is best used in conjunction with other frameworks (Moudoubah et al. 2021; Zhang and Zhou, 2014). Its complexity might overwhelm resource-limited TVET institutions (Mutebi and Ferej 2023; Okumu and Bbaale 2019).

The COSO framework, while focusing on risk management and control, lacks the quantitative aspects necessary for assessing and improving project success in Ugandan TVETs (Gomes and Romão 2023). Adapting COSO to TVETs may enhance digitization project outcomes, particularly by addressing comprehensive risk and control management (Riyadi et al. 2021; Horwath et al. 2012).

PRINCE2's rigid structure and reliance on predefined templates make it less suitable for the dynamic environment of Ugandan TVET digitization projects (Cooke 2016; Hughes et al. 2017).

The National IT Project methodology (NITA-U 2013), tailored for Uganda, falls short in emphasizing process quality monitoring—a critical factor for effective digitization. Its linear approach to IT governance does not align well with the complex nature of TVET digitization projects.

Integrating Agency Theory with these frameworks led to the development of a conceptual model that enhances TVET digitization efforts in Uganda. Agency Theory ensures alignment of stakeholder interests and accountability in project execution. Combined with DeLone and McLean's Information Systems Success Model, which evaluates system quality, user satisfaction, and digital system impacts (DeLone et al. 2018), and Dynamic Capabilities Theory, which fosters organizational agility and adaptation to technological changes (Teece et al. 1997), this hybrid approach provides a robust framework for addressing digitization complexities. Therefore, a customized approach that incorporates the strengths of these frameworks, addresses their limitations, and integrates the constructs of Agency Theory, DeLone and McLean's model, and Dynamic Capabilities Theory is optimal for guiding successful digitization initiatives in Uganda's TVET institutions (Majdalawieh and Khan 2022; Olaniyi et al. 2024).

2.2 | Conceptual Model

Drawing from previous studies (Mahaney and Lederer 2003, 2011), this study introduces a conceptual model that addresses gaps in understanding the relationship between digitization and project success (Joshi et al. 2022), aligning with insights from agency theory that emphasize high-quality, effective organizational processes (Jackson 2024). This conceptual model incorporates critical elements, including goal conflict, communication, shirking, task programmability, and contract type, with a central focus on process quality as a pivotal mediating influence on the effectiveness of digitization projects in Ugandan TVETs (Berthon et al. 2002; Ozili 2023).

In accordance with agency theory, the framework emphasizes that for effective digitization projects, principals should prioritize the highest quality in each process (Joshi et al. 2022), which is managed by agents (Groener and Andrews 2019; Schoen et al. 2012) with strong support from top management. Decision-making at all stages of the transformation process requires clear communication to minimize goal conflicts and ensure alignment between principals and agents (Lang and Müller 2021). These challenges are particularly acute in Uganda, where the transition to digitized systems has faced

obstacles such as conflicting goals, information asymmetry, and resource mismanagement (Confidential 2021). Poor communication and unclear responsibilities have exacerbated these issues, as project teams often prioritize competing tasks over their primary responsibilities (Nakaziba and Ngulube 2024). Addressing these challenges requires fostering transparency and collaboration to ensure that objectives are well articulated and implemented effectively (Eisenhardt 1989; Mohammadi et al. 2022).

Shirking, a recurring issue in digitization projects, arises when agents neglect their responsibilities, favoring other activities instead of maintaining focus on the disciplined approach required for success (Mahaney and Lederer 2003). To counteract this, task programmability is essential. Task programmability involves the precise definition and structuring of tasks, including clear objectives, timelines, dependencies, and required resources (Joshi et al. 2020). This systematic approach eliminates ambiguities, enabling top management to monitor progress effectively and equipping implementers with actionable directives. By enhancing transparency and accountability, task programmability promotes alignment with organizational goals and fosters efficiency across all stages of the digitization process.

Process quality emerges as a critical variable within this conceptual model, particularly in the Ugandan TVET context. Building on principles of dynamic capabilities theory, process quality encompasses monitoring at both operational and strategic levels, as well as active participation from top management (Carvalho and Sampaio 2022; Sampaio et al. 2022). Effective monitoring ensures thorough evaluation of each step in a digitization project, coupled with the enforcement of rewards for success and consequences for underperformance. These practices promote continuous improvement, minimize duplication, and maximize the likelihood of achieving high-quality outcomes (Türk 2023; Berman et al. 2024).

Globally, digitization projects face persistent challenges, particularly in developing economies. Developing countries like Uganda struggle with a 30% success rate in digitization projects due to inadequate monitoring and evaluation, digital exclusion, resource misallocation, and stakeholder conflicts (Drechsler 2018; Fattah and Setyadi 2021). These challenges are compounded by the absence of robust policies and frameworks to guide implementation (Stoica 2021). Despite significant investments in ICT infrastructure, Uganda's 70% failure rate reflects these global trends, underscoring the critical need for improved governance and strategic alignment (Kituyi et al. 2024; Nabulongo et al. 2023).

The COVID-19 pandemic further highlighted the need for robust digitization systems in Uganda, as remote learning became essential during lockdowns (Nakaziba and Ngulube 2024). However, the rapid implementation of digitization efforts revealed additional challenges, including inadequate oversight and ineffective monitoring mechanisms. The Auditor General's report emphasized the importance of rigorous monitoring and quarterly reporting on the status and challenges of digitization efforts to enhance project outcomes (Audit 2022). These findings align with the conceptual model's focus on process quality and stakeholder accountability as key determinants of success.

Exemplary cases from Estonia and Finland illustrate the transformative potential of digitization. Estonia's technological innovation and Finland's focus on digital education during the pandemic underscore the value of clear communication, effective governance, and robust monitoring mechanisms (Bogdandy et al. 2020; Kattel and Mergel 2019). These insights serve as valuable lessons for Uganda's TVETs, which must prioritize process quality and transparent communication to overcome implementation challenges.

This conceptual model, grounded in agency theory and complemented by the DeLone and McLean Information Systems Success Model and dynamic capabilities theory, emphasizes the importance of high-quality processes, rigorous monitoring, and clear communication. By addressing goal conflicts, minimizing shirking, and ensuring task programmability, this model provides actionable insights to enhance the effectiveness of digitization projects in Ugandan TVETs and aligns with global best practices.

The conceptual model is supported by Table 1 below, which summarizes the key elements and sub-elements derived from the theoretical frameworks, providing a description, their source theory, and corresponding references for clarity and alignment.

2.3 | Research Hypotheses

The research hypotheses for digitization projects in Ugandan TVET institutions focus on key factors such as goal conflict, shirking, communication, task programmability, process quality, and contract type. These hypotheses, illustrated in the conceptual model in Figure 1 and in Table 2 aim to examine the relationships and effects of these variables on the effectiveness of digitization projects. The hypotheses are as follows:

These research hypotheses are crucial for understanding digitization projects in Ugandan TVET institutions. Taking inspiration from the work of Mahaney and Lederer (2003), the hypotheses outlined above are customized to fit the Ugandan context, acknowledging the distinct challenges faced by a developing economy compared to those in developed economies. The hypotheses focus on factors such as goal conflict, shirking, communication, task programmability, process quality, and contract type. Investigating these hypotheses within the Ugandan context provided valuable insights for improving the effectiveness, which ultimately could lead to the success of digitization projects. The following section details the research methods, including design, data collection, and analysis, using both quantitative and qualitative approaches to comprehensively understand these factors.

3 | Research Methods

This section describes the research methods used to examine the factors influencing digitization success in TVET institutions. This paper employed quantitative methods to explore the factors influencing the success of digitization in TVET institutions. The quantitative data were analyzed using SPSS v22. This study utilized the Smart-PLS method within

TABLE 1 | Key model elements with theories and references.

Model element/ sub-element	Short description	Source theory	Supporting reference
Goal conflict	Conflicts arising from misaligned objectives between principals and agents.	Agency theory	Lang and Müller (2021); Eisenhardt (1989)
Communication	Exchange of information to reduce information asymmetry and ensure alignment.	Agency theory	Mohammadi et al. (2022); Eisenhardt (1989)
Shirking	Neglect of responsibilities by agents, focusing on non-essential tasks.	Agency theory	Mahaney and Lederer (2003)
Task programmability	Ability to clearly define and structure tasks for effective execution.	Agency theory	Joshi et al. (2020); Eisenhardt (1989); Mahaney and Lederer (2003)
Process quality	Ensures high-quality outcomes through continuous improvement and evaluation by sensing opportunities and threats, seizing resources, and transforming of organizations through digitization sustainably.	Dynamic capabilities theory	Teece et al. 1997; Carvalho and Sampaio (2022); Sampaio et al. (2022); Berman et al. (2024)
Contract type	Specifies whether the relationship between principals and agents is behavior-oriented or outcome-oriented.	Agency theory	Eisenhardt (1989); Mahaney and Lederer (2003)
Digitization	The degree to which users engage with and utilize digitization systems effectively, combined with their satisfaction levels reflecting perceptions of system usefulness and quality.	DeLone and McLean IS success model	DeLone and McLean (1992); Wang and Wang (2022)



FIGURE 1 | Conceptual model for successful digitization projects (derived from Mahaney and Lederer 2003).

structural equation modeling for factor analysis. The research followed a pragmatic approach, using abductive methodology, to refine the conceptual model given the subjective and objective nature of the inquiry of this study. Overall, a descriptive

field study was conducted to derive a tailored model for enhancing digitization success in TVET institutions. Building on the outlined methods, the next section describes the research design, detailing the framework and approach used

TABLE 2 | Hypotheses on digitization project effectiveness.

Hypothesis	Summary of supporting reference
H1a: Goal conflict has a significant negative effect on digitization projects in Ugandan TVET Institutions.	Might and Fischer (1985); Eisenhardt (1989)
H1b: Goal conflict has a significant negative effect on process quality in digitization projects in Ugandan TVET institutions.	Sindre and Sørungård (1996); Slocum et al. (2002)
H2: Shirking has a significant negative effect on process quality in a digitization project for Ugandan TVETs.	Judge and Chandler (1990); Baiman (1990)
H3: Communication has a significant positive effect on process quality in digitization in Ugandan TVET institutions.	Pinto and Mantel (1990); Eisenhardt (1989); Eisenhardt and Eisenhardt (2018)
H4: Task programmability has a significant positive effect on process quality in digitization projects in Ugandan TVET institutions.	Eisenhardt and Eisenhardt (2018)
H5a: Process quality mediates the relationship between goal conflict and digitalization in Ugandan TVETs.	Wu et al. (2018); Fahmi and Arifianto (2021)
H5b: Process quality mediates the relationship between shirking and digitization in Ugandan TVETs.	Rosse and Miller (1984); Marin-Garcia and Lloret (2008); Wang et al. (2023)
H5c: Process quality mediates the relationship between communication and digitization in Ugandan TVETs.	Kozhakhmetova et al. (2019); Carvalho 2014; Nguyen and Watanabe (2017)
H5d: Process quality mediates the relationship between task programmability and digitization in Ugandan TVETs.	Grabner and Speckbacher (2010); Mahaney and Lederer (2003)
H6: Contract type moderates the relationship between process quality and digitization in Ugandan TVETs.	Eisenhardt (1989); Mahaney and Lederer (2003)
H7: Process quality positively affects digitization projects in Ugandan TVETs.	Lappi (2019); Vendraminelli et al. (2023); Dąbrowska et al. (2022)

to structure and conduct the study on digitization success in TVET institutions.

3.1 | Research Design

The following section presents the research design, outlining the framework and methodologies employed to investigate the factors influencing digitization success in TVET institutions. This inquiry adopted design science research (DSR) as its research methodology to design a model for digitization in Ugandan TVETs.

DSR is a methodology that focuses on creating and evaluating artifacts to address specific problems or challenges (Hevner et al. 2004). In the context of this research, DSR was utilized to develop a model for digitization projects in Ugandan TVET institutions. The methodology involved iterative cycles of relevance, rigor, and design to ensure the creation of a valuable and effective solution (Hevner 2007; Vom Brocke et al. 2020).

In this study, the DSR relevance cycle begins with identifying the requirements for the design and evaluation of the digitization model (Hevner 2007). This phase involved conducting a field study to gather insights into the factors influencing digitization in TVETs (Otieno 2023). The data collected during this phase provided the foundation for understanding the specific needs and challenges faced by TVET institutions in Uganda regarding digitization.

The rigor cycle during this research study emphasized the use of established theories, methodologies, and literature to inform the design process (Hevner 2007). In this research, theories such as agency theory (Jensen and Meckling 1976), the DeLone and McLean Information Systems Success Model (DeLone and McLean, 1992), and elements of dynamic capabilities theory (Takahashi et al. 2016; Teece et al. 1997) were leveraged to develop a comprehensive and theoretically grounded model. This cycle ensured that the digitization model was not only practical but also aligned with existing knowledge and best practices in the field.

The design cycle in this study involved creating and refining the digitization model for TVET institutions (Hevner 2007). This phase included designing the model based on the gathered insights and theories (Hevner and Chatterjee 2010), evaluating the effectiveness of the model through quantitative and qualitative data analysis (Salisu 2020; Mahaney and Lederer 2003), and refining it based on feedback from the potential users of the model and empirical evidence from rigorous scientific research (Patton 1999; Creswell and Clark 2017; Rupani and Vyas 2023). The iterative nature of the design cycle allowed for continuous improvement and validation of the model's efficacy in enhancing digitization project effectiveness in TVETs.

Generally, the application of DSR in this study is explained in Figure 2. The design science method used in this study facilitated the systematic development and evaluation of a model tailored to the specific needs and challenges of digitization in Ugandan TVET institutions. By following the principles of DSR, the research ensured that the resulting model was not only theoretically grounded but also practical and effective in addressing real-world digitization issues.

The methodology used in this study aligns with DSR, which incorporates three essential components: the problem domain, research phases, and knowledge base. The problem domain, depicted in the left compartment of Figure 2, encapsulates the environment of the study focusing on the challenge of improving the success of digitization projects in Ugandan TVET institutions. This domain includes stakeholders such as principals, instructors, ICT heads, administrators, and students who are impacted by the digitization process.

In the middle section of Figure 2, which represents the research phases, the study follows the established principles of information systems research, specifically the build and evaluate phases, as outlined by Hevner et al. (2004). The build phase involves designing the model for effective digitization, while the evaluate phase incorporates field studies and structured walk-through techniques to assess the model's effectiveness.



FIGURE 2 | Design science research model (adapted and guided by Hevner et al. 2004).

On the right side of Figure 2, the knowledge base signifies the theoretical foundation and methodologies used in the study, drawing from theories such as agency theory (Jensen and Meckling 1976), the DeLone and McLean information systems success model (DeLone and McLean 1992), and elements of dynamic capabilities theory (Takahashi et al. 2016). These theories and methodologies guided this research process, aiding in both the development and evaluation of the digitization model. The designed model in this study produces theory, practical application, and evaluation methods within the context of information system project research, contributing valuable insights to the field of information systems. The subsequent section discusses the data collection techniques used in the study.

3.2 | Data Collection

This section outlines the data collection methods used to gather perceptions into the factors influencing digitization success in TVET institutions. The study rigorously explored the effectiveness of digitization projects in Ugandan TVET institutions through a meticulously planned data collection strategy. To ensure comprehensive insights, convenience sampling was used to gather responses from accessible participants, balancing practicality with efficiency.

A purposive sampling strategy was employed to select institutions representing diverse specialties and sizes within the TVET sector, with a strategic focus on centers of excellence where digitization investments were concentrated. A structured questionnaire captured perspectives from stakeholders across six designated centers, providing a detailed view of digitization project success. Student participants from technical colleges, where 2-year diploma courses are the norm, shared their experiences regarding the use and satisfaction with digitization

efforts. These students were randomly selected to obtain unbiased views on the use and user satisfaction of the digitization project in their specific institution.

In addition, structured interviews with 177 participants, including Ministry officials, college principals, instructors, and students, further enriched the data. Quantitative data were analyzed using advanced statistical techniques such as PLS-SEM, while qualitative insights from open-ended interview questions provided a deeper understanding of digitization implementation and management within TVET institutions.

The next section examines the reliability of the tools used in the study, including internal consistency tests such as Cronbach's alpha, which assesses the robustness of the measures applied to evaluate factors influencing digitization success.

3.3 | Internal Consistency

This section reviews the internal consistency tests applied to the research tools to verify their reliability in assessing the factors influencing digitization success in TVET institutions. A general discussion of the results in this study is presented in the sections that follow. Table 3 shows the composite reliability (CR) and Cronbach's alpha (CA) values for the constructs and their variables. Values exceeding 0.70 indicate that the internal consistency standards were met (Hair et al. 2021).

The internal consistency tests in this study confirm that the research tools met reliability standards, with composite reliability and Cronbach's alpha values exceeding 0.70. The next section details the results of the factor analysis, providing further insights into the constructs related to digitization effectiveness in TVET institutions.

TABLE 3 | Results of CR (composite reliability) and CA (Cronbach's alpha).

Constructs	Composite reliability (CR rho-A)	Composite reliability (CR rho-C)	Cronbach's alpha (CA)
Criteria	0.818	0.818	0.724
Politics	0.886	0.904	0.872
Power	0.889	0.886	0.831
Counterproductive multitasking	0.93	0.936	0.92
Self-deployment	0.886	0.917	0.855
CEO-CIO relationship type	0.938	0.940	0.916
Information asymmetry	0.855	0.871	0.783
Outcome oriented contract	0.734	0.882	0.732
Behavior oriented contract	0.92	0.917	0.879
Monitoring and evaluation	0.963	0.908	0.878
Top management participation	0.991	0.929	0.893
IT resources usage	0.868	0.909	0.867
User satisfaction	0.845	0.904	0.839

TABLE 4 | Highest level of education for each respondent category.

Highest level of education	Frequency	Percent%
Bachelor's degree	30	30
Certificate	31	31
Diploma	15	15
Master's degree	16	16
Post graduate diploma	7	7

4 | Exploratory and Confirmatory Factor Analysis

This section presents the results of the factor analysis, highlighting how the data was structured and the relationships among the constructs related to digitization effectiveness in TVET institutions. Partial Least Squares software was used to carry out exploratory and confirmatory analyzes of these data to verify the conceptual framework and test the hypotheses. Partial least squares (Smart PLS) software was used to facilitate the analysis of the complex relationships between the variables in this study, to test structural hypotheses, and to provide predictive insights in research models (Castellanos 2021).

The results of this study showed that despite the extensive experience of college principals (averaging 15 years), they had limited digitization exposure. This was also detrimental to the amplification of digitization effectiveness and success in these TVET institutions. Table 4 provides the level of education of the respondents in this study.

The total cost of the digitization effort for digitizing the 12 TVET institutions was over \$1,000,000. This study highlighted that most institutions lacked a skilled IT manager or CIO, who is trained and skilled in ICT. In situations where one was present, only one CIO had the requisite ICT skills and had a positive relationship with the CEO, greatly impeding the advancement of digitization, as revealed in the results of this study.

The responsible office for ICT was filled by someone assigned to manage the role without requisite training, as observed in several instances. Table 5 shows the titles and responsibilities of the respondents in this survey. This table also describes the roles of students, who played an important role in this study by helping us understand how people use the systems in TVET institutions. Their feedback on how often they used the systems, how satisfied they were, and the benefits they received was very important, as they are the main users and key focus of these digitization projects meant to improve teaching and learning.

4.1 | Confirmatory Factor Analysis Results for Goal Conflict

The CFA for goal conflict is presented in Table 6. Three factors (power, criteria and politics) were retained after the construct “policy” and all its indicators were deleted.

TABLE 5 | Titles and responsibilities ($n = 100$).

Job description	Frequency	Percent%
Academic registrar	7	7
Commissioner TVET	1	1
Head of division or department	19	19
Head of ICT	4	4
ICT officer institution	7	7
Institution principal	7	7
Instructor at TVET institution	8	8
Principal officer TVET	2	2
Project implementer	1	1
Project supervisor	2	2
Student	42	42
Total	100	100

4.2 | Reliability and Validity for Goal Conflict

Scores (Cronbach's alpha) above 0.7 were considered satisfactory. To complement Cronbach's alpha, an average variance extracted (AVE) above 0.5 for all factors and a heterotrait–monotrait ratio (HTMT) below 0.85 for each pair of constructs were confirmed, as shown in Table 6.

This study evaluated the reliability and validity of the instruments for measuring goal conflict. The test scores show that Cronbach's alpha scores exceeded 0.7, indicating satisfactory internal consistency. The AVE was above 0.5 for all factors, confirming good convergent validity, while the HTMT was below 0.85 for each pair of constructs, demonstrating adequate discriminant validity. These findings, as detailed in Table 6, confirm that the measurement model is both reliable and valid.

4.3 | Reliability and Validity of Communication

The results in Table 7 show that the AVE for all the factors is greater than 0.5 and that the HTMT ratio is greater than 0.2 but less than 0.85, as was postulated by Henseler et al. (2015).

Table 7 Confirms the discriminant validity of the two factors. Furthermore, the SRMR of 0.079 for Communication falls within the acceptable range for the SRMR index, which is between 0 and 0.08 (Hu and Bentler 1999), showing a good model fit for the measurement model for Communication.

The findings of this study emphasize the critical relationship between CIOs and CEOs in influencing digitization outcomes.

4.4 | Confirmatory Factor Analysis Results for Contract Type

The CFA for contract type is presented in Table 8. Two factors (outcome-oriented and behavior-oriented) were retained after analysis.

TABLE 6 | Reliability and validity results for goal conflict.

	Cronbach's alpha	CR	CR	AVE	HTMT	
		rho-A	rho-C		Criteria	Politics
Criteria	0.724	0.818	0.818	0.624		
Politics	0.872	0.886	0.904	0.616	0.494	
Power	0.831	0.889	0.886	0.666	0.562	0.52

Note: Model fit indices: SRMR=0.0091, d_ULS=0.756, d_G=0.313, Chi-square=178.257, NFI=0.756.

TABLE 7 | Reliability and validity results for communication.

	Cronbach alpha	CR	CR	AVE	HTMT
		rho-A	rho-C		Information asymmetry
CEO-CIO relationship type	0.916	0.938	0.940	0.798	
Information asymmetry	0.783	0.855	0.871	0.695	0.594

Note: Model fit indices: SRMR=0.079, d_ULS=0.173, d_G=0.091, Chi-square=57.669, NFI=0.870.

TABLE 8 | Reliability and validity results for contract type.

	Cronbach alpha	CR	CR	AVE	HTMT
		rho-A	rho-C		Behavior oriented
Outcome oriented	0.732	0.734	0.882	0.789	
Behavior oriented	0.879	0.92	0.917	0.735	0.488

Note: Model fit indices: SRMR=0.072, d_ULS=0.108, d_G=0.085, Chi-square=54.420, NFI=0.820.

TABLE 9 | Reliability and validity results for process quality.

	Cronbach's alpha	CR	CR	AVE	HTMT
		rho-A	rho-C		Top management participation
Monitoring and evaluation	0.878	0.963	0.908	0.769	
Top management participation	0.893	0.991	0.929	0.813	0.167

Note: Model fit indices: SRMR=0.079, d_ULS=0.152, d_G=0.141, Chi-square=92.099, NFI=0.746.

4.5 | Reliability and Validity of Contract Type

The results in Table 8 show that the indicators retained in the summary of the measurement model of contract type guarantee both reliability and validity. Table 8 shows that for both the outcome- and behavior-oriented contract indicators, the Cronbach's alpha value after testing for reliability is greater than 0.7, indicating compliance with internal consistency. These indicators were later found not to be significant when establishing the structural model.

4.6 | Reliability and Validity of Process Quality

The results in Table 9 below demonstrate that the indicators retained in the summary of the measurement model of process quality guarantee both reliability and validity.

Convergent validity and discriminant validity were assured. The AVE for both factors is greater than 0.5, and the HTMT for both constructs is less than 0.85 (Henseler et al. 2015), which is the threshold for the HTMT ratio. Additionally, the SRMR of 0.079 in Table 9 falls within the allowable range for the SRMR index between 0 and 0.08 (Hu and Bentler 1999).

4.7 | Reliability and Validity of Digitization

The results in Table 10 show that the indicators retained in the summary of the measurement model of digitization guarantee both reliability and validity. Furthermore, the AVE for all factors is greater than 0.5, and the HTMT for the construct pair in Table 10 is less than 0.85.

The factor analysis results presented in this section confirm the discriminant validity of the constructs, demonstrate good model fit with SRMR values within the acceptable range, and ensure both reliability and validity of the indicators for Communication, Contract Type, and Digitization. Specifically, the AVE values exceeding 0.5 indicate that more than half of the variance in the indicators is captured by the respective constructs, reflecting strong convergent validity. Additionally, the HTMT ratios below 0.85 show that the constructs are sufficiently distinct from each other, confirming discriminant validity.

5 | The Model for Digitization

This section presents a comprehensive model specifically designed to guide Ugandan TVETs and similar organizations through the digitization project journey, covering the planning, implementation, and transformation phases. The model integrates theoretical constructs and practical insights to address the complexities of digitization projects in these institutions.

The Task Programmability construct, coded as TP in SPSS, was assessed using three key indicators: having a clear, written

methodology for executing the digitization project (TP1); clear procurement guidelines followed from start to finish of the digitization project (TP2); and reliance on clear specifications from IT professionals for digitization procurements (TP3). The beta coefficients and significance levels of TP1, TP2, and TP3 are presented in Figure 3. Since there were no predefined dimensions for the Task Programmability construct, these indicators were directly evaluated in the model.

The model in Figure 3 combines established practices from Agency Theory, theoretical insights from the DeLone and McLean Information Systems Success Model, and practical considerations from the Dynamic Capabilities Theory. This integration provides a visual roadmap that Ugandan TVETs and similar organizations can use to navigate digitization effectively.

The key constructs incorporated in the model in Figure 3 include Shirking, Communication, Goal Conflict, Process Quality, and Task Programmability, all of which are critical for successful digitization. Together, these elements offer a structured approach to planning, implementing, and managing digitization efforts. The next section will explore the applicability of this model, highlighting its potential to guide effective digitization initiatives in Ugandan TVETs and similar contexts.

TABLE 10 | Reliability and validity results for digitization.

		CR	CR		HTMT
	Cronbach's alpha	rho-A	rho-C	AVE	IT resources usage
IT resources usage	0.867	0.868	0.909	0.715	
User satisfaction	0.839	0.845	0.904	0.759	0.824

Note: Model fit indices: SRMR=0.069, d_ULS=0.261, d_G=0.192, Chi-square=123.372, NFI=0.749.



FIGURE 3 | Model for digitization in Ugandan TVETs.

5.1 | Applicability of the Model

This section explores the applicability of the model, emphasizing its role in providing a conceptual basis for enhancing digitization efforts within Ugandan TVET institutions. The digitization model, depicted in Figure 3, offers a structured approach to guide understanding and decision-making in digitization efforts. It helps stakeholders align project goals with institutional objectives, improve communication, identify areas for automation and efficiency, and encourage stakeholder engagement. The model further supports continuous progress monitoring, quality assurance, and iterative improvement to ensure long-term relevance and effectiveness.

As Hevner et al. (2004) emphasize, a key goal of DSR is to ensure that artifacts provide utility and practical value. This section discusses the applicability of the model in guiding digitization efforts within Ugandan TVET institutions. For example, consider a digitization project in a TVET institution specializing in automotive engineering training. The institution, designated as a center of excellence, aims to integrate AR tools for immersive engine assembly simulations and IoT sensors to monitor workshop equipment usage and maintenance needs. The project aligns with institutional objectives to enhance practical skills delivery and improve resource efficiency. The model provides a conceptual basis for understanding how stakeholders, including Ministry officials, instructors, and students, can be engaged during the planning phase to ensure their needs and expectations are integrated into the project. It also offers insights into how AR-based training modules and IoT sensors can be incorporated to provide real-time data on equipment usage, supporting improved resource management and effective learning outcomes.

However, the applicability of the model is not without limitations. A significant challenge is the uneven resource availability across TVET institutions in Uganda. While some centers of excellence are well-equipped, many institutions lack essential infrastructure, such as reliable internet connectivity, stable power supply, and access to advanced digital tools, which are crucial for implementing the model effectively. Institutional readiness is another key concern; staff training levels, digital literacy, and the willingness of stakeholders to embrace advanced technologies vary widely. Without addressing these disparities, the adoption of the model may be inconsistent across institutions. Furthermore, many digitization initiatives in Ugandan TVETs rely heavily on external funding, making projects vulnerable to delays or disruptions if funding becomes unavailable.

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a conceptual basis for understanding how stakeholders, including Ministry officials, instructors, and students, can be engaged during the planning phase to ensure their needs and expectations are integrated into the project. It also offers insights into how AR-based training modules and IoT sensors can be incorporated to provide real-time data on equipment usage, supporting improved resource management and effective learning outcomes. This scenario illustrates how the model informs project planning and implementation, ensuring that digitization efforts align with institutional goals and the evolving demands of technology.

The value of the model lies in its ability to provide a structured approach for understanding how advanced technologies can be integrated, stakeholders engaged, and project outcomes monitored. By bridging theory and practice, the model addresses key challenges in digitization projects and offers practical insights for improving institutional effectiveness. However, for the model to achieve its full potential, concerted efforts are needed from institutions and stakeholders to address disparities in resource availability, ensure institutional readiness, and secure sustainable funding mechanisms. These efforts will be critical for successful implementation across the diverse landscape of Ugandan TVET institutions.

6 | Discussion of Findings

This section presents a discussion of the findings, highlighting the key challenges and opportunities influencing the success of digitization projects in Ugandan TVET institutions. While existing literature emphasizes management engagement, the findings reveal that operational oversight and task evaluation alone are insufficient for managing such projects effectively (Eisenhardt and Eisenhardt 2018; Thompson 1967). Instead, strategic-level monitoring and evaluation emerged as essential for the success of digitization initiatives, complementing operational monitoring of processes.

The study identifies several challenges, including unclear task definitions due to inadequate communication, unsatisfactory monitoring of issues tied to process quality, internal conflicts caused by goal misalignment, and suboptimal task planning due to insufficient task programmability. These findings align with prior research emphasizing the importance of addressing these issues to enhance project outcomes (Mahaney and Lederer 2003).

Agency theory provides valuable insights into the dynamics between stakeholders and implementers in these projects, focusing on conflicts of interest and how mechanisms such as governance structures can align these interests. Contrary to expectations, traditional outcome-based contracts did not significantly influence project outcomes, likely due to the prevalence of behavior-based contracts in Ugandan TVETs. Instead, the study highlights process quality as a critical mediator that aligns stakeholder interests and enhances project performance. This emphasizes the importance of robust governance mechanisms to address agency challenges and foster success (Biesenthal and Wilden 2001; Eisenhardt 1989; Ansell and Gash 2007).

The findings also highlight significant opportunities within institutional structures, such as hierarchies, defined roles, and formal procedures, which support the operationalization of dynamic capabilities theory. These structures facilitate sensing, seizing, and transforming opportunities essential for project effectiveness (Teece et al. 1997). Effective hierarchies and clearly defined roles improve information flow and decision-making, ensuring stakeholder feedback is integrated into project progress (Turner and Zolin 2012; Di Maddaloni and Davis 2018). By defining decision-making authority and guiding resource allocation, these structures enhance operational efficiency, resolve competing priorities, and improve task programmability, enabling institutions to adapt to dynamic educational needs (Harris et al. 2017; Grunefeld et al. 2021).

The study further highlights the critical role of process quality in achieving effective digitization. It highlights opportunities for fostering stronger communication channels, building harmonious CEO–CIO relationships, and establishing clearly defined roles and responsibilities, all of which enhance project outcomes (Akhtar 2023; Benlian and Haffke 2016). The findings emphasize the importance of combining strategic monitoring, effective governance, and dynamic institutional structures to address the challenges and maximize the opportunities in digitization efforts within Ugandan TVET institutions.

7 | Recommendations

This section provides structured recommendations based on the findings of the study, framed through the lens of agency theory. The recommendations address the key elements of the proposed model to guide practitioners and scholars in overcoming principal-agent challenges and enhancing the success of digitization projects in Ugandan TVET institutions.

7.1 | Strengthening Process Quality

To minimize information asymmetry and ensure alignment between principals and agents, robust monitoring systems should be implemented at both operational and strategic levels. These systems should provide real-time tracking of progress and outcomes. Standardized project management practices, coupled with targeted training programs, can empower agents to maintain high levels of process quality, reducing inefficiencies and shirking.

7.2 | Addressing Goal Conflicts

Shared organizational objectives are critical for reducing goal misalignment. Strategic planning workshops can help principals and agents align their goals and foster a shared vision for digitization projects. Conflict resolution mechanisms, such as clear protocols for addressing disagreements, should be established to manage disputes effectively. Contracts must clearly outline measurable outcomes and responsibilities, ensuring agents understand their roles and reducing ambiguity that often leads to goal conflicts.

7.3 | Improving Communication

Clear communication is essential for aligning efforts and ensuring that principals and agents work cohesively. Structured communication channels, such as regular meetings and project management platforms, can reduce delays and misunderstandings. A strong CEO–CIO collaboration is particularly vital, as this relationship drives strategic alignment. Regular joint planning sessions and mutual goal-setting activities can further enhance collaboration and improve project outcomes.

7.4 | Enhancing Task Programmability

Defining specific, actionable steps for each task and assigning clear responsibilities to agents reduces moral hazard and ensures accountability. Flexible work plans, adaptable to evolving needs and challenges, allow institutions to respond dynamically to changes in project requirements. This adaptability enhances the overall effectiveness of digitization efforts.

8 | Conclusions

This section presents the conclusions derived from the study, providing key insights and actionable strategies to improve digitization projects in Ugandan TVET institutions. By applying agency theory, the study identified essential factors for effective digitization and proposed a model tailored to strengthen project processes within educational institutions. Using design science methodology, the study developed a specialized model grounded in agency theory, which provided a deeper understanding of the dynamics affecting digitization projects in developing economies. The findings, drawn from Ugandan TVET institutions, offer valuable lessons that are broadly applicable to similar contexts.

8.1 | Limitations

Despite the robust design and comprehensive analysis, this study has several limitations. First, the sample size was limited to a specific number of Ugandan TVET institutions, which may affect the generalizability of the findings to other regions or sectors. Second, while the study employed a mixed-methods approach, some nuanced qualitative insights could have been missed due to time constraints and access challenges. Third, the study primarily focused on the agency theory framework, leaving room for incorporating other theoretical perspectives, such as institutional theory or technology acceptance models, to provide a more holistic understanding of digitization project success.

8.2 | Research Contributions

This study extends the application of agency theory to digitization projects in educational institutions, emphasizing process quality as a critical mediator in aligning interests between principals and agents. The study also contributes to the literature by highlighting the unique challenges faced in developing economies, particularly the limited efficacy of outcome-based contracts in such settings.

The study offers a practical framework for addressing common issues in digitization projects, such as unclear roles, inadequate monitoring, and goal misalignment. By emphasizing the importance of CEO–CIO collaboration, it provides actionable strategies for institutional leaders to improve decision making, strategic alignment, and communication in digitization projects.

The study demonstrates the utility of design science in developing and validating models for complex organizational challenges. The mixed-methods approach employed—combining surveys, interviews, and focus group discussions—provides a replicable template for future research in similar contexts.

8.3 | Policy Implications

Policymakers must prioritize the creation of clear governance structures for digitization projects, focusing on role clarity, process quality, and robust monitoring mechanisms. Effective governance frameworks should promote strategic-level oversight alongside operational monitoring to ensure the sustainability of digitization initiatives.

For Uganda, specific attention should be given to promoting stronger CEO–CIO relationships within TVET institutions. Regular strategic planning sessions, mutual goal-setting, and open communication channels are essential to bridging gaps between IT and institutional leadership. Additionally, policymakers should encourage the adoption of training programs to enhance the skills of project managers and stakeholders, ensuring alignment with national digitization goals.

8.4 | Future Research Directions

This study opens avenues for future research to address its limitations and explore related areas. Future studies could examine the role of cultural factors in shaping digitization project outcomes in different regions. Additionally, incorporating other theoretical frameworks, such as institutional theory, could provide a broader perspective on governance challenges. Longitudinal studies tracking the implementation of the proposed model over time would also offer insights into its practical efficacy. Finally, expanding the research to other sectors, such as healthcare or government, could enhance the generalizability of the findings.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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