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Achieving Sustainable Digital Transformation in TVET Institutions through Enterprise Architecture

Surya Sumarni Hussein[1]*, Norlida Ramly[2], Wan Azlin Zurita Wan Ahmad[2], Muhammad Irfan Arif Mohammed Ridzuan[1], Puteh Melor Wesma Salehen[3], Duong Dang[4]

[1] *School of Computing Sciences, College of Computing, Informatics and Mathematics, Universiti Teknologi MARA, Shah Alam Selangor, 40450, MALAYSIA*
[2] *Jabatan Digital Negara, Kementerian Digital, Cyberjaya, Selangor, 63000, MALAYSIA*
[3] *Institut Kemahiran Belia Negara, Kuala Langat, Jalan Sultan Abdul Samad, Banting 42700, MALAYSIA*
[4] *University of Vaasa, Wolffintie 32, 65200 Vaasa, FINLAND*

*Corresponding Author: suryasumarni@uitm.edu.my
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Abstract

The approach of Enterprise Architecture (EA) in Technical and Vocational Education and Training (TVET) institutions holds significant potential for the institution's digital transformation. This study explores key factors to sustain digital transformation in TVET Institutions using a Systematic Literature Review (SLR) and semi-structured interviews. The SLR provides a comprehensive overview of existing literature on EA in educational contexts, focusing on its role in aligning institutional goals with industry requirements. Common themes and research gaps identified through this review set the stage for empirical investigation. Interviews with IT administrators, academia, and experts offer practical insights into the challenges and opportunities associated with EA implementation in TVET institutions, validating findings from the literature and uncovering unique contextual factors relevant to TVET institutions in Malaysia. The thematic analysis highlights several key factors, namely, management support and their involvement, a clear business vision and goal strategy, and the adoption of emerging technologies such as Artificial Intelligence and the Internet of Things towards sustainable digital transformation in TVET institutions. The findings indicate that a well-implemented EA framework can significantly drive the digital transformation of TVET institutions, leading to better-prepared graduates and a more adaptable workforce. This study provides a detailed analysis of the key factors to sustain digital transformation in TVET Institutions and offers practical recommendations for policymakers and educational leaders. The insights gained can guide future initiatives aimed at the digital transformation of TVET institutions, contributing to a more competitive and responsive educational sector in Malaysia.

1. Introduction

In the era of rapid technological advancements, Technical and Vocational Education and Training (TVET) institutions are increasingly recognized as critical in equipping the workforce with the skills necessary to thrive in the digital economy. Digital transformation within these institutions is essential to ensure that they remain relevant and effective in meeting the demands of Industry 4.0. This transformation involves not only the adoption of new technologies but also a fundamental shift in institutional processes and strategies to foster innovation, flexibility, and responsiveness (UNEVOC, 2021). Enterprise Architecture (EA) plays a pivotal role in facilitating this digital transformation. EA provides a structured framework that aligns an institution's strategic objectives with its IT infrastructure and processes, ensuring that all components work harmoniously towards common goals. By adopting EA into TVET institutions, these organizations can achieve better strategic alignment, resource efficiency, and adaptability to industry needs, ultimately enhancing their sustainability (Van De Wetering et al., 2021 & Van De Wetering et al., 2020).

The necessity for digital transformation in TVET is further underscored by the global shift towards digital learning environments, accelerated by the COVID-19 pandemic. This shift has highlighted the urgent need for TVET institutions to develop digital competencies among both educators and students. Competencies encompass the knowledge, skills, attitudes, and behaviors essential for successfully performing tasks or activities (Salleh & Sulaiman, 2019). Additionally, programs such as the UNESCO-UNEVOC TVET Leadership Programme have been instrumental in training TVET leaders to navigate and lead digital transformation initiatives effectively (UNEVOC, 2021). This research paper investigates the key factors for sustainable EA implementation in Malaysia's TVET institutions. Through a comprehensive review of recent literature and empirical data gathered from interviews with key stakeholders, this study aims to provide actionable insights and recommendations for policymakers and educational leaders. The goal is to support the development of a more competitive and responsive TVET sector that can effectively contribute to the nation's economic and social development.

1.1 Enterprise Architecture

EA is a structured approach to assist an enterprise or organization in understanding their ecosystem cross over the domains of business (customer, stakeholder, strategic partners, processes, capabilities, and their interrelations), data (internal and external data, digital and manual data), application (internal application (core and support application) and external application) and technology (network, digital/emerging devices, data center, hardware, and software). EA also helps in understanding the challenges faced by the enterprise/organization and eases the process of identifying the solutions for each of the challenges to achieve the targeted vision by producing a realistic roadmap to move from the current state to the future state. The term enterprise architecture, or EA, refers to a logical collection of concepts, procedures, and models that are applied in the planning and execution of an enterprise's infrastructure, information systems, business procedures, and organizational structure. It establishes the starting and ending points for the technological infrastructure, processes, applications, data, and capabilities of a business. Additionally, it makes it easier to create a plan for reaching the specified goal state (Shanks et al., 2018).

According to Anthony et al. (2019) an environment, relationships, design principles, and evolution of a system are all depicted in an EA. It documents and communicates to stakeholders the key business and IT components effectively and efficiently. An architecture is required to handle the complexity of any kind of organization. The components of a system that comprise the hardware, software, network, and structure are referred to as the architecture. However, architecture includes the underlying ideas or characteristics of a system in its surroundings, as represented by its constituent parts, interrelationships, and design and evolutionary principles (ISO/IEC/IEEE, 2020). Van De Wetering et al. (2020) state that organizations utilize EA for a variety of goals, including business transformation, strategy execution, alignment between business and IT, IT standards management, complexity management, improved communication, and project compliance.

This study offers an EA framework created by previous studies (Bokolo et al., 2020) to achieve interoperability and infrastructure flexibility toward the digitalization of institutions. This study varies from earlier research because it uses qualitative data. The presented EA framework is shown in Figure 1. According to Berkel et al. (2018), the physical infrastructure layer consists of the institutions' tangible assets. Real-time data created by this layer is sent to the technology layer via physical sources (Petersen et al., 2019). The sensors, metering, Internet of Things, and sensing devices (such as smart card readers, weather sensors, RFID chips tags, and smart card readers) that are placed across the institutions and produce real-time data are captured by the physical infrastructure layer (Anthony et al., 2019). All the technologies used across the institutions, including big data, processing, cloud computing, ubiquitous computing, and service-oriented architecture, are included in the technological layer. According to Berkel al. (2018), this layer offers the hardware and software infrastructures that are necessary to deliver digital services. Infrastructures required to gather, manage, process, and temporarily store real-time data are included in this layer. Additionally, this layer sets either locally or cloud-hosted servers. According to Otto et al. (2018), the data space layer is the intelligence of the architecture since it contains the data

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needed to provide digital services. Furthermore, the data space layer identifies the data that the institutions use to deliver digital services (Petersen et al., 2019). The data space layer gathers unprocessed real-time data from sensors and devices, processes online data from institution apps, examines historical data, and finally obtains third-party data from outside sources (Anthony Jr., 2020).

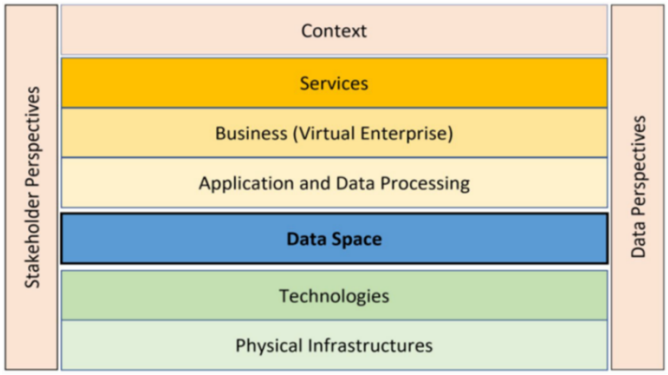

Fig. 1 *Enterprise architecture framework (Source: Bokolo et al., 2021)*

Additionally, relational and non-relational databases supporting urban processes are found at the data space layer. All applications that are implemented to offer services to stakeholders and citizens are included in the application and data processing layer. To provide services, this layer leverages information from the data space layer (Anthony et al., 2019). Moreover, data is processed and transformed by this layer into information that is helpful for digital services (Berkel et al., 2018). To facilitate the digitalization of urban activities, this layer offers applications that expose digital services (Anthony Jr., 2020).

The business layer oversees enumerating all collaborators or businesses engaged in function provision and process orchestration to provide services to users. Operational tasks that supply and offer business services are included in the business layer (Berkel et al., 2018). The institution's action plans, resources, and capabilities are displayed by the service layer. Thus, the purpose of this layer is to competently achieve the stated key performance goals and efficiently execute the given outputs (Anthony et al. 2019). According to Bokolo et al. (2020), the context layer comprises needs related to stakeholders' desires, concerns, and key performance indicators (KPIs) that enhance quality of life. According to Anthony et al. (2019), this layer consists of the set of objectives, limitations, guiding principles, and essential criteria for the institution's efforts. The interests of users and other institution stakeholders are likewise captured via the context layer. Based on the research conducted by Eskaluspita et al. (2020) and Defriani et al. (2019), it was determined that the frameworks had different approaches and varying levels of information. The Zachman framework was found to be the most thorough. Additionally, several scholars have recently investigated the many frameworks that can be used to develop enterprise architectures.

The article from Řepa and Svatoš (2019) presents a generic EA metamodel for digital transformation. The proposal uses TOGAF, Archimate, UML, BPMN, and the methodology for modelling and analysis of business processes (MMABP). The metamodel contains four levels of abstraction, two levels of the system (business function and business processes), and two detailed levels (process step model and process task model). Puspita's (2019) studies, evaluate a ZFEA-based EA model for a logistics management organization. This model allows you to see and define the running firm to make it more structured and connected with IT development. The concept has two perspectives: the company's owner and the IT planner. In addition, the following categories are used to explain each perspective: assets data, motivation, functional processes, support staff, location, and time.

The Malaysian government's IT environment has undergone significant transformation in the past 40 years. Currently, 77% of government services are available online. Being the largest employer in the nation, the government has responded favourably to this abrupt shift, but it still has a way to go before meeting the expectations of the global community and its external stakeholders. There must be an immediate overhaul of the current work process because the current method cannot continue. Excellent services might be provided by those agencies that were able to align their IT infrastructure with their business processes. Thus, to improve the delivery of digital government services, EA must be put into practice (Hussein et al., 2018). Even four years after adopting EA, the implementation of EA initiatives in those organizations is still viewed as minimal and unimportant (Abu Bakar N. et al., 2019). Given that significant government funds were used to implement EA in the Malaysia Public Sector institutions, this scenario alarmed the administration. Additionally, due to disparities in motivation, technology adoption at the personal and organizational levels may differ. Information system (IS)/IT adoption decisions and needs are considered at the organizational level, whilst at the individual level, technology acquisition, use, and sustainability are the primary issues. According to Goh and Arenas (2020), public sector organizations might include local governments, statutory authorities, and the federal government. Due to the

diversity of organizations that make up Malaysia's public sector, asymmetrical organizational adoption of EA may take place (Chatfield and Reddick, 2018; Fu et al., 2018). Based on the study conducted by Hussein et al. (2018), MyGovEA is an approach that helps an organization change its technical and business aspects. The goal of the MyGovEA Blueprint is to support public sector agencies in promoting EA projects for their institution by providing a framework, methodology, and implementation plan. MyGovEA deployment is crucial for improving the delivery of services by the Digital Government by coordinating business and ICT strategies. By using information from the centralised EA repository as a reference, MyGovEA practices will assist the government (Hussein et al., 2018).

1.2 Vocational Institution

In Malaysia, numerous ministries and agencies provide Technical Vocational Education and Training (TVET) programs at the certificate, diploma, degree, and postgraduate levels. Until 31 December 2023, Malaysia's government, through the National TVET Council (MTVET) announced there are a total of 1,345 TVET institutions, across the country with 669 public TVET institutions, 652 private TVET institutions and 24 TVET institutions under the state government. Vocational institutions are crucial in providing students with practical skills for future employment (Skunhom et al., 2023). Digitalization in Technical Vocational Education and Training (TVET) is essential for adapting to the changing work landscape and globalization challenges (Ab Wahab et al., 2023). The COVID-19 pandemic has highlighted the importance of digital curriculum development in vocational learning institutions to ensure quality education and productivity (Masrom et al., 2023). Vocational education focuses on hands-on experience in industry, commerce, and information technology, preparing students for the job market's demands (Skunhom et al., 2023; Hamidi, 2013)

To ensure the sustainability and clear directions of TVET education, five strategic thrusts: comprehensive and synergistic governance, world-class quality and education pathways, efficient and productive industry collaboration, sustainable TVET financing, and promoting TVET as the primary career choice in National TVET Policy 2030 had been introduced with aims to enhance the quality and relevance of TVET programmes by aligning them with industry demands (National TVET Policy, 2030). As a result of the realization that TVET is crucial to the nation's economic growth, the Malaysian Qualification Framework (MQF) was developed to oversee and manage TVET progression to satisfy industry needs and provide a clear definition of the roles and responsibilities of TVET instructors in Malaysia. Substantially, the Department of Skills Department (DSD), Ministry of Human Resources and Malaysia Qualification Agency (MQA) are the respective bodies that harmonize and strengthen governance and institutional mechanisms for TVET implementation related to accreditation and quality assurance within three main pillars of TVET pathways as illustrated in Figure 2. To summarize, TVET instructors are crucial in deciding the skills of the workforce of the future (UNESCO-UNEVOC, 2020). The Ministry of Education's role in restructuring programs with outcome-based education and investing in smart simulator technologies is crucial to meet industry needs and equip the new generation with the necessary skills (Masrom et al., 2023 & Tekle et al., 2024).

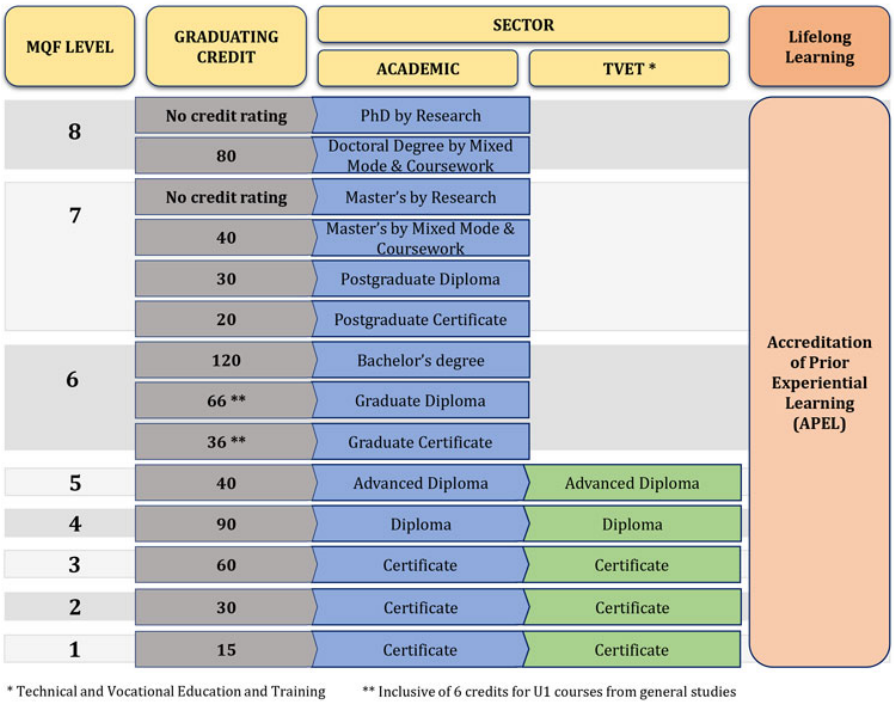

Fig. 2 *Malaysian qualification framework 2.0 (Source: Malaysian Qualification Agency, 2020)*

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1.3 Digital Transformation

Digitization, digitalization, and digital transformation, often referred to as "the three Ds," are three separate but related facets of the evolution of digital technology that has been emphasized by numerous academics and industry experts (Bloomberg, 2018; Gong & Ribiere, 2023; Reinitz, 2020). These terms denote successive stages of the digital evolution of an organization, as depicted in Figure 3. The first stage, digitization, refers to the conversion of analogue information into a digital format that can be stored, processed, and transmitted by computers. The second, digitalization, involves the use of digital technologies to optimize business processes, enhance or innovate services, and enable new capabilities. An example of digitalization is businesses utilizing online platforms and social media channels for product marketing and reaching potential customers globally. The third, digital transformation, encompasses both digitization and digitalization but extends beyond these two. It is a comprehensive change that involves using digital technologies, such as big data, cloud computing, IoT, AI, and blockchain, to alter or create new business models, cultures, and customer experiences to meet changing market demands. Thus, for TVET institutions in Malaysia, digitalization is an ongoing development and implementation towards industry revolution 4.0 (IR 4.0). Currently, TVET institutions in Malaysia focus on websites and applications to serve their stakeholder towards digitalization TVET institutions need to enhance their website and applications to improve delivery services and stakeholders' satisfaction. A good website and application should provide not only useful functions but also support comfortable interaction between the user and the website. This new paradigm was defined as web comfortability and important elements towards the adoption of digital transformation (Bidin, 2018 et al., Lokman et al., 2013 & Lokman et al. 2012).

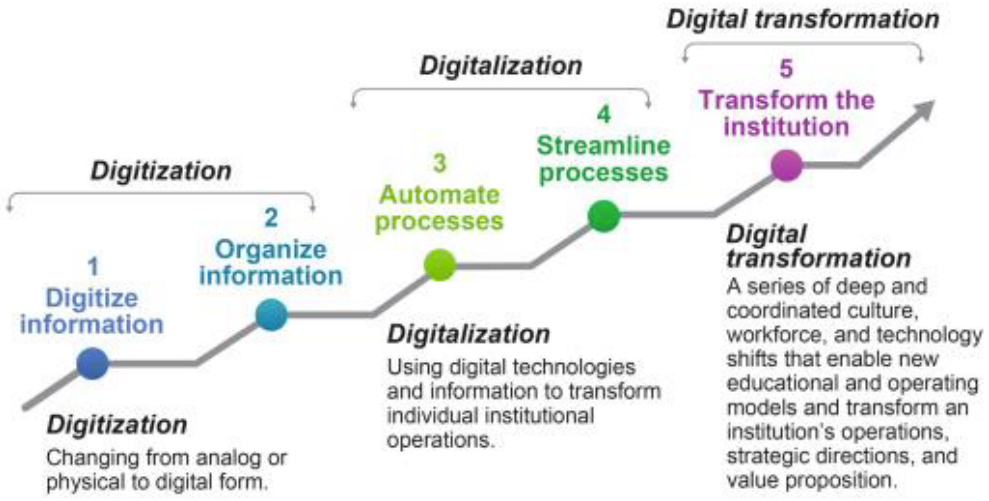

Fig. 3 *Stages of digital transformation (*Source: Brooks and McCormack (2020)

1.4 Sustainability

Geissdoerfer, Vladimirova, and Evans (2018) defined sustainable development as a human activity carried out in a way that preserves the functions of the earth's ecosystems, a change in human lifestyle that maximizes the likelihood that living conditions will continuously support security, well-being, and health, especially by maintaining the supply of non-replaceable goods and services, and an indefinite perpetuation of all life forms. Sustainability is the ability to continue and sustain accomplishments throughout a given period, as defined in the context of a general lifespan. When it comes to business and the economy, sustainability refers to producing goods and services in a way that minimizes damage to the environment and does not rely on non-renewable resources. By emphasizing addressing current demands without compromising the ability of future generations to meet their own, sustainable development expands on this idea. It includes an active process of change in which people work to improve their standard of living by finding a way to combine social justice and economic success in a way that also protects and improves the environment (Hamidi et al., 2023). Essentially, for the benefit of present and future generations, sustainability and sustainable development highlight the necessity of ecological awareness, responsible resource use, and the maintenance of socio-economic equilibrium (Erda et al., 2020).

The term sustainable in this context describes how systems, procedures, and technological solutions are developed and put into place inside an organization to support environmental responsibility and sustainability. Businesses may minimize their environmental impact, cut down on resource consumption, and help create a more sustainable future by incorporating sustainable practices into corporate architecture (Gupta et al., 2021). EA is a critical component of business, giving a formal approach to aligning an organization's IT infrastructure with its

overall aims and objectives. However, as the emphasis on sustainability grows, businesses must include a sustainable strategy in EA procedures. This ensures that corporations may effectively address environmental and social issues while being profitable. To achieve sustainable EA, businesses must connect their information systems, technological assets, and resources with their business operations. This integration enables an effective reaction to change environmental and market conditions, allowing organizations to harness the true potential of innovative and disruptive digital business models (Wetering et al., 2021). On TVET, sustainability is a must due to the encompasses of industry demand and workforce of Malaysia to become a developed country by the year 2030.

2. Methodology

Preliminary data for this study were gathered using semi-structured interviews and a systematic literature review (SLR). The SLR follows a methodology similar to that of a comprehensive research process, where it involves a rigorous and scientific approach to gather, evaluate, and synthesize existing studies. The process entails a structured procedure designed to meticulously identify, locate, assess, and analyze all relevant information and academic literature available on a particular topic. Through systematically reviewing the literature, researchers can identify gaps in knowledge, highlight patterns, and generate insights that contribute to both theoretical development and practical application in their field. Additionally, the SLR process is well-documented, transparent, and reproducible, ensuring the credibility and reliability of the findings derived from it. Reliability is a process of analyzing the quality of the measurement process which is utilized for data collection in social science and TVET research (Salleh, Sulaiman, Gloeckner, 2023). This section explains the interview technique, the methodology used in SLR, and the data analysis procedure. Fig. 4 illustrates how the investigation was carried out.

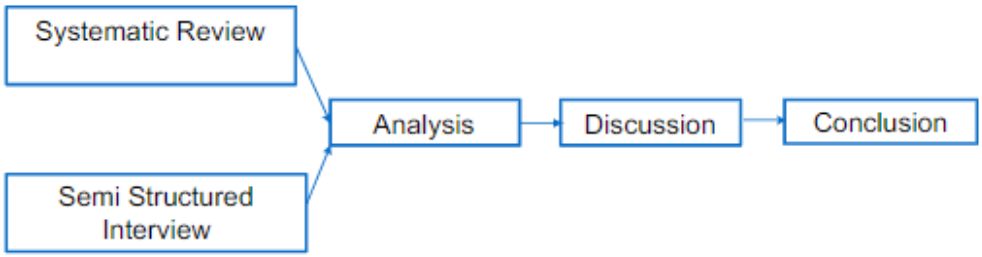

Fig. 4 *Process of conducting the study*

2.1 Systematic Literature Review

Based on a systematic literature review (SLR), the study aims to shed more light on the key factors to sustain digital transformation in TVET institutions through EA. In conducting SLR, databases such as SpringerLink, Science Direct, ACM, and IEEE are selected due to the relevancy of the EA domain. We explored articles selected based on keywords selected namely ENTERPRISE ARCHITECTURE and SUSTAINABILITY, TVET and DIGITAL TRANSFORMATION. From these keywords, 19 articles are selected to answer the research question "What are the key factors towards sustainability of EA implementation?". Ultimately, a total of four articles are being evaluated for further analysis.

2.2 Semi-structured Interviews

Semi-structured interviews were used in this study to collect preliminary data that is relevant to TVET in the Malaysian setting. We conducted a series of interviews with four (4) experts and practitioners of digital transformation initiatives from the public and academic sectors in Malaysia to understand the factors towards sustainability of EA implementation. The interview was conducted on a one-to-one basis using online tools with time spent from 30 minutes to one (1) hour for each interview. Based on the respondent's experience and the scenarios that were discussed during the interview sessions, the data was analysed. The data also was supported by related documents with the Malaysian Public Sector EA establishment process and the Malaysian Public Sector ICT initiative such as the MyGovEA Blueprint, MyGovEA Enterprise Architecture Capability Maturity and Change Readiness Assessment and Malaysian Public Sector ICT Strategic Plan 2021-2025. Interviews were conducted separately from 28 February to 8 April 2023 as shown in Table 1.

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Table 1 *Interview information*

Position	EA Public Sector Core Team (TOGAF 9.1 Certified)	Principal Assistant Director (EA Practitioner)	Information Technology Officer (EA Practitioner)	Academician (EA Practitioner)
Expert ID	E1	E2	E3	E4
Organisation	Agency A	Agency B	Agency C	Agency D
Category	Core Team from Central Agency	EA Practitioner	EA Practitioner	EA Practitioner
Interview Session	28 February 2023	28 February 2023	8 March 2023	8 April 2023

The researchers used Yin's (2010) data analysis procedure, which includes familiarisation, transcription, data organisation, data coding, developing the description and themes, and report writing, to analyse the preliminary data. Software called Taguette and Computer Assisted/Aided Qualitative Data Analysis (CAQDAS) are used in this study to code data. The researchers developed the themes and code by adhering to the Framework Analysis Guideline, which was derived from Ritchie, Lewis, Nicholls, & Ormston (2013). The categories and themes can be established appropriately from the outset of the investigation thanks to this framework. Any newly discovered themes may be added to the hierarchical tree of themes during the coding process. The findings from the research will be discussed in the following section.

3. Result

In this section, the study result is based on the SLR, and interview session conducted. The result presented is the synthesis of evidence from SLR and interviews to investigate the key factors to sustain digital transformation in TVET institution through EA.

3.1 Key Factors to Sustain Digital Transformation in TVET Institution Based on SLR

Based on the thematic analysis technique that was done by using Taguette software, the study discovered that maintaining digital transformation presents several difficulties that reduce its effectiveness of implementation. One significant issue is obtaining legitimacy from the team, or actors involved. Without the support and acknowledgment of stakeholders, it may present a lack of credibility and a struggle to gain traction within the relevant communities or industries. Effective collaboration may also be prevented by a lack of integration across a variety of dimensions, including knowledge domains, organizational structures, communication philosophies, and technical features. Resolving sustainability concerns holistically requires achieving coherence across these disparate parts (Erda G. P et al., 2018). Based on Figure 5, shows the themes and the factors that have been tagged by using Taguette software.

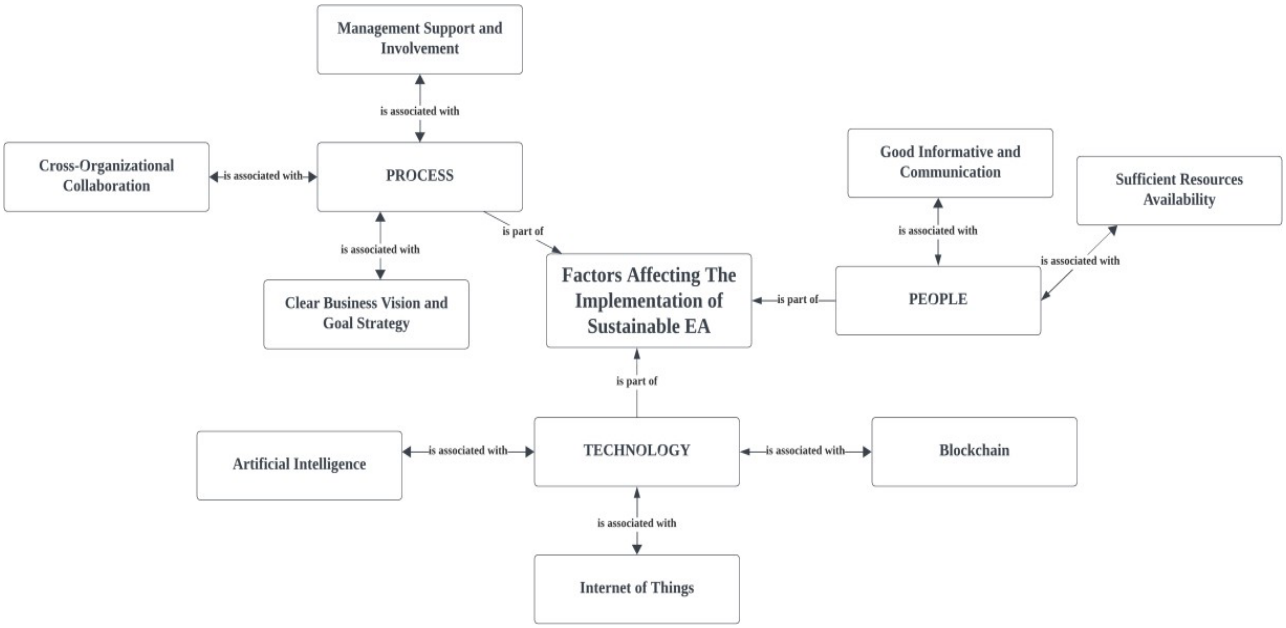

Fig. 5 *Mapping of the theme and factors tag by using Taguette software*

SLR research question 1 is to identify the key factors to sustain digital transformation in TVET institution through EA. Eight key factors of EA implementation's sustainability were identified from past authors' literature and studies based on Table 2.

Table 2 *Factors of EA implementation's sustainability based on SLR*

Theme	Factors	Authors			
		Montree et al., 2021	Nunung et al., 2020	Anassaya et al., 2023	Bokolo et al., 2020
People	Good and Informative communication	/	/	/	/
	Sufficient Resources Availability	/			
	Management Support and Involvement	/			
Process	Cross-Organizational Collaboration		/	/	
	Clear business vision and Goal Strategy	/	/		
Technology	Artificial Intelligence			/	/
	Internet of Things			/	/
	Blockchain Technology			/	

3.2 Key Factors to Sustain Digital Transformation in TVET Institution Based on Interview

Finding the important elements in this study was the first step in the data analysis process. According to Bazeley (2009), it is no longer generally accepted or practicable for researchers to approach their data using an inductive research approach if they do not already have theoretical conceptions in mind for the study. A qualitative

researcher would also already know what kinds of things can be gathered from the data if they began investigating with theories (Bazeley, 2009). The results of the interview will be discussed in this section. The combined themes and codes that result from the results of the interviews and SR are concluded. The results can be categorised into three themes: technology, people, and process, as shown in Table 3.

Table 3 *Factors of EA implementation's sustainability on interview*

Theme	Factors	Excerpt of feedback
People	Good and Informative communication	*"...Ensuring a common understanding of the architecture, methodology and artefacts are crucial in sustainable EA initiatives" (E1 & E2)*
	Sufficient Resources Availability	*"...EA Resources are important for the establishment of EA; however, the resources need to be reallocated accordingly to make the best use of it" (E4)*
	Management Support and Involvement	*"...Stakeholder support is important and must constantly engaged with EA practitioners to ensure they can play their role in supporting the EA practices (E2)* *"...Management commitment is important in driving EA establishment" (E3)*
Process	Cross-Organizational Collaboration	*"...We need to collaborate among institutions in sharing technology and knowledge to strategies digital transformation" (E4)*
	Clear business vision and Goal Strategy	*".... consensus on the definition and vision of EA must be derived from all participating stakeholders before the EA project can start" (E1)*
Technology	Artificial Intelligence	*"...The usage of technology such as AI can help expedite the learning process" (E4)*
	Internet of Things	*"...IoT technology can be leveraged in TVET curriculum to accelerate digitalization process" (E4)*
	Blockchain Technology	*"...We should investigate blockchain technology. Blockchain can support sharing of decentralized educational resources and platforms, fostering collaboration among institutions." (E3 & E4)*

4. Discussion

4.1 Theme 1: People

Employees in the IT department in the institution focused on the IT and technical aspects. They also had experience with IT projects but not EA. Under certain conditions, the EA programs ignored business services and highlighted IT issues. The institution must have EA teams with the abilities and skills to carry out EA programs. The key criteria were expertise, experience, background, and views on the EA process and its role (Lokman et al., 2019). Engagement of the top management and the employees of the organization to participate in the EA effort is crucial in driving digital transformation in TVET institutions.

4.2 Theme 2: Process

The literature on EA indicates that the process by which EA is adopted and evolves is an important factor in facilitating and sustaining digital transformation in the public sector, as evidenced by the case of the Vietnamese government (Dang & Bui, 2023). This process encompasses various stages, such as how EA is introduced to an organization through business vision, strategy, and inter-agency collaboration; or how an organization theorizes, formulates, and revises EA to align with its digital transformation initiatives or strategic digital plans. In the context of the studied case, the implementation of enforced policies allows organizational decisions and guidelines to be executed based on established formal processes and pre-existing authorizations. Unfortunately, there has been no legislation or policy mandating the adoption of EA practices within Malaysian government agencies. This

absence of a mandate provides these agencies the autonomy to interpret and implement EA in alignment with the Malaysian Public Sector Digital Strategic Plan 2021-2025. Consequently, state agencies can refer to national practices or programs (e.g., MyGovEA) to contextualize EA practices, thereby translating abstract concepts from the national level into their specific environments. This process enhances interoperability, comparability, and ultimately, the broader adoption of EA.

4.3 Theme 3: Technology

EA plays a pivotal role in aligning technology infrastructure with organizational goals, including sustainability. Integrating advanced technologies like AI and blockchain can significantly enhance sustainability efforts within an EA framework. AI automates processes, enhancing efficiency and reducing resource-intensive tasks. Blockchain ensures the immutability and transparency of sustainability metrics and compliance records. A TVET institution could use AI to manage energy-efficient smart grids and blockchain to verify and track sustainable processes. This integration ensures transparent, efficient, and sustainable operations, aligning with both EA principles and sustainability goals.

5. Conclusion

The primary aim of this research is to explore key factors for sustainable EA implementation in Malaysia's TVET institutions. Digital transformation in Technical and Vocational Education and Training (TVET) institutions is essential for preparing a workforce capable of meeting the demands of the rapidly evolving industrial landscape. According to Salleh and Sulaiman (2019), a growing trend focuses on transforming workers' knowledge, expertise, and skills to enhance their competence and better align them with the demands of the evolving workforce. Enterprise Architecture (EA) emerges as a strategic tool in this transformation, offering a comprehensive framework to align educational objectives with industry needs, optimize resource utilization, and enhance institutional responsiveness. This study has explored the key factors necessary for the sustainable implementation of EA within Malaysia's TVET institutions, utilizing a combination of SLR and thematic analysis of stakeholder interviews. This study reveals that eight key factors can be categorized into three main elements which are Process, People, and Technology. The findings underscore the critical importance of management support and their involvement, a clear business vision, and goal strategy, and the adoption of emerging technology such as Artificial intelligence and the Internet of Things in the is the key factors of sustainable digital transformation. These factors collectively ensure that TVET institutions can remain agile, resource-efficient, and strategically aligned with the dynamic requirements of the job market. By providing a detailed analysis of these key factors, this study offers valuable insights for policymakers, educational leaders, and practitioners involved in the strategic planning and management of TVET institutions. The insights from this study pave the way for further research and implementation efforts, ultimately aiming to enhance the effectiveness and sustainability of TVET programs in Malaysia's public sector.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm their contribution to the paper as follows: ***study conception and design:*** *Surya Sumarni Hussein, Puteh Melor Wesma;* ***data collection:*** *Norlida Ramly;* ***analysis and interpretation of results:*** *Wan Azlin Zurita Wan Ahmad, Surya Sumarni Hussein;* ***draft manuscript preparation:*** *Surya Sumarni Hussein, Duong Dang, Muhammad Irfan Arif. All authors reviewed the results and approved the final version of the manuscript.*

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