

The Development of the Enterprise Architecture Framework to Spearhead the Higher Education Institution's Digital Transformation Based on a Socio-Technical System Theory Perspective

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How to cite this article: Sim Ying Yee, Nur Azaliah Abu Bakar, Hatma Suryotrisongko, Khakim Ghazali, Putu Deny Arthawan Sugih Prabowo, Dwi Nur Amalia(2024) The Development of the Enterprise Architecture Framework to Spearhead the Higher Education Institution's Digital Transformation Based on a Socio-Technical System Theory Perspective. Library Progress International, 44(3), 26655-26663

Abstract— In the dynamic landscape of higher education, the digital revolution is reshaping traditional practices, presenting both opportunities and challenges. While global discourse on digital transformation in education is expanding, a notable research gap persists, particularly in developing countries where the adoption of digital initiatives is still unfolding. This gap is pronounced in these regions' Higher Education Institutions (HEIs), necessitating tailored strategies that account for the dual dimensions of technological and social intricacies. This study addresses this research gap by leveraging socio-technical systems (STS) theory, a framework uniquely attuned to the interplay between technology and organisational culture. Specifically focusing on HEIs in developing countries, we delve into the resistance to change from faculty, staff, and students and the imperative for robust technological infrastructure. We aim to provide practical insights and solutions, moving beyond theoretical discussions prevalent in current literature. The research unfolds three critical phases: identifying socio-technical factors, crafting a robust Enterprise Architecture (EA) framework grounded in theoretical principles, and evaluating its real-world implementation. Using Institut Teknologi Kalimantan (ITK) Indonesia as a case study, our anticipated outcomes extend beyond streamlined service delivery and digital integration to encompass refined pedagogical practices. By addressing the intricate challenges of digital transformation in higher education, particularly in developing countries, this study aims to contribute significantly to advancing knowledge in the field.

Keywords—Enterprise Architecture, Digitalization, Higher Education Institutions, Enterprise Architecture Framework, Digital Transformation

INTRODUCTION

In the ever-evolving landscape of higher education, digital transformation has emerged as a pivotal force, leading institutions to switch into an era where innovation intertwines with tradition. Digital transformation refers to the fundamental changes driven by integrating digital technologies into various organisational functions that navigate the complexities of the modern educational environment [1]. As educational institutions grapple with the challenges of modernisation, Digital transformation stands out as a pivotal concept. For instance, the renowned

Institut Teknologi Kalimantan (ITK) is currently positioned at the forefront of this transformative journey, entrusted by the East Kalimantan Provincial Government to undergo a digital transition. In this context, the study aims to explore Digital transformation within higher education, providing insights and a strategic roadmap for institutions, particularly through the lens of the unique challenges faced by ITK. As the impending digital revolution shapes the future of education, understanding and strategically navigating Digital Transformation becomes imperative for institutions aiming to thrive in this dynamic landscape.

In conjunction with the imperative of Digital Transformation in higher education, Enterprise Architecture (EA) emerges as a strategic methodology to synchronise business processes and technological infrastructure. EA, defined as a conceptual blueprint that aligns an organisation's structure and functions with its technology, is pivotal in facilitating the efficient integration of digital technologies within HEIs [2]. For instance, ITK, entrusted by the East Kalimantan Provincial Government for its digital transition, underscores the significance of EA in managing operations, allocating resources, and optimising technological utilisation. EA offers a comprehensive perspective, allowing HEIs to identify inefficiencies and gaps in existing systems [3]. The study seeks to delve into the application of EA in the educational ecosystem, focusing on ITK and aiming to develop a tailored framework that addresses the intricate challenges posed by Digital Transformation. As institutions strive for effective digital integration, EA emerges as a cornerstone, providing the strategic foundation necessary to navigate the complexities of this transformative journey.

In HEIs, the integration of digital technologies presents a complex landscape with challenges and opportunities. Faculty, staff, and students in HEIs often resist change as educational paradigms evolve [4]. Successful Digital transformation goes beyond technology; it requires a holistic realignment of entrenched business processes. For example, ITK's transition to a digitally oriented campus involves addressing technological aspects and organisational and cultural shifts. This study rigorously examines the challenges and successes in HEIs during Digital Transformation, offering insights into effective strategies. As the digital revolution shapes higher education, understanding dynamics within HEIs becomes crucial for successful integration.

In the age of widespread digitalisation and the push for Digital Transformation, HEIs face challenges beyond just dealing with technology. Faculty, staff, and students resisting change, rooted in institutional habits, become a major roadblock to smoothly adopting digital initiatives. At the same time, HEIs are constrained by limited resources, making it hard to invest significantly in robust digital infrastructure and training programs. Additionally, there are noticeable differences in technological skills among stakeholders, making the digital journey even more complicated. This complex scenario highlights the importance of tailored strategies that not only tackle resistance and resource issues but also consider the diverse needs of the academic community. Each HEI has unique dynamics; addressing these complexities is crucial for successful digital integration [5].

In addressing the multifaceted challenges arising from digitalisation in HEIs, EA emerges as a vital strategic tool. In the evolving landscape of HEIs navigating Digital Transformation complexities, EA is a structured framework essential for aligning business processes and technological infrastructure. This systematic approach offers a comprehensive perspective on existing systems, discerning inefficiencies and redundancies in technology and operations. As emphasised by [6], EA assumes paramount significance in optimising ongoing operations and furnishing a blueprint for assimilating emergent technologies. Notably, amid conspicuous variations in technological proficiency among faculty, staff, and students, EA operates as an integrative methodology that effectively addresses these disparities. Unfolding along the trajectory of achieving effective digital integration, EA ensures a seamless alignment between organisational strategies and the imperatives of Digital Transformation [2], [6].

In navigating the evolving landscape of HEIs and their journey toward Digital Transformation, the overarching aim of this paper is to present a comprehensive and tailored EA framework. This framework, to be developed through collaborative research within the ITK context, addresses the intricate challenges digitalisation poses in the educational ecosystem. By drawing on the principles of Socio-Technical System Theory and incorporating three levels of EA (Strategic, Segment, and Projects/Solutions), the ITK Digital Enterprise Architecture Framework aims to provide a holistic view of the entire educational landscape at ITK. This paper endeavours to contribute valuable insights into the practical application of EA as a strategic tool in enhancing the efficiency of HEIs, facilitating digital transformation, and efficiently addressing operational challenges. The expected outcome of this research is to resolve existing challenges at ITK and offer a blueprint that can be extrapolated to other HEIs, fostering sustainable digital transformation in higher education.

1. Literature Review

Digital technology has ushered in an era of significant transformation across various sectors, including HEIs. Digital transformation integrates emerging digital technologies into organisational processes, substantially improving operational efficiency and user experiences [1]. In higher education, digital transformation encompasses the reimagining and restructuring of traditional teaching and administrative practices by incorporating technologies like IoT, big data, cloud computing, mobile systems, and collaboration networks [7]. This transformation is not merely technological but extends to reshaping customer experiences, operational processes, and business models [5]. The literature highlights that digital transformation in higher education is a multifaceted process that impacts instruction, knowledge acquisition, research, support services, administration, and communication [1]. However, the pace of transformation in HEIs is often slower compared to other industries due to the strong adherence to conventional teaching methods and practices [8].

HEIs must establish clear digital transformation strategies to overcome these challenges, fostering stakeholder collaboration and ensuring alignment with organisational goals [9]. A study by Coral and Bernuy [4] emphasises the pervasive influence of digital technologies on all facets of higher education. The research explores the creation of new infrastructures and increased utilisation of digital media to address the evolving needs of students and staff. Hence, digital transformation is a holistic process involving integrating emerging technologies into various aspects of higher education. Despite its transformative potential, the sector faces challenges due to the slow pace of adoption and the need for strategic vision.

HEIs are undergoing a profound shift with the integration of digital technologies. The complexities of incorporating these technologies into established practices pose substantial challenges. The alignment of business processes is critical for successfully implementing digital transformation in HEIs, covering areas such as student admissions, academic program management, lecture delivery, and financial governance [5]. Challenges in HEI digitalisation include resistance to change from faculty, staff, and students, necessitating investments in network infrastructure, data storage systems, and user-friendly interfaces [4]. The digital divide among students, arising from disparities in technology access, further complicates the transformation process. Efficient digitalisation requires addressing these challenges, adapting to technological advancements, and providing comprehensive training to stakeholders [7].

Research indicates that faculty and staff resistance and resource constraints pose significant hurdles in the digitalisation journey of HEIs [4], [5]. In conclusion, HEIs face challenges in aligning established practices with digital technologies, requiring strategic investments, and addressing resistance from various stakeholders.

1.1 EA IN DIGITALISATION

Enterprise Architecture (EA) is a strategic methodology aiming to align business processes and information technology infrastructure within an organisation [6]. It involves identifying and documenting integration requirements and establishing standardisation principles for an organisation's operating model [3], [6]. EA comprises four layers: business, data, applications, and technology infrastructure, providing a comprehensive perspective on an organisation's systems and procedures. The Open Group Enterprise Architecture Framework (TOGAF) is a widely adopted approach for implementing EA, categorising architecture into strategic, segment, and project/solutions levels. EA's advantage lies in its ability to identify gaps, redundancies, and inefficiencies, serving as a foundation for developing a target state architecture aligned with an organisation's strategies [10]. As a justification, Gartner's projection that 40% of organisations will employ enterprise architects to generate business innovations by 2022 underscores the growing importance of EA [6]. Hence, EA is a conceptual framework that aligns business processes and technology infrastructure, providing a structured approach for organisations to optimise their operations.

The digitalisation of HEIs is confronted with several challenges. Faculty, staff, and student resistance to change stand out as a significant barrier to the seamless integration of digital technologies [4]. Resource constraints, including financial limitations and technical proficiency disparities, hinder HEIs' capacity to invest in robust digital infrastructure and comprehensive training programs. Disparities in technological proficiency among stakeholders further complicate the digitalisation process, emphasising the intricate nature of this transformation within HEIs [4], [5], [7]. Addressing institutional resistance, navigating resource limitations, and catering to a diverse academic community must be critical focal points in overcoming these challenges [7]. Research indicates that the digital divide among students, stemming from variations in technology accessibility, exacerbates existing disparities in educational opportunities [5]. All in all, faculty, staff, and student resistance, resource constraints,

and technological proficiency disparities pose significant challenges to HEI digitalisation.

1.2 DIGITAL TRANSFORMATION IN ITK

ITK plays a pivotal role in technological education in East Kalimantan. Established in 2014, ITK is entrusted to support regional development by the East Kalimantan Provincial Government. With a commitment to leveraging technology, ITK is transitioning into a digitally oriented campus, aligning with the government's initiative to relocate the administrative capital. ITK's mission is to enhance educational quality and public services by leveraging technology, positioning it as a key player in the digitalisation of higher education. The institution, entrusted by the East Kalimantan Provincial Government, is poised for a digital transition, making it an ideal subject for exploring an EA framework tailored to the unique challenges of the educational ecosystem. The rapid introduction of digital technologies necessitates a comprehensive reevaluation of higher education processes involving fundamental aspects such as student admissions, academic program management, lecture delivery, and financial governance. However, this alignment encounters resistance from various stakeholders within HEIs, necessitating investments in network infrastructure, data storage systems, and user-friendly interfaces. Moreover, the relentless pace of technological progress mandates continual evaluation, adaptation, and educational instruction to harness emerging technologies effectively. Within this complex landscape, the study finds its purpose – to provide a strategic roadmap for HEIs, exemplified through the case study of ITK.

ITK has a digital aim to create a digitally enriched educational ecosystem. The ITK Digital Enterprise Architecture Framework, grounded in the Socio-Technical System (STS) Theory, aims to address operational challenges, facilitate digital transformation, and align with the evolving needs of the institution. The envisioned ITK Digital Enterprise Architecture Framework spans strategic, segmental, and project-specific levels, providing a holistic view of ITK's educational landscape. The goal is to resolve immediate operational challenges and lay a sustainable foundation for a digitally driven future. For example, the ITK Digital Enterprise Architecture Framework aims to enhance educational quality, public services, and operational efficiency by leveraging technology. As a result, ITK's digital aim revolves around creating an efficient and sustainable digitally driven educational ecosystem through comprehensive EA.

1.3 RELATED THEORY & STUDY

The Socio-Technical System (STS) Theory recognises the interdependencies between social and technical elements within an organisation. Originating in the 1950s, the theory emphasises the need to harmonise novel technologies with organisational frameworks, cultural norms, and operational procedures [11]. In the context of digital transformation in HEIs, STS Theory underscores the significance of integrating technologies with social dynamics, organisational structure, and processes. It advocates for understanding and addressing social and cultural factors to optimise the implementation of digital initiatives [11], [12]. Applying STS Theory to the digital transformation process in higher education helps identify and address social and cultural factors influencing the success of digital initiatives [13]. Therefore, STS Theory provides a valuable framework for understanding the interplay between social and technical elements in digital transformation. Recognising the intricate interplay between social and technical elements in digital transformation, this study leverages the Socio-Technical System Theory. Focusing on the case of ITK, entrusted by the East Kalimantan Provincial Government and standing at the forefront of technological education, this research aims to develop an Enterprise Architecture (EA) framework grounded in the Socio-Technical System Theory. The envisioned ITK Digital Enterprise Architecture Framework spans strategic, segmental, and project-specific levels, aspiring to provide a comprehensive view of the institution's educational landscape.

Recognising the intricate interplay between social and technical elements in digital transformation, this study leverages the Socio-Technical System Theory. This theory underscores the necessity of harmonising novel technologies with organisational frameworks, cultural norms, and operational procedures for successful digital initiatives in HEIs. Focusing on the case of ITK, this research aims to develop an EA framework grounded in Socio-Technical System Theory. ITK, entrusted by the East Kalimantan Provincial Government, stands at the forefront of technological education. The envisioned ITK Digital Enterprise Architecture Framework, spanning strategic, segmental, and project-specific levels, aspires to provide a comprehensive view of the institution's educational landscape.

This study anticipates not only resolving operational challenges at ITK but also paving the way for a sustainable and digitally enriched educational experience and facilitating a transformative journey for ITK and, by extension, other HEIs. As the educational landscape evolves, the integration of EA emerges as a linchpin for enhancing

teaching, learning, and overall educational experiences in the digital age. Within this complex landscape, the study finds its purpose – to provide a strategic roadmap for HEIs, specifically exemplified through the case study of ITK. This institution, entrusted by the East Kalimantan Provincial Government, is poised for a digital transition, making it an ideal subject for exploring an EA framework tailored to the unique challenges of the educational ecosystem.

The integration of the Socio-Technical System (STS) Theory into developing an Enterprise Architecture (EA) framework is proposed to address the challenges in HEI digitalisation. This integrated approach aims to harmonise social and technical elements, ensuring the effective implementation of digital initiatives. The proposed solution involves three stages: identifying factors influencing socio-technical systems in HEI digital transformation, developing an EA framework grounded in STS Theory across strategic, segmental, and project-specific levels, and evaluating the framework's implementation within the unique context of ITK. Applying STS Theory in developing the ITK Digital Enterprise Architecture Framework is expected to address operational challenges, enhance service delivery, and facilitate the integration of digital educational advancements. As this concept paper unfolds, it navigates three pivotal phases: firstly, identifying factors influencing socio-technical systems in HEI digital transformation; secondly, formulating an EA framework grounded in Socio-Technical System Theory; and lastly, evaluating the proposed framework within the unique context of ITK. The anticipated outcome is not merely the resolution of operational challenges at ITK but a blueprint for sustainable digital transformation across HEIs. Beyond the immediate impact, this study envisions a future where digital advancements seamlessly enrich teaching, learning, and overall educational experiences, transcending geographical and technological divides.

The literature review provides insights into the challenges and opportunities associated with digital transformation in Higher Education Institutions, specifically focusing on ITK. Integrating Enterprise Architecture and Socio-Technical System Theory emerges as a strategic solution to navigate the complexities of HEI digitalisation, aiming to create a sustainable and digitally enriched educational ecosystem.

1.4 SUMMARY

The rapid introduction of digital technologies necessitates a comprehensive reevaluation of higher education processes. Fundamental aspects such as student admissions, academic program management, lecture delivery, and financial governance demand a meticulous alignment with digital imperatives. However, this alignment encounters resistance from various stakeholders within HEIs, necessitating investments in network infrastructure, data storage systems, and user-friendly interfaces. Moreover, the relentless pace of technological progress mandates continual evaluation, adaptation, and educational instruction to harness emerging technologies effectively [4]. Enterprise Architecture (EA) emerges as a strategic beacon amid this digital transformation. Offering a holistic perspective, EA synchronises business processes and technological infrastructure, serving as a conduit for operational improvement and interoperability. However, the effective implementation of EA demands strategic planning, stakeholder engagement, and ongoing governance [3]. To address the intricate nature of digital transformation within HEIs, the study integrates the Socio-Technical System Theory, acknowledging the interdependence between social and technical elements. In the context of ITK, situated under the stewardship of Institut Teknologi Sepuluh Nopember Surabaya (ITS), the study gains practical ground. ITK's mission to leverage technology aligns seamlessly with Indonesia's broader initiative, amplifying its significance. The study's objective is clear – to forge an EA framework that transcends the traditional silos within ITK's educational ecosystem. By collaborating with stakeholders and employing the Socio-Technical System Theory, the framework aspires to enhance efficiency, facilitate digital transformation, and address operational challenges. As this concept paper unfolds, it will navigate three pivotal phases. First, identifying factors influencing socio-technical systems in HEI digital transformation; second, formulating an EA framework grounded in Socio-Technical System Theory; and lastly, evaluating the proposed framework within the unique context of ITK. The anticipated outcome is not merely the resolution of operational challenges at ITK but a blueprint for sustainable digital transformation across HEIs. Beyond the immediate impact, this study envisions a future where digital advancements seamlessly enrich teaching, learning, and overall educational experiences, transcending geographical and technological divides.

2. Research Methodology

The research methodology is structured into three coherent phases to systematically address the complexities of developing a robust EA framework for HEIs undergoing digital transformation. The initial phase focuses on formulating the framework by conducting an in-depth literature review and analysing ITK official documents, business processes, and relevant data. Identifying antecedents and outcomes of socio-technical deployment on

HEI digital transformation constitutes a pivotal milestone.

In the second phase, the primary objective is to develop and deploy the proposed EA framework. This involves formulating the EA framework based on Socio-Technical System Theory (STS) and three EA levels (Strategic, Segment, Projects/Solutions). Additionally, the design and creation of EA development tools are undertaken, followed by a crucial step of validating and refining the framework through consultations with experts. The ultimate milestone in this phase is the successful deployment of the EA framework and tools at the ITK case study, providing tangible and practical outcomes.

The third and final phase centres on evaluating the proposed EA framework. This includes thoroughly assessing the ITK EA framework for HEI digital transformation and leveraging survey questionnaires with ITK stakeholders. Furthermore, a Transfer of Knowledge (ToK) Workshop ensures stakeholders' shared understanding of the framework and tools. The research concludes with finalising findings documenting the process, outcomes, and lessons learned. This comprehensive methodology ensures a systematic progression from understanding the theoretical foundations to practical deployment and evaluation, contributing valuable insights to digital transformation in HEIs.

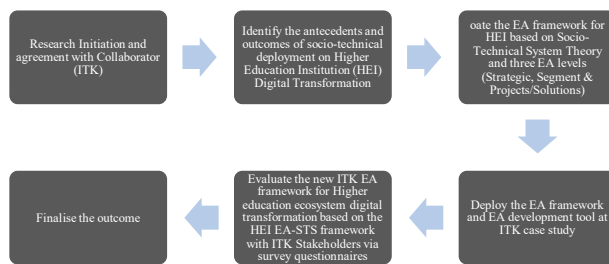


Figure 1. Project Flow

3. Research Framework Development

EA is the conceptual framework ensuring harmonisation between business processes and information technology infrastructure. It illustrates the integration and standardisation needs of an organisation's operating model [3]. Furthermore, this architectural framework serves as a theoretical framework that defines the structure and functioning of an organisation. An enterprise architect endeavours to determine the most efficient methods for achieving the current and future objectives of the organisation [6]. According to Gartner, in 2019, enterprise architects and technology innovators must prioritise coordination and artificial intelligence. According to a projection, by 2022, approximately 40% of organisations are expected to employ enterprise architects' services to generate novel business innovations enabled by emerging technologies [10].

EA comprises four layers: business, data, applications, and technology infrastructure. These layers delineate the functioning of information systems, processes, organisational units, and individuals within an organisation as a cohesive entity. The Open Group Enterprise Architecture Framework (TOGAF) facilitates the implementation of layers, classifying the architecture level into three distinct levels: strategic level architecture, segment-level architecture, and project and solutions level architecture [14]. The details of the Architecture Map Level layer are depicted in **Figure 2**.

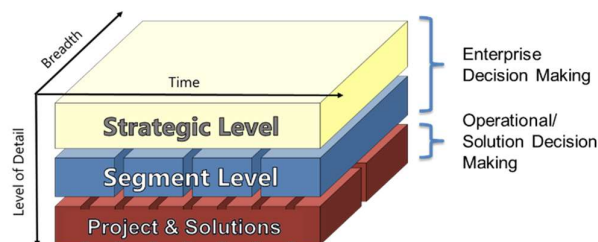


Figure 2. A visual representation of the Enterprise Architecture Level Map

The elucidation for each stratum in the Architecture Level Map is as follows:

- Strategic Level Architecture provides a comprehensive overview of a top-level organisation's overarching structure and operations. Organisational information is utilised to ascertain the strategic trajectory of the organisation as well as to inform the provision of all agency services.
- Segment-level architecture offers a more comprehensive elucidation than strategic-level architecture. It encompasses core functions, support functions, and other components that vary depending on the architecture's scope. The data acquired from the organisation will be comprehensive and result in development of a program or strategy for implementing the desired architecture.
- The Project/Solutions Level Architecture pertains to more intricate architectural information than the preceding two layers. The primary emphasis lies in developing architectural capabilities to enable their realisation in products or system applications that the organisation will adopt.

Trist et al. initially introduced the Socio-Technical System (STS) Theory. In the 1950s, scholars focused on enhancing work system performance by investigating how employees effectively navigate technological challenges and uncertainties. This theoretical framework acknowledges the interdependence between social and technical components within organisational systems [14]. Within the realm of digital transformation, the theory underscores the imperative of not solely focusing on implementing novel technologies but also their harmonisation with the social dynamics, organisational structure, and processes inherent to higher education institutions. Institutions can enhance their ability to navigate the complexities of digital transformation by developing a comprehensive understanding of the interrelationship between technology and the social system. **Figure 3** depicts the Socio-Technical System (STS) Theory.

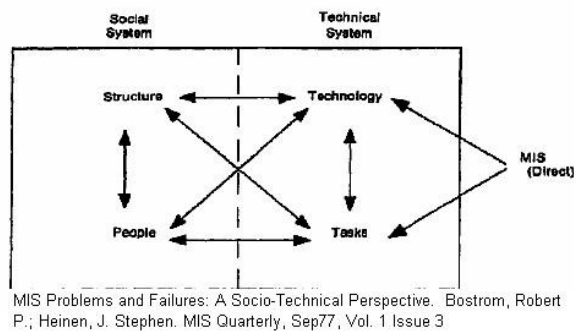


Figure 3. Socio-Technical System (STS) Theory

Applying the Socio-Technical System Theory to the digital transformation process in higher education yields numerous advantages. Various social and cultural factors can influence the utilisation of digital initiatives, which can impede or enhance their successful adoption. Consequently, institutions benefit from identifying and addressing these factors to optimise the implementation of such initiatives. Institutions must understand stakeholders' attitudes, beliefs, and behaviours to devise effective strategies for addressing resistance and fostering a favorable digital culture [13], [15]. Furthermore, the theory emphasises the significance of engaging stakeholders in designing and executing digital solutions, promoting collaboration and a sense of ownership.

Numerous scholarly investigations in digital transformation have employed the Socio-Technical System Theory as a theoretical framework for conducting analysis. One area of study has examined the effects of digital technologies on teaching and learning methods in higher education. This research has considered the socio-technical factors that affect the acceptance and incorporation of these technologies [15]. Previous research has explored the necessary organisational modifications for achieving effective digital transformation, encompassing technical and social aspects [12], [13]. These studies offer valuable insights into the challenges, opportunities, and strategies for digital transformation in higher education institutions by utilising the Socio-Technical System Theory.

Based on an analysis of market studies and a comprehensive review of the literature, it is evident that most research and proposed solutions about the EA Framework in Indonesian HEIs have primarily focused on either the Strategic Level or the Project/Solution Level. However, there is a notable absence of extensive investigations

encompassing all three levels, namely the Strategic Level, Segment Level, and Project/Solution Level, employing a top-to-bottom approach. Hence, this study will be the inaugural endeavour to comprehensively explore all tiers within the realm of EA while concurrently aligning with the core business operations of ITK in their pursuit of digitalisation. This will be achieved by integrating the Socio-Technical System Theory into the research framework. This perspective will provide a valuable framework for comprehending the digital transformation process in HEIs. The utilisation of this technology aids organisations in addressing social dynamics, surmounting resistance, and cultivating collaboration.

4. Conclusion and Future Works

In conclusion, this concept paper delves into the intricate digital transformation landscape within HEIs, focusing on the strategic integration of EA grounded in the Socio-Technical System Theory. Using the case study of ITK, this project underscores the significance of harmonising technological advancements with organisational frameworks, cultural norms, and operational procedures. By bridging theoretical foundations with practical applications, the study aims to offer insights and a roadmap for HEIs, navigating the complexities of digitalisation. As HEIs grapple with the challenges and opportunities presented by the digital era, the integration of EA emerges as a linchpin for orchestrating a seamless and efficient digital transformation journey.

On the other hand, the future work envisioned for this study involves a comprehensive empirical investigation within HEIs. The planned research will delve into developing and implementing the proposed EA framework grounded in the Socio-Technical System Theory. This empirical phase will involve extensive collaboration with stakeholders, including faculty members, administrative staff, and students, to ensure the holistic alignment of digital strategies with the cultural and operational nuances of the institutions. Additionally, the implemented framework's efficacy will be evaluated, gauging its impact on operational efficiency, digital innovation incorporation, and the overall quality of educational experiences. The anticipated outcome is to contribute to the theoretical discourse on EA in HEIs and provide practical insights and recommendations for sustainable digital transformation, fostering a future where technology seamlessly enriches teaching, learning, and overall educational experiences.

ACKNOWLEDGEMENT

This work is supported by the 2023 Joint Research Scheme (JRS) of the SATU (Southeast Asia and Taiwan Universities) Presidents' Forum², and funded by ITS's grant for international research collaboration ("Penelitian Departemen" scheme), under contract number: 2327/PKS/ITS/2023 and Universiti Teknologi Malaysia under research grant PY/2023/00782

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