Navigating Digital Transformation: A Case Study of Thailand's Higher Education and Energy Sectors

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Abstract

Digital Transformation has become a powerful tool to promote changes across industries all over the world. This comparative study investigates the distinct digital transformation (DX) journeys of Thailand's higher education and energy sectors by examining their organizational strategies and practices. The study followed a sequential, two-phase design. Phase 1 employed a questionnaire-based assessment to determine the digital maturity profiles of candidate organizations; scores were calculated descriptively and served only to identify comparable cases. Phase 2 used qualitative, semi-structured interviews to explore digital transformation practices in depth. Findings show that the higher education sector mainly focuses on supporting the educational experience and operations through the integration of digital technology, whereas the energy sector focuses on improving operational efficiency and adapting to align with future energy trends. This study also shows that both sectors are able to enhance their work efficiency and service quality by implementing digital transformation that aligns with strategic goals and the business environment.

Keywords: 1) Digital Transformation 2) Higher Education 3) Energy Industry 4) Digital Maturity 5) Technology-Organization-Environment

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Introduction

Digital transformation (DX) has emerged as a critical force driving change across various sectors globally, marking a significant shift towards adopting digital technologies that redefine traditional products and services. In Thailand, the "University 4.0" initiative under the broader Thailand 4.0 policy illustrates a strategic commitment to integrating innovative educational principles. This initiative seeks to transform universities into hubs of technological and innovative excellence, aligning administrative practices and resource allocation with broader societal needs (Royal Thai Embassy, Washington D.C., 2021).

The urgency for universities to adapt has been highlighted by societal shifts such as the industrial revolution, digitalization, and globalization. The pandemic underscored the need for rapid adaptation as universities swiftly transitioned to online learning environments, demonstrating their capacity to utilize digital tools under pressure (Imran, et al., 2025, p.1). Simultaneously, the energy sector is increasingly being influenced by DX, which has yielded substantial gains in efficiency and profitability through applications like real-time analysis that bolster environmental safety (Mohaghegh, 2005, p. 86); Internet of Things (IoT) technologies that enhancing operational safety (Singh, et al., 2022, p. 3).

The percentage of companies investing in various growth strategies shows that the top investment is in DX (AlixPartners, 2024, p. 10). The selection of the higher education sector and the energy sector for this study is intentional and significant. In the energy sector, the commitment to DX is crucial for advancing regulatory compliance and environmental goals, promoting a shift towards more sustainable energy practices (KPMG, 2023; McKinsey, 2023). These two sectors are fundamentally different in their organizational structures, strategic objectives, stakeholder expectations, and regulatory environments. Such stark contrasts offer a unique opportunity to investigate how DX manifests across diverse contexts, providing empirical insights that go beyond mere evaluations based on digital maturity scores (Vial, 2019, p. 133; Rodriguez-Abitia and Bribiesca-Correa, 2021, p. 4). Moreover; focusing on digital maturity within DX is critical subsequently it helps organizations systematically evaluate and enhance their capabilities across essential areas to effectively respond to digital challenges and opportunities.

This study aims to (1) explore the current DX landscape, (2) highlight the differences in DX processes based on digital maturity and (3) identifies critical success factors for DX in the higher education sector and the energy sector. Additionally, this research aims to develop guidelines for integrating DX within the higher education sector and the energy sector.

Literature Review

Digital Transformation (DX)

Digital Transformation (DX) refers to organizational changes influenced by digital technologies, encompassing flexible organizational structures propelled by digital ecosystems (Hanelt, et al., 2021, pp. 1160–1161). DX focuses on organizational changes, reshaping organizational cultures, adapting to new ways

in which society manages information, and the evolving demands for organizational services (Mergel, et al., 2019, p. 1). DX consists of the following elements: (1) using technology to transform service delivery; (2) employing technology to transform organizational cultures and relationships with stakeholders; and (3) value creation as a transformation outcome of service delivery (Mergel, et al., 2019, pp. 2-3). Along with these factors, the potential contributions of DX in organizations are also identified, which include: 1) the optimization of physical and digital resources; (2) the enhancement of competitive advantages; (3) increased value creation for customers; and (4) cost reduction (Reis and Melão, 2023, p. 6).

In this study, DX is defined as a change initiated by transformational information technology, leading to changes in business models. It entails significant alterations in business processes, specifically regarding the impact of IT on organizational structures, routines, and capabilities (Hanelt, et al., 2021, pp. 1172-1173; Mergel, et al., 2019, p. 3).

Digital Transformation in Thailand

Recent studies in Thailand's higher education sector highlight leadership qualities, management models, IT staff competencies, and key factors like strategy and technology as crucial for DX (Sirilak and Wannasri, 2023, pp. 46–52; Sukkerd and Khongmalai, 2022, pp. 157-174; Tungpantong, et al., 2021, pp. 9-19). In contrast, the energy sector focuses on improving efficiency and sustainability through digital platforms, supply chain optimization, and policy innovations such as Small Modular Reactors. Building on these insights, our research aims to compare DX in the higher education and energy sectors in Thailand by assessing their digital maturity and digital disruption index. This comparison will help identify sector-specific strengths and challenges, ultimately enabling us to propose a practical implementation framework to guide DX across both industries.

Digital Maturity

Aslanova and Kulichkina (2020, p. 444) state that a company's ability to adapt appropriately to development in the digital age, integrate digital accomplishments into business operations, and enhance staff members' digital competencies are all considered aspects of digital maturity. The process of gradually integrating organizational procedures, people, and other resources into digital processes and vice versa is known as "digital maturity" (Aslanova and Kulichkina, 2020, p. 445).

The Digital Maturity Model 5.0 developed by Forrester Research, Inc. was utilized in this study (VanBoskirk, et al., 2017, pp. 1-17). This model is used to evaluate the fundamental elements of a corporation's overall degree of DX (VanBoskirk, et al., 2017, pp. 1-17). There are four dimensions: organization, culture, technology, and insights. The organization dimension includes the alignment of the business in supporting the strategy of DX, as well as governance and execution. The culture dimension refers to the evaluation of how pervasive and supportive digital culture is within a particular company. The technology dimension is concerned with integrating evolving digital technologies into a company's operations, while the insights dimension assesses how well

a company uses data to drive organizational strategy (Ćurak, et al., 2024, p. 3).

The levels of digital maturity vary across organizations. The first level, referred to as Sceptics, encompasses organizations that reject digitalization. The second level, known as Adopters, includes those who primarily rely on traditional methods to accomplish tasks. Collaborators represent the third level; while they engage in collaboration, they lack an insight-driven approach, such as being data-driven or guided by consumer experiences. The highest level of digital maturity, Differentiators, is characterized by demonstrating ad hoc excellence (VanBoskirk, et al., 2017, pp. 6-9).

Disruption index

The Disruption Index measures the impact of digital technologies on various industries, indicating how significantly they have been affected by DX. This process of DX often results in a higher Disruption Index score, reflecting the extent of changes and innovations implemented (Bharadwaj, et al., 2013, pp. 471-482). The higher education sector and energy sectors may share different level of Disruption Index due to unique operational and regulatory environments (Nambisan, et al., 2019, pp. 223-238). Although both industries have embraced technological advancements, their goals, operational models, and stakeholder interactions remain distinct.

Theoretical Foundation: The Technology-Organization-Environment (TOE) Framework

The Technology-Organization-Environment (TOE) framework, developed by Tornatzky and Fleischer (1990, p. 152), remains one of the most widely recognized theoretical models for explaining DX adoption across various industries (Díaz-Arancibia, et al., 2024, pp. 1-31). By categorizing the key determinants of DX adoption into three dimensions—technology, organization, and environment (see Table 1.) - the TOE framework provides a structured approach to analyzing the factors that influence digital adoption (Amini and Jahanbakhsh Javid, 2023, p. 3-4; Zhu, et al., 2006, pp. 601–602, 607–609).

Although foundational diffusion and acceptance models such as Rogers' Diffusion of Innovation (DOI) theory (2003, pp. 5-7) and the Technology Acceptance Model (TAM) (Davis, 1989, pp. 320-322) offer valuable insights, those theories concentrate on innovation characteristics and individual perceptions, respectively, and therefore underrepresent meso-level and macro-level forces that shape organizational DX. In contrast, the TOE framework explicitly integrates technological readiness, intra-firm capabilities and external institutional pressures, allowing researchers to capture multifactor dynamics that are especially salient in emerging-economy contexts characterized by infrastructure gaps and regulatory volatility. Subsequent evidence from European and African firms confirms that environmental uncertainty and competitive intensity variables absent from TAM are often the strongest predictors of enterprise-wide DX initiatives (Awa, et al., 2016, pp. 1-3; Zhu, et al., 2006, pp. 608-609). Accordingly, TOE can provide a comprehensive framework for investigating the digital-transformation journeys of this study.

Table 1 TOE Dimensions

TOE Dimensions		
Technological Dimension	**Organizational Dimension**	**Environmental Dimension**
The technological dimension of the TOE framework encompasses an organization's access to digital technologies, their compatibility with existing systems, and the perceived benefits of adoption. This dimension plays a pivotal role in DX, as technological readiness directly affects the success of implementation (Amini and Jahanbakhsh Javid, 2023, p. 3-4).	Organizations must adopt agile processes, data-driven decision-making, and interdisciplinary teamwork to enhance efficiency and technological integration. By effectively integrating this dimension, organizations can build a resilient framework for long-term digital success (Komathi and Sim, 2024, p. 5).	The environmental dimension encompasses external factors that influence an organization's adoption of digital technologies. Competitive pressures within the market force firms to continuously adapt and integrate new technologies to maintain their competitive advantage.

The flexibility of the TOE framework allows researchers to tailor its constructs based on organizational characteristics and the specific technologies under consideration. This adaptability enables a more precise analysis of the factors driving DX in different sectors (Komathi and Sim, 2024, p. 5).

Methodology

This study applies a case study approach (Eisenhardt, 1989, p. 533) to study the DX in the higher education sector and the energy sector. The varying degrees of digital disruption between the higher education and energy sectors have led to distinct approaches in DX. The higher education sector is experiencing significant disruption, particularly in teaching technologies and service delivery systems, as institutions strive to meet evolving stakeholder expectations (Alenezi, et al., 2023, p. 3). In contrast, the energy sector remains comparatively stable due to its mature technological infrastructure for manufacturing, and is proactively preparing for future DX through strategic planning and innovation readiness (Canton, 2021, p. 684).

For the higher education sector, the medical school was selected as a case and it is one of the top five universities in Thailand. For the energy sector, a leading energy company in Thailand was selected which has operated more than 40 years across Asia pacific. After evaluated the digital maturity level across some higher educations and private organizations, only two cases suitable for this study (59.33 for higher education and 59.00 for energy company). The overview of the two cases shows in Table 2.

Table 2 Overview of the Two Case Studies

Criteria	Higher Education	Energy Company
Business	A medical school	An International Versatile Energy Provider
Organizational type	Non-profit	Private organization that listed on the Stock Exchange of Thailand (SET)
Size	Around 2,000 employees	Around 6,000 employees
Head quarter	Chiang Mai (Thailand)	Bangkok (Thailand)
Year of establishment	1959	1983
Main Drive for Dx	To better response the customer need	New strategic plan
Year of Dx project initiation	2021	2020

The aim of this study is to provide the DX implementation framework across different contexts or industries. The methodology is divided into two main parts followed a sequential, two-phase design. Phase I employed a questionnaire-based assessment (diagnostic survey) to determine the digital-maturity profiles of candidate organizations (Volf, et al., 2024, p. 668); scores were calculated descriptively and served only to identify comparable cases. Phase II used qualitative, semi-structured interviews to explore digital-transformation practices in depth.

To describe this phenomenon, The measurement of the digital maturity level in this study was based on The Digital Maturity Model 5.0. The measurement was validated by four academic experts in the field of management. This study examined the digital maturity score using questionnaire and the digital maturity score was calculated. The questionnaire consisted of two main sections: 1) Organizational information and digital transformation (DX) initiatives (seven questions); 2) Respondents' perspectives on digital maturity in terms of organisational IT support (seven questions), IT culture (seven questions), technology (seven questions), and internal systems (seven questions).

This study adopted the approach of Glaser and Strauss (2012, p. 1) using semi-structured interviews to collect data. After digital maturity level assessment, in-depth interview was used to collect insight data of DX implementation. The interviews were conducted among employees who were involved in the DX processes listed in Table 3.

Table 3 Participant Information

Organization	Employee Level			
Level	**Top manager**	**Middle manager**	**Operation**	**Total**
Higher Education	2 (Dean & Deputy dean)	2 (Head of department)	4 (2 Lecturers & 2 Staffs)	8
Energy	2 (Director)	2 (Head of department)	4 (Staffs)	8

The participants were asked for consent and data were recorded during the interviews. Then transcriptions were coded and analyzed by content analysis. The codes and themes were identified and analyzed by three researchers. The frequency of sentences and words with common themes was mentioned. ATLAS.ti software was used to facilitate the analysis. The group of researchers discussed about the codes, themes and the categories of each question to answer the research questions.

Results

Digital Maturity Dimension

This study categorizes the digital maturity assessment into four key dimensions—culture, organization, technology, and insights as illustrated in Figure 1.

Comparative data analysis: digital maturity in higher education vs. energy sectors

Although their aggregate digital maturity scores are comparable, the higher education and energy sectors display distinct strengths and weaknesses across the four digital maturity dimensions (see Figure 1).

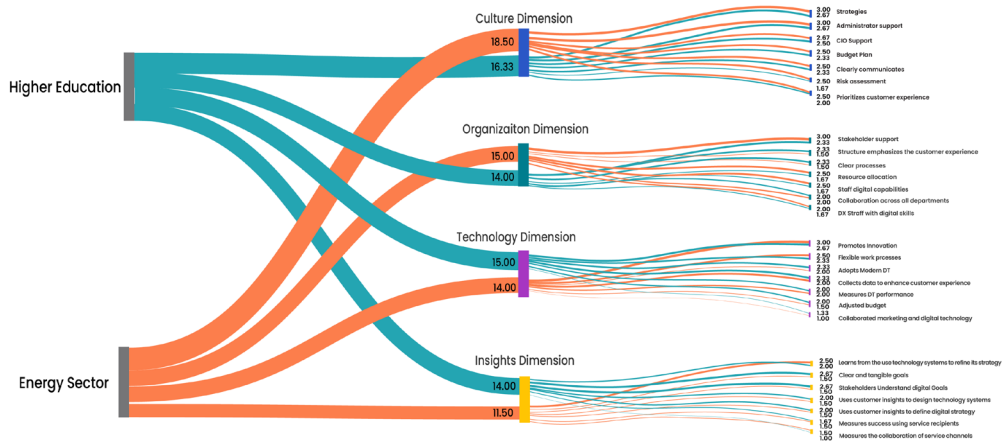

Figure 1 Digital Maturity Score

Culture Dimension

The energy sector surpasses the higher education sector in cultural maturity (18.50 vs. 16.33), particularly in goal-setting for digital strategy (3.00) and alignment of employee performance with digital objectives (2.50). Strong risk assessment practices (2.50) help facilitate innovation. Meanwhile, the higher education sector demonstrates stronger leadership commitment to digital strategies, with high scores in administrative and executive support (2.67). Institutions prioritize digital literacy through training at all levels (2.33) and emphasize clear communication of the digital vision (2.33). However, risk assessment for innovation (1.67) and customer experience prioritization (2.00) remain areas of weakness.

Organization Dimension

The energy sector slightly outperforms the higher education sector (15.00 vs. 14.00), excelling in resource allocation (2.50), staff capabilities (2.50), and stakeholder engage-

ment in digital initiatives (3.00). Nevertheless, the sector lags behind in customer experience orientation (1.50). In the meantime, the higher education sector emphasizes customer experience in digital strategy (2.33) and possesses well-structured digital management processes (2.33). However, resource allocation (1.67) and staff digital capabilities (1.67) are weak, suggesting a gap in digital workforce readiness.

Technology Dimension

The higher education sector scores slightly higher in technological maturity (15.00 vs. 14.00). Institution exhibit flexibility in budgeting for digital technology (2.00) and adopt modern digital tools (2.33). However, interdepartmental coordination, particularly between marketing and digital technology units (1.33), remains a challenge. The energy sector, in contrast, demonstrates strength in innovation-driven DX (3.00) and flexible work processes (2.67). Moreover, it effectively integrates digital technologies (2.50); however, budget constraints (1.50) and departmental silos (1.00) hinder seamless implementation.

Insights Dimension

The higher education sector establishes clear digital goals (2.67) and ensures that stakeholders understand how their performance aligns with digital strategies (2.67). They leverage customer insights in digital strategy formulation (2.00). However, there is room for improvement in evaluating the collaboration between service channels (1.00). In contrast, the energy sector faces significant challenges in this area, scoring lower in goal-setting (1.50), stakeholder understanding of digital impact (1.50), and customer insights integration into digital strategy (1.50 to 2.00). However, it performs better in refining digital strategy through system usage feedback (2.50).

In conclusion, both sectors contribute uniquely to digital maturity: the higher education sector excels in leadership support, governance, and customer-centric strategies, while the energy sector leads in resource allocation, innovation, and digital workforce capabilities. Addressing these areas will help both sectors balance strengths and close sector-specific gaps for more effective DX.

Results from in-depth interview

The in-depth interviews provided insights that helped identify key challenges and opportunities, ensuring that the framework (figure 1.) is both practical and tailored to the specific needs of the organization.

Intent: Data-Driven Organization

Both sectors prioritize cultural change by fostering continuous learning and embedding a DX mindset, respectively, to drive digital improvements. They focus on enhancing operational efficiency through streamlined processes and data-driven optimization. Furthermore, they put effort in improving customer experience by leveraging data to better meet stakeholder needs, while strategically adopting appropriate technologies to support digital initiatives and decision-making. Continuous improvement is also emphasized in both sectors, with mechanisms in place to gather feedback, identify areas for enhancement, and track the progress of their DX efforts. See Table 4.

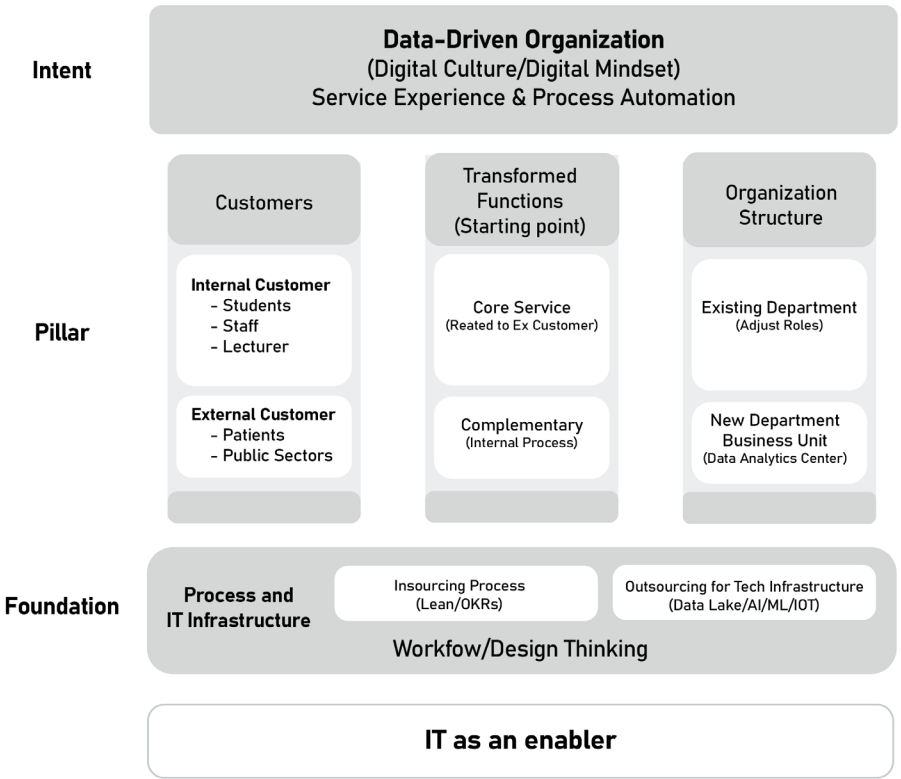

Figure 2 Digital Transformation Implementation Framework

Table 4 Data-Driven Organization Summary

Aspect	Higher Education	Energy Industry
Cultural Change and Mindset	Emphasizes fostering a culture that supports continuous learning and innovation.	Focuses on embedding a digital transformation mindset within the organization, enabling each unit to drive its own digital improvements.
	"By supporting continuous learning culture and innovation, it helps to make sure that our staffs are ready to embrace new technology and new ways of operations."	*"We want to create digital transformation culture into our organizational culture, therefore; all functions can improve their ability in all digital aspects."*
Operational Efficiency	Streamlines internal processes to increase productivity and reduce manual workloads.	Uses data to optimize processes and improve efficiency across all departments.
	"It is essential to improve internal operation in order to increase an efficiency and reduce workloads by applying Electronic Medical Record system (EMR)."	*"The use of data and Information Technology helps our organization to greater monitor and improve operation effectively."*

Aspect	Higher Education	Energy Industry
Enhanced Customer Experience	Enhances service delivery quality and efficiency to patients and stakeholders.	Enhances the experience of both internal and external customers using data to understand and meet their needs.
	"By using "voice of customer -voc" from our students and patients, we can solve and improve our service in time. VOC system gives us suggestions and informs any problems they experience."	*"When we listen to our customer and we try to understand their needs and provide the best values for them."*
Strategic Use of Technology	Builds a robust IT infrastructure and adopts appropriate technologies to support digital initiatives.	Implements the right technologies to support data-driven strategies and ensure effective utilization of data for decision-making.
	"Our strategic investment in technology such as EMR system and Telemedical platform significantly enhance our productivity and effectiveness."	*"It is unnecessary to apply all activities... we just need to make it fast, make it better so we change from enable technology to become enabler."*
Continuous Improvement	Establishes mechanisms for continuous feedback and improvement to refine digital strategies.	Uses data to identify areas for improvement and track progress of digital initiatives.
	"Our commitment to continuous improvement is evident in our use of IT systems to monitor and enhance service delivery in real time."	*"We found our 'Data Center-DC" to effectively facilitate data collection, and data accessibility."*

Pillar: Customers, Transformed Function, and Organization Structure

The 1st Pillar: Customers

Both sectors recognize the importance of internal and external customers in DX journeys, nevertheless their approaches highlight different focal points. The higher education sector emphasizes improving educational and healthcare services. Their goal is to enhance the overall educational experience and streamline administrative processes, improve patient care quality, and engage with public sector stakeholders for community health initiatives. Simultaneously, the energy sector places a strong emphasis on enhancing employee experience and customer satisfaction.

The 2nd Pillar: Transformed functions

Transformed functions

Transformed functions reflect an organization's approach to getting started. The key point in implementing DX is begin with transforming a specific business unit or function and then expand it to the organizational level. There are different issues in each sector, as follows.

The higher education sector

Core service:

For a medical school, the transformed functions chosen as the starting point were related to providing patients with services such as telemedicine and a patient referral system. After the core functions in these areas were successfully transformed, the next step was to select functions related to student service, namely teaching and research.

Complementary functions:

The complementary functions include human resources, finance and accounting, and public relations. Starting DX with a challenging internal processes targets management-level functions or departments where the lack of change creates significant difficulties.

The energy sector

DX starts with raising awareness of the importance of change across the organization by management. At that time, each department will come up with strategies and guidelines to achieve the organization's goals. The first issue is automation where HR transactions should be automated to provide 24/7 on-demand services. The second issue is developing data analytics capabilities to extract business solutions from previously unrecognized and uninterpretable data. Finally, the third issue is integrating and pursuing digital opportunities within working processes.

The 3rd Pillar: Organizational structure

Both sectors have to adjust the roles of existing business units to efficiently respond to customer needs. The higher education sector has to restructure because the vision and policies of management team have changed as a result, they have implemented the DX policy to improve the service. The higher education sector has to adapt the technology for academic activity such as online classroom, database network for researcher and better service system for patients. For the meantime, the energy company focuses on applying the technology mindset to all employees as they are required to integrate technology into their routine jobs to improve performance. Additionally, for a medical school the data analytics center, online training and tele-med were established. The data analytics center plays a role as a data provider for managers, researchers, lectures and students to improve their activities. Tele-med was a new business to serve the patients under distancing, sensitive and pandemic conditions. On the other hand, smart energy unit has been established for the energy organization where it provides more opportunities to address future energy trends. It also invested in green energy technologies such as solar farms; the concern is not only with the benefits but also with environmental issues in order to meet future customer needs.

Foundation:

The implementation of a DX foundation involves both the DX project practice and the utilized IT infrastructure. This section discusses the process approaches and digital technologies used in the DX project. The first step is process improvement, which involves; (1) analyzing the current (as-is) processes, (2) identifying value-adding and non-value-adding processes, and (3) then improving them to achieve the desired (to-be) processes.

The higher education sector

Roadmap planning:

The implementation of the DX project is conducted in-house. For planning, the university management outlines the roadmap to effectively communicate it to its faculties. As mentioned, "The university implemented the DX project internally. Management develops a roadmap to clearly communicate the plan to the faculties."

Process approach:

Lean principles are applied to manage and improve work processes, streamlining them before introducing digital technology. Additionally, total quality management (TQM) is utilized in educational business practices and digital project implementation. The Agile Approach is employed for project execution. As mentioned, "We use lean principles to manage and improve our work processes. We also apply TQM in our educational practices and digital projects. For executing projects, we go with the Agile approach."

Digital technology:

Both in-house development and outsourcing are employed for digital technology development in the higher education sector. The choice depends on the budget allocated by the university, the complexity of the technology, and the skill level of the IT staff. Various technologies are used in DX projects, including (1) IOT for temperature measurement of drug treatment, (2) data lakes for supporting research activities, (3) machine learning, (4) social listening tools, (5) the MIS system used for back-office operations, and (6) e-learning platforms for teaching. As mentioned, "We use both in-house and outsourced development, depending on the university's budget, the complexity of the technology, and our IT staff's skills.".

The energy sector:

Roadmap planning:

The company hires a consulting firm to assist in planning the DX project in its early stages. After this initial phase, the company's units independently manage the project without further outsourcing. As mentioned, "We hire professional consultants to provide a roadmap and guidance for DX. One of the reasons for engaging consultants is to gain an external perspective on our organization."

Process approach:

In the process management of the energy sector, the same approaches used in the higher education sector are applied, specifically the Lean and Agile methodologies. As mentioned, "The process flows of each department should be streamlined before initiating a transformation"

Digital technology:

In the back office, such as the HR department, the employees in the department develop their use of simple technology, such as Google Cloud Services or low-code and no-code applications. Meanwhile, the core functions use customized software packages, such as ERP and MRP, etc. As mentioned, "Our choices for implementing IT are based on functions. For example, we chose commercial software packages to support core processes such as ERP and MRP. For some tasks, we implement applications ourselves using simple technology."

Discussion

The DX journeys of the higher education and the energy sector demonstrate distinct priorities shaped by their operational environments, organizational missions, and stakeholder expectations. These differences are particularly apparent in how each sector approaches data-driven transformation, technological adoption, and cultural readiness.

In the higher education sector, DX initiatives are primarily aimed at improving service quality and operational efficiency by fostering a culture of continuous learning and innovation. Institutions focus on building robust IT infrastructure and strategically adopting digital systems to support academic and administrative functions. By applying data-driven decision-making practices, higher education sector can identify areas for improvement and iteratively refine their digital strategies. This ultimately enhances the quality of services such as student learning support and academic management (Chigbu and Makapela, 2025, p. 4; Jin, et al., 2025, p. 9). However, the transition to a fully data-driven culture remains difficult. The literature underscores the challenges of institutional inertia, resistance to change, and limited staff readiness in adopting data-centric approaches (Gkrimpizi, et al., 2023, p. 7; Sirilak and Wannasri, 2023, p. 92).

In contrast, the energy sector emphasizes embedding a DX culture centered on innovation, agility, and functional accountability. Digital initiatives in this sector are oriented toward improving both internal operations and external customer experience. Organizations employ advanced analytics and real-time data monitoring to support operational decision-making and respond swiftly to market dynamics (Mok, 2025). This sector also places greater emphasis on performance tracking and continuous improvement. Despite these strengths, key obstacles persist-particularly in data governance, cybersecurity, and integrating new technologies into legacy systems (KPMG, 2023; Mok, 2025,).

These differences between sectors suggest that digital maturity does not progress uniformly across all TOE dimensions. Cultural readiness and insight capabilities-two critical pillars in the maturity model-diverge significantly between sectors. Hgher education sector often lag in cultivating a digital-first mindset, constrained by traditional governance and slower policy responsiveness (Bravo-Jaico, et al., 2025, p. 5; Singun, 2025, p. 11), whereas energy organizations, responding to competitive and market forces, are more agile in leveraging data insights for strategic gains. These patterns support the TOE framework's premise that organizational and environmental contexts critically shape technological innovation (Tornatzky and Fleischer, 1990, p. 154; Hanelt, et al., 2021, p. 1163).

Moreover, the findings provide empirical support for the DX Implementation Framework proposed in this study. The framework outlines a sector-sensitive roadmap for DX maturity, an approach supported by research indicating that digital strategies must be tailored to specific industry contexts (Matt, Hess and Benlian, 2015, p. 339). By aligning key components—technology infrastructure, organizational capability, cultural readiness,

leadership, and stakeholder engagement—the framework adopts the holistic perspective that the literature identifies as crucial (Vial, 2019, p. 128; Hanelt, et al., 2021, p. 1168). In both sectors, successful implementation hinged not only on technology acquisition but also on leadership commitment and cross-functional collaboration. This finding strongly resonates with seminal work in the field, which posits that digital transformation is primarily a challenge of leadership, not technology (Westerman, et al., 2014; Forbes Tech Council, 2021), and that broad managerial and employee involvement is a key determinant of success (Henriette, et al., 2015, p.12)

Implications of the Study

Theoretical Contribution

This study contributes to DX research by showing that organizations with similar digital maturity levels can experience different DX outcomes due to sector-specific factors such as organizational context, operational focus, and stakeholder expectations. Using the TOE framework, the findings highlight that digital maturity alone does not ensure DX success; alignment with industry-specific conditions is essential. The study further extends the TOE framework by illustrating how digital maturity shapes organizational strategy, processes, and culture differently across sectors. The proposed sector-sensitive DX framework offers a practical model for understanding and guiding DX in varied organizational contexts, particularly in emerging economies.

Pratical Contribution

This study identifies five key capability clusters-culture, workforce capability, technology stack, data practices, and risk governance-that explain the sectors' differing DX outcomes (see Figure 1). Drawing on this evidence and practitioner guidance (Accenture, 2023; Booth, Patel and Smith, 2020), Table 4 presents focused, practical recommendations for similar organizations.

Table 5 Capability Clusters, Empirical Signals, and Recommended Actions

Capability cluster	Evidence from cases	Actionable guidance
Culture	Energy firm outperforms on risk assessment; university excels in vision communication.	• Pilot "fail-fast" projects • Cascade digital purpose statements, then track staff awareness
Workforce capability	Energy firm scores higher on staff digital skills (2.50 vs 1.67).	• Launch micro-credentials linked to reviews • Rotate digital "champions" to share expertise
Technology stack	University leads on budgeting flexibility; energy firm leads on innovation.	• Prioritize modular, API-ready platforms • Reallocate 10–15% budget to emerging tech (e.g., IoT, AI)
Data practices	University stronger in goal alignment; energy firm stronger in feedback loops.	• Establish data lakes with role-based access • Use customer-journey analytics to refine digital strategy
Risk governance	Both cases lag in customer-experience (CX) risk metrics.	• Introduce CX-related key-risk indicators

Limitations

This study is subject to three key limitations. First, its narrow sectoral scope—focusing on a single university and one energy company in Thailand—limits the generalizability of the findings to other industries or national contexts. Second, the assessment of digital maturity relies solely on the Forrester Digital Maturity Model, which may exclude other relevant dimensions, such as platform orchestration or ecosystem integration. Third, the cross-sectional nature of the data, collected at a single point in time, constrains the ability to draw causal inferences or examine the progression of digital maturity over time.

Future Research

Longitudinal replication across multiple disruption tiers could test whether culture continues to dominate under extreme turbulence. Comparative studies incorporating public-sector cases would clarify the role of regulatory mandates in TOE configurations. Finally, coupling platform-ecosystem metrics with digital-maturity scores may reveal whether ecosystem participation accelerates—or merely accompanies—DX progress in emerging economies.

Bibliography

Accenture. (2023). **360° value report 2023: Driving reinvention.** Retrieved February 11, 2025, from https://www.accenture.com/content/dam/accenture/final/corporate/corporate-initiatives/sustainability/document/360-Value-Report-2023.pdf

Alenezi, M., Wardat, S. and Akour, M. (2023). The need of integrating digital education in higher education: Challenges and opportunities. **Sustainability,** 15(6), 4782.

AlixPartners. (2024). **AlixPartners digital disruption survey 2024.** Retrieved March 11, 2025, from https://www.alixpartners.com/insights/102jjaa/alixpartners-digital-disruption-survey-2024/

Amini, M. and Jahanbakhsh Javid, N. (2023). A multi-perspective framework established on diffusion of innovation (DOI) theory and technology, organization and environment (TOE) framework toward supply chain management system based on cloud computing technology for small and medium enterprises. **International Journal of Information Technology and Innovation Adoption,** 11(8), 1217–1234.

Aslanova, I. V. and Kulichkina, A. I. (2020). Digital maturity: Definition and model. In **Proceedings of the 2nd International Scientific and Practical Conference (MTDE 2020)** (pp. 443–449). Dordrecht, Netherlands: Atlantis Press.

Awa, H. O., Ukoha, O. and Emecheta, B. C. (2016). Using T-O-E theoretical framework to study the adoption of ERP solution. **Cogent Business & Management,** 3(1), 1-23.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A. and Venkatraman, N. (2013). Digital business strategy: Toward a next generation of insights. **MIS Quarterly,** 37(2), 471-482.

Booth, A., Patel, N., and Smith, M. (2020, September 3). **Digital transformation in energy: Achieving escape velocity.** Retrieved March 20, 2025, from https://www.mckinsey.com/industries/oil-and-gas/our-insights/digital-transformation-in-energy-achieving-escape-velocity

Bravo-Jaico, J., Maquen-Niño, G. L. E., Germán, N., Valdivia, C., Alarcón, R., Aquino, J.et al. (2025). Assessing digital transformation maturity in higher education institutions: A correlational analysis by actors and dimensions. **Frontiers in Computer Science,** 7, 1549262.

Canton, H. (2021). **International energy agency—IEA. In The europa directory of international organizations 202**1 (pp. 684-686). Milton Park, Abingdon, Oxfordshire, England: Routledge.

Chigbu, B. I. and Makapela, S. L. (2025). Data-driven leadership in higher education: Advancing sustainable development goals and inclusive transformation. **Sustainability,** 17(7), 3116.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. **MIS Quarterly,** 13(3), 319–340.

Díaz-Arancibia, J., Hochstetter-Diez, J., Bustamante-Mora, A., Sepúlveda-Cuevas, S., Albayay, I. and Arango-López, J. (2024). Navigating digital transformation and technology adoption: A literature review from small and medium-sized enterprises in developing countries. **Sustainability,** 16(14), 5946.

Eisenhardt, K. M. (1989). Building theories from case study research. **The Academy of Management Review**, 14(4), 532–550.

Forbes Technology Council. (2021, December 8). **Leadership, not technology, is the key to accelerating digital transformation.** Retrieved August 13, 2025, from https://www.forbes.com/councils/forbestechcouncil/2021/12/08/leadership-not-technology-is-the-key-to-accelerating-digital-transformation/

Gkrimpizi, T., Peristeras, V. and Magnisalis, I. (2023). Classification of barriers to digital transformation in higher education institutions: A systematic literature review. **Education Sciences,** 13(7), 746.

Glaser, B. and Strauss, A. (2017). **Discovery of grounded theory: Strategies for qualitative research.** Milton Park, Abingdon, Oxfordshire, England: Routledge.

Hanelt, A., Bohnsack, R., Marz, D. and Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. **Journal of Management Studies,** 58(5), 1159-1197.

Henriette, E., Feki, M. and Boughzala, I. (2015). The shape of digital transformation: a systematic literature review. In **Proceedings of the 9th Mediterranean Conference on Information Systems (MCIS 2015)** (pp. 1–13). Samos, Greece: Association for Information Systems.

Imran, M., Almusharraf, N. and Abbasova, M. Y. (2025). Digital learning transformation: A study of teachers' post-Covid-19 experiences. **Social Sciences & Humanities Open,** 11, 101228.

Jin, R., Peng, Y., Wang, Z., Wang, J., Tang, J. and Zhang, M. (2025). Data-driven educational decision-making: How to enhance educational quality and management efficiency. **Journal of Higher Education Research,** 5(6), 550-553.

Komathi, W. and Sim, C. H. (2024). Shaping a digital future: Examining Technology, Organization and Environment (TOE) framework. **Journal of Technology Management and Business,** 11(1), 80-97.

KPMG. (2023). **Global tech report 2023: Energy sector insights.** Retrieved March 11, 2025, from https://kpmg.com/xx/en/our-insights/esg/kpmg-global-tech-report-2023-energy-sector-insights.html

Mergel, I., Edelmann, N. and Haug, N. (2019). Defining digital transformation: Results from expert interviews. **Government Information Quarterly,** 36(4), 101385.

Mohaghegh, S. D. (2005). Recent developments in application of artificial intelligence in petroleum engineering. **Journal of Petroleum Technology,** 57(04), 86-91.

Mok, A. (2025). **Utilities are tiptoeing into AI as climate change and data center growth add stress to the energy grid.** Retrieved June 11, 2025, from https://www.businessinsider.com/utilities-modernize-energy-grid-generative-ai-predictive-maintenance-2025-7

Nambisan, S., Lyytinen, K., Majchrzak, A. and Song, M. (2019). Digital innovation management: Reinventing innovation management research in a digital world. **MIS Quarterly,** 43(1), 223-238.

Reis, J. and Melão, N. (2023). Digital transformation: A meta-review and guidelines for future research. **Heliyon,** 9(1). e12834.

Rodriguez-Abitia, G. and Bribiesca-Correa, G. (2021). Digital transformation in higher education institutions: A systematic literature review. **Sustainability,** 13(7), 3829.

Rogers, E. M. (2003). **Diffusion of innovations** (5th ed.). New York, NY: Free Press.

Royal Thai Embassy. (2021). **Thailand 4.0.** Retrieved March 11, 2025, from https://washingtondc.thaiembassy.org/en/index

Singh, R., Akram, S. V., Gehlot, A., Buddhi, D., Priyadarshi, N. and Twala, B. (2022). Energy System 4.0: Digitalization of the energy sector with inclination towards sustainability. **Sensors,** 22(17), 6619.

Singun, A. J. (2025). Unveiling the barriers to digital transformation in higher education institutions: A systematic literature review. **Discover Education,** 4(1), 37.

Sirilak, S. and Wannasri, J. (2023). The management model for higher education institutions in the digital era. **Journal of Education and Innovation,** 25(1), 46–52.

Sukkerd, D. and Khongmalai, O. (2022). IT staff competency development for university digital transformation. **Suan Dusit Graduate School Adcademic Journal,** 18(2), 157-174.

Tornatzky, L. G. and Fleischer, M. (1990). **The processes of technological innovation.** Lexington, MA: Lexington Books.

Tungpantong, C., Nilsook, P. and Wannapiroon, P. (2021). Factors influencing digital transformation adoption among higher education institutions during digital disruption. **Higher Education Studies**, 12(2), 9-19.

VanBoskirk, S., Shar, P., Gill, M., Green, D., Berman, A., Swire, J. and Birrell, R. (2017). **The digital maturity model 5.0.** Cambridge, MA: Forrester Research, Inc.

Vial, G. (2019). Understanding digital transformation: A review and a research agenda. **The Journal of Strategic Information Systems,** 28(2), 118-144.

Volf, L., Dohnal, G., Beránek, L. and Kynčl, J. (2024). Navigating the fourth industrial revolution: SBRI - a comprehensive digital maturity assessment tool and road to industry 4.0 for small manufacturing enterprises. **Manufacturing Technology,** 24(4), 668–680.

Westerman, G., Bonnet, D. and McAfee, A. (2014). **Leading digital: Turning technology into business transformation.** Boston, Massachusetts: Harvard Business Review Press.

Zhu, K., Dong, S., Xu, S. X. and Kraemer, K. L. (2006). Innovation diffusion in global contexts: Determinants of post-adoption digital transformation of European companies. **European Journal of Information Systems,** 15(6), 601-616.