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Fragmented Systems to Integrated Digital Transformation: An Enterprise Architecture Model for Indonesian Private Higher Education

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ABSTRACT

Digital transformation in private higher education requires the integration of institutional strategy, governance, people, information systems, and technology. However, many Indonesian Private Higher Education Institutions (PTS) still experience fragmented information systems, limited data integration, weak business-IT alignment, and the absence of a contextual architectural blueprint. This study develops an Enterprise Architecture for Digital Transformation (EADT) model for Indonesian PTS. A Design Science Research approach was used through problem identification, framework analysis, component synthesis, contextual analysis, model development, and expert validation. Enterprise Architecture and Digital Transformation components were identified and mapped against factual institutional needs and transformation barriers. The resulting model integrates strategic, business, information, technology, governance, human, and digital-capability dimensions within a hierarchical architecture. The EADT model provides a contextual framework for aligning institutional objectives with digital-transformation implementation in Indonesian private higher education.

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1. INTRODUCTION

Digital transformation (DT) has become an important strategic agenda in higher education because digital technologies increasingly influence teaching, learning, administration, institutional governance, and decision-making. This transformation extends beyond technology adoption and involves changes in organizational processes, institutional culture, service delivery, and strategic management (Kang and Xu, 2025; Khurniawan and Supriadi, 2024; Exarchou et al., 2024).

Private Higher Education Institutions (*Perguruan Tinggi Swasta*, PTS) in Indonesia face increasing pressure to improve academic services, operational efficiency, institutional responsiveness, and competitiveness. However, DT is often implemented through separate systems and individual technology projects, resulting in fragmented information systems, limited integration, data silos, and weak coordination between institutional and technological strategies (Phan et al., 2024; Alenezi and Akour, 2023; Sararuch et al., 2023). A major challenge is the alignment between institutional strategy and information technology. Technology investments may provide limited value when business processes, information systems, data, governance, and technological infrastructure develop independently. Enterprise Architecture (EA) provides a structured mechanism for connecting organizational strategy with business, information, applications, and technological infrastructure (Atencio et al., 2022; Zhou et al., 2020; Meutia et al., 2022). Although EA provides a systematic architectural structure, generic EA frameworks may not fully represent the organizational characteristics, governance arrangements, resource limitations, human readiness, and transformation barriers experienced by Indonesian PTS. Higher education in technology-intensive fields also requires institutional adaptation, curriculum responsiveness, and differentiated approaches to address changing technological and educational demands (Glushchenko, 2024). Studies on EA in higher education have also largely focused on applying established frameworks rather than adapting architectural components to specific institutional transformation conditions (Phan et al., 2024; Alenezi and Akour, 2023). DT frameworks provide a complementary perspective by emphasizing strategy, leadership, organizational capability, technology, culture, customer experience, and transformation processes. However, DT frameworks generally provide less architectural detail for connecting institutional strategy with business, information, application, technology, and governance structures. EA and DT therefore offer complementary perspectives in which EA provides architectural structure while DT provides transformation-oriented capabilities.

Previous studies have examined EA frameworks, DT, and barriers to transformation in higher education, but limited attention has been given to integrating these perspectives within a contextual architecture for Indonesian PTS (Aditya et al., 2021; Gkrimpizi et al., 2023). The research gap is therefore not simply the absence of another architectural framework, but the lack of a model that connects EA and DT components with the factual needs and institutional barriers experienced by Indonesian PTS.

This study develops an EA for DT (EADT) model that integrates architectural and transformation components and evaluates their relevance against the factual conditions of Indonesian private universities. This study aims to: (i) identify relevant EA and DT components from established frameworks; (ii) identify factual DT needs and inhibiting factors in Indonesian PTS; (iii) map these conditions against the identified EADT components; and (iv) develop an integrated and contextual EADT model for Indonesian PTS. The novelty of the study lies in structuring EA and DT components according to institutional needs and

transformation barriers rather than merely combining existing frameworks. The resulting model extends the initial EADT conceptual framework by providing more detailed architectural components for supporting DT in PTS (Soegoto *et al.*, 2026).

2. METHOD

2.1. Research Design

This study employed a Design Science Research (DSR) approach because the primary objective was to develop an artifact in the form of an EADT model. The research process consisted of problem identification, EA and DT framework analysis, component identification and synthesis, analysis of factual needs and inhibiting factors, contextual mapping, and model development. The overall research stages are summarized in **Figure 1**.

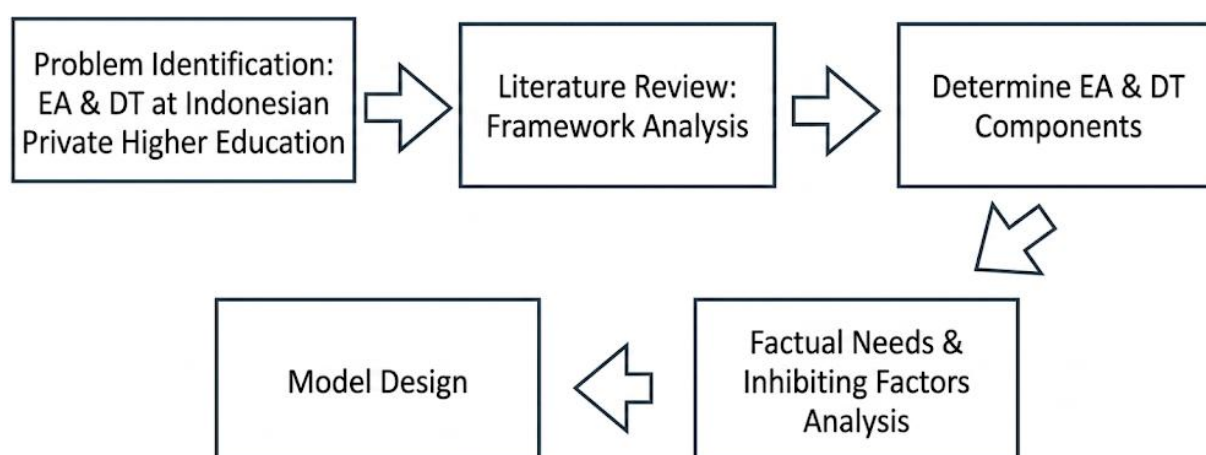


Figure 1. Research stages for developing the EADT model.

2.2. Problem Identification

The first stage identified major DT challenges in Indonesian PTS through literature analysis, institutional documents, interviews, and focus group discussions. The analysis focused on information-system fragmentation, business-IT misalignment, governance, technological infrastructure, human-resource capability, institutional readiness, and other barriers affecting DT.

2.3. EA and DT Framework Analysis

Existing EA and DT frameworks were reviewed to identify architectural and transformation dimensions relevant to higher education. The EA analysis considered widely adopted frameworks such as TOGAF and Zachman, supported by literature mapping using Publish or Perish and VOSviewer (Cameron and McMillan, 2013; Meutia *et al.*, 2022). Publish or Perish was used to retrieve and organize bibliographic records, while VOSviewer was used to visualize relationships among keywords and framework-related terms. The literature mapping covered publications from 2018 to 2024 using the keywords “enterprise architecture higher education institution” and “digital transformation framework in higher education institution” across Crossref, Semantic Scholar, Google Scholar, and Scopus. DT frameworks were also reviewed to identify recurring dimensions related to strategy, technology, governance, organizational capability, operations, leadership, culture, and stakeholder experience. The EA search returned 1,226 records across the four data sources, while the DT search returned 1,631 records across the same sources. VOSviewer was used to visualize the relationships

among keywords, frameworks, and higher-education research themes. A total of ten frameworks, consisting of three EA frameworks and seven DT frameworks, were included in the component analysis.

2.4. Identification and Synthesis of EADT Components

Components from the selected EA and DT frameworks were extracted and compared. Components with identical labels were consolidated, while components with different terminology but similar conceptual meanings or functions were grouped into common categories. This process reduced duplication while retaining relevant architectural and transformation dimensions. The resulting preliminary EADT components represented areas such as strategy, business architecture, governance, information, applications, technology, security, processes, people, leadership, culture, digital capability, and stakeholder experience. These components were subsequently evaluated against the institutional conditions identified in Indonesian PTS.

2.5. Analysis of Factual Needs and Inhibiting Factors

Empirical data were collected from several Indonesian private universities through interviews, focus group discussions, document analysis, and questionnaires. The analysis focused on two main categories: factual DT needs and inhibiting factors. Factual needs included ICT infrastructure, academic information systems, online learning platforms, human-resource development, financial support, institutional strategy, and digital support for academic activities. Inhibiting factors included financial constraints, limited technological competence, infrastructure limitations, system fragmentation, resistance to change, weak policy support, cybersecurity concerns, digital-literacy limitations, and organizational coordination problems. These findings were compared with barriers reported in previous higher-education studies ([Aditya *et al.*, 2021](#); [Gkrimpizi *et al.*, 2023](#)).

2.6. Contextual Mapping

The identified EADT components were mapped against factual needs and inhibiting factors to determine their contextual relevance. Each component was examined according to its potential contribution to addressing institutional requirements or transformation barriers. This stage transformed the preliminary framework synthesis into a contextual architecture. Components were therefore not retained solely because they appeared frequently in established frameworks, but because they were relevant to the actual DT conditions of Indonesian PTS.

2.7. EADT Model Development

The results of component synthesis and contextual mapping were used to develop the final EADT model. The components were organized hierarchically to connect institutional vision and strategy with business architecture, governance, information, applications, technology, security, processes, people, leadership, culture, digital capability, and stakeholder experience. The model extends the initial EADT conceptual framework by providing more detailed architectural components for addressing information-technology and organizational-governance challenges in PTS ([Soegoto *et al.*, 2026](#)).

2.8. Model Validation and Data Analysis

The developed model was evaluated through expert review involving specialists in EA, DT, information systems, and higher-education management. The review focused on the model's

relevance, completeness, contextual suitability, and implementation feasibility. Feedback from the experts was used to refine the structure and relationships among the EADT components. Qualitative data from interviews, focus group discussions, and institutional documents were analyzed using thematic analysis. Gap analysis was used to examine differences between existing institutional conditions and the architectural capabilities required for DT. Questionnaire results were analyzed descriptively, while framework analysis was conducted through component comparison, consolidation, and contextual mapping.

3. RESULTS AND DISCUSSION

3.1. Digital Transformation Challenges in Indonesian Private Higher Education

DT in Indonesian PTS is constrained by interconnected technological, organizational, and governance problems. Major challenges include fragmented information systems, weak business-IT alignment, uneven technological infrastructure, limited digital competence, budget constraints, resistance to change, and insufficient institutional policy support. DT cannot be addressed only through technology acquisition because organizational readiness, leadership, governance, and human capability are equally important (Aditya *et al.*, 2021; Gkrimpizi *et al.*, 2023). Evidence from higher education also shows that the effective use of digital technologies depends on perceived usefulness, digital readiness, institutional support, and adequate technological infrastructure (Ahmed *et al.*, 2026). DT requires an institutional architecture capable of connecting strategic objectives with operational and technological implementation. Fragmented systems and data silos reflect not only technical limitations but also weak architectural coordination across institutional units. This condition strengthens the need for an integrated approach combining EADT perspectives (Alenezi and Akour, 2023; Sararuch *et al.*, 2023).

3.2. Architectural and Digital Transformation Frameworks

Several EA frameworks are widely used across academic and industrial contexts. As shown in **Figure 2**, TOGAF and Zachman are among the most prominent frameworks, together with Gartner, FEAF, and DoDAF, indicating the broad adoption of structured EA approaches in different organizational settings (Cameron and McMillan, 2013). To further examine the relevance of EA frameworks in higher education, a literature-mapping analysis was conducted using Publish or Perish and VOSviewer. As presented in **Figure 3**, the search returned 1,226 records across Crossref, Semantic Scholar, Google Scholar, and Scopus for the 2018–2024 period, with TOGAF, Zachman, and EA Planning appearing prominently in the higher-education literature. In parallel with the EA analysis, established DT frameworks were reviewed to identify transformation-oriented dimensions that could complement architectural perspectives. **Figure 4** presents several widely recognized DT frameworks, including MIT, Capgemini, DXC, McKinsey, Gartner, Cognizant, and PwC, which emphasize strategy, technology, organizational capability, leadership, and transformation management.

The relevance of DT frameworks to higher education was further examined through literature mapping using Publish or Perish and VOSviewer. As shown in **Figure 5**, the search returned 1,631 records across Crossref, Semantic Scholar, Google Scholar, and Scopus for the 2018–2024 period. Higher-education research more frequently emphasizes technological, organizational, strategic, and capability-related dimensions than the direct adoption of a single DT framework. Nevertheless, these dimensions correspond closely to those represented in established DT frameworks, supporting their use as conceptual references for

subsequent component analysis. Their integration provides a stronger basis for developing a contextual transformation architecture.

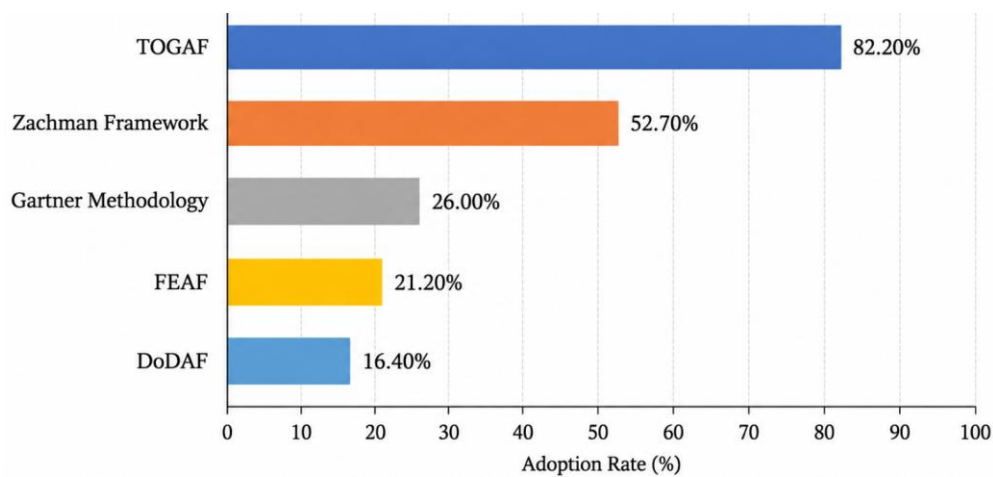


Figure 2. Most widely used EA frameworks in academia and industry.

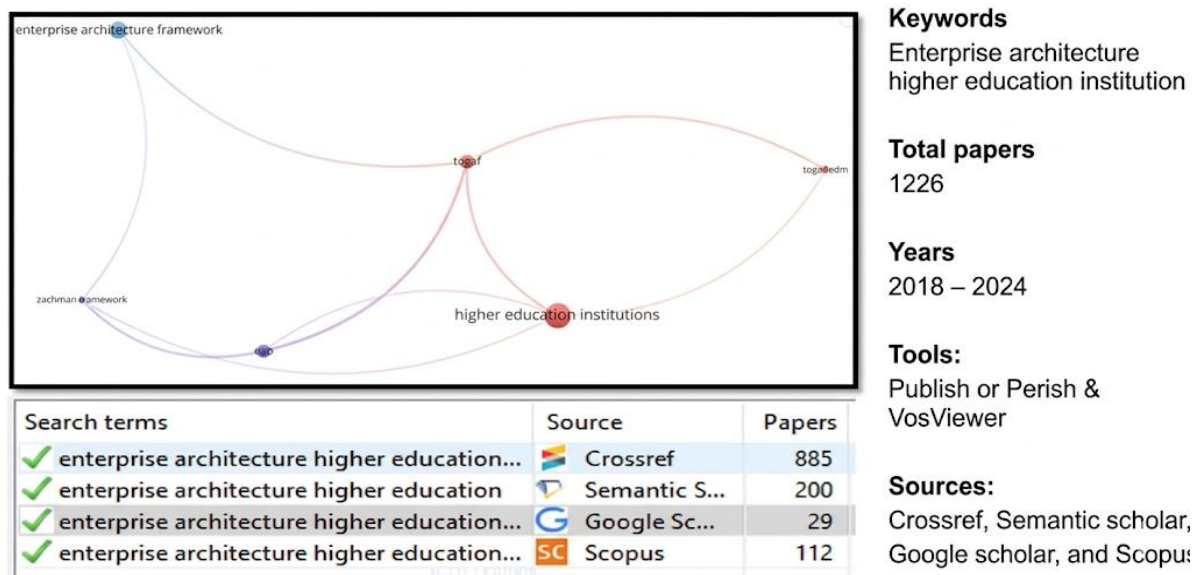


Figure 3. Literature-mapping analysis of EA frameworks in higher education using Publish or Perish and VOSviewer.

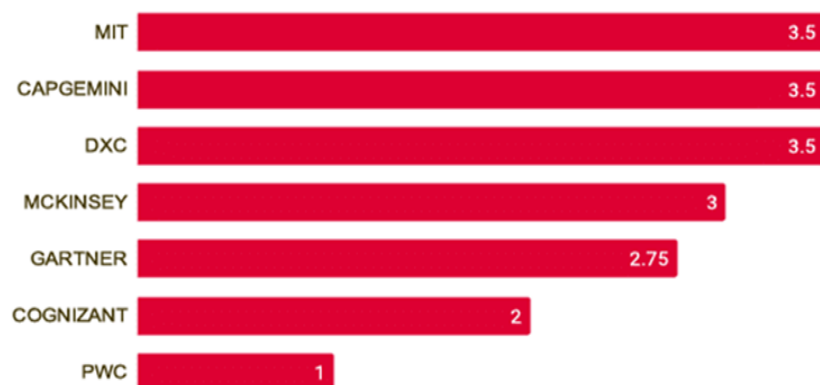


Figure 4. Selected widely used DT frameworks.

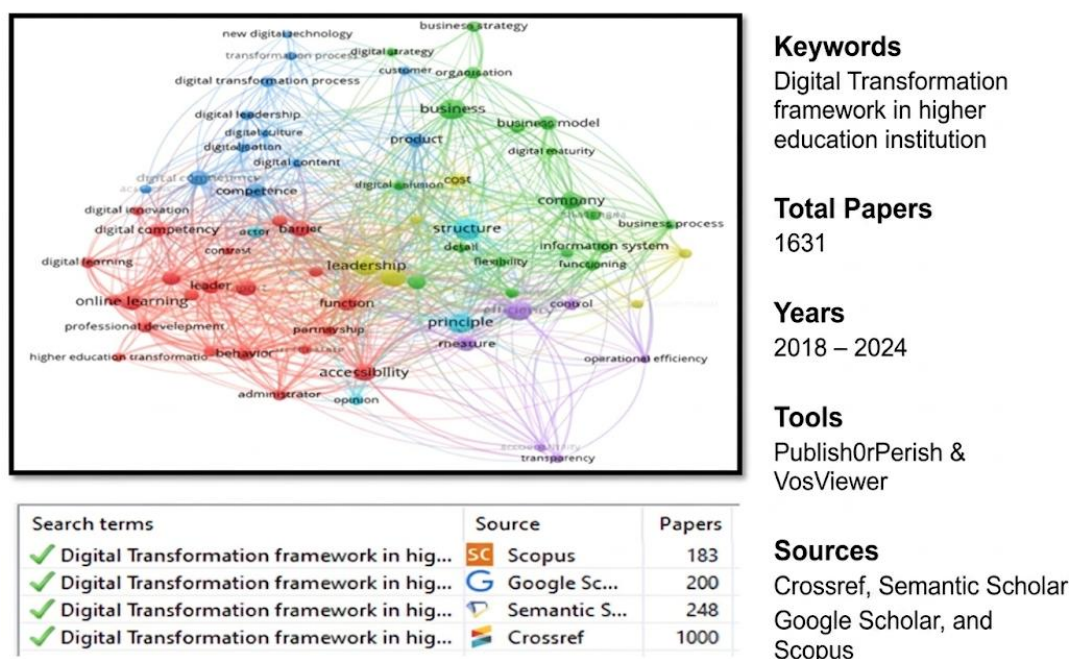


Figure 5. DT frameworks in PTS using Publish or Perish and VOSviewer.

Three EA frameworks and seven DT frameworks were selected for component analysis. **Figure 6** summarizes the ten frameworks used as the conceptual sources for identifying and synthesizing the EADT components.

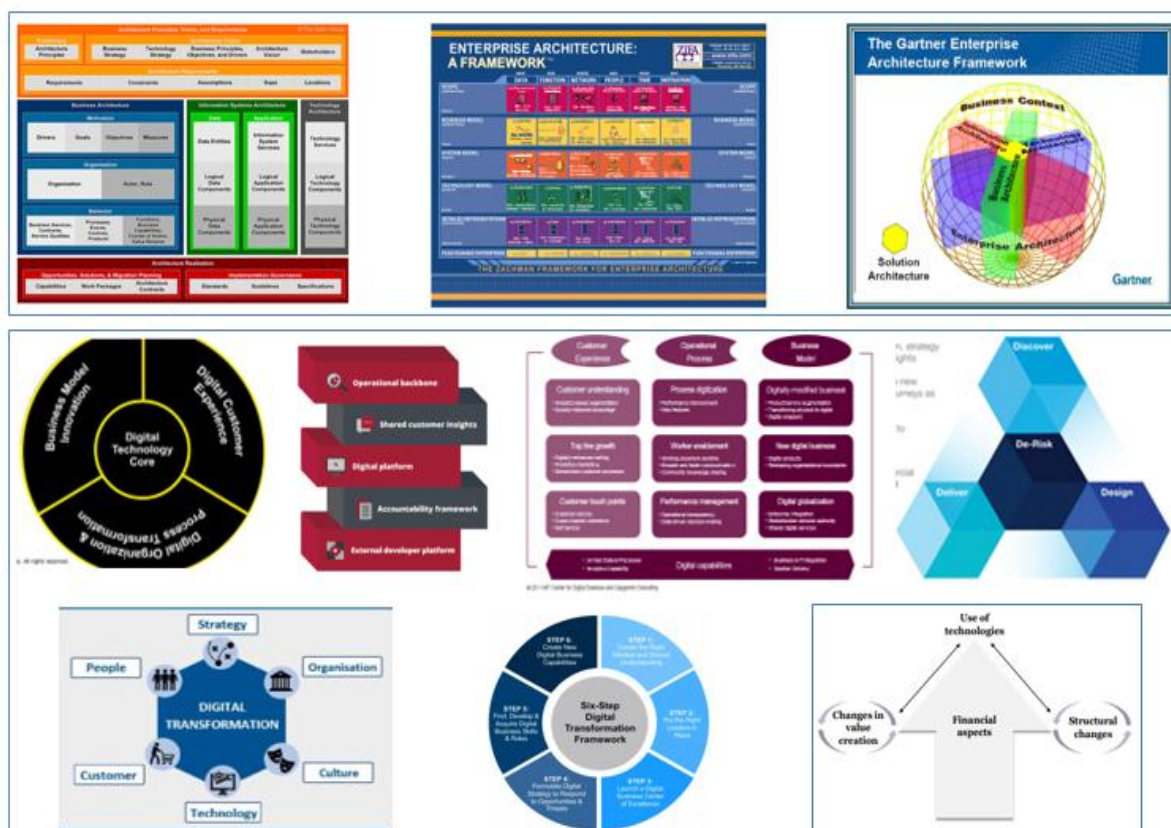


Figure 6. EADT frameworks selected for component analysis.

3.3. Identification of EADT Components

The comparison of three EA frameworks and seven DT frameworks produced a preliminary set of architectural and transformation components. Components with identical or conceptually similar functions were consolidated to reduce duplication. The selected frameworks were decomposed into their constituent components, and identical or conceptually similar elements were consolidated to reduce duplication. As shown in **Figure 7**, the synthesis produced a set of EADT components covering strategic, business, governance, information, application, technological, security, process, human, leadership, cultural, and digital-capability dimensions.



Figure 7. Synthesized components of the EADT model.

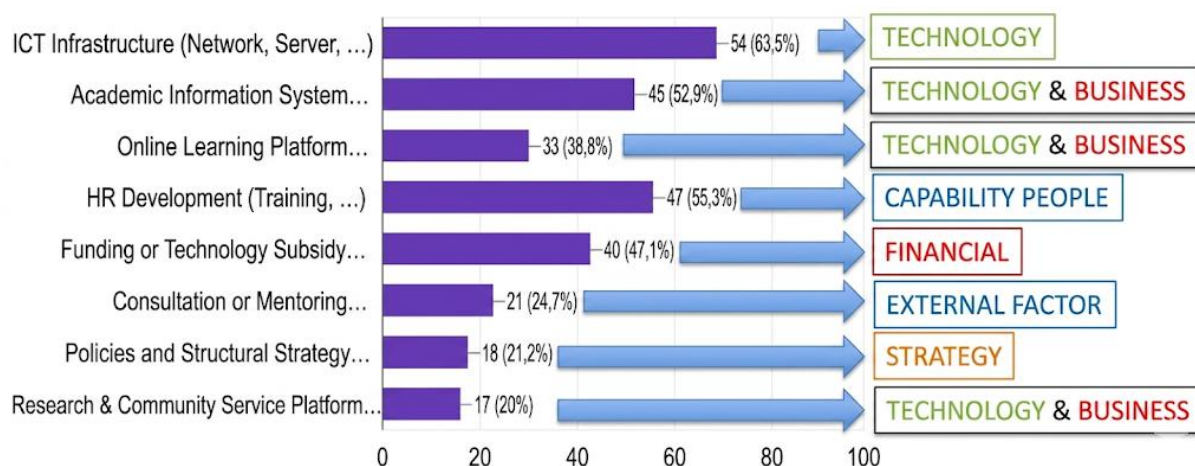
The resulting components included strategy, architecture vision, business architecture, governance, information architecture, application architecture, technology architecture, security architecture, process transformation, people, leadership, culture, digital capability, and stakeholder experience. To clarify their functional roles, the identified components were organized into major EADT component groups, as presented in **Table 1**. DT requires interaction among multiple architectural layers rather than isolated technological interventions. Strategic and business dimensions define institutional direction, while information, applications, technology, and security provide implementation mechanisms. Human capability, leadership, culture, and stakeholder experience function as transformation enablers that support successful institutional adoption.

3.4. Factual Needs and Inhibiting Factors

The factual DT needs identified through the questionnaire are summarized in **Figure 8**. Indonesian PTS require not only ICT infrastructure and academic information systems but also online learning platforms, human-resource development, financial support, consultation or mentoring, institutional policies and strategies, and digital support for research and community-service activities. **Table 2** further groups these factual needs according to their institutional roles and corresponding EADT dimensions. The distribution of these needs demonstrates that DT should be approached as an institutional capability rather than as a technology-acquisition program. Technology-related needs were particularly prominent, but institutional capability, financial resources, and strategic direction were also important.

Table 1. Main EADT component groups and their functions.

COMPONENT GROUP	REPRESENTATIVE COMPONENTS	MAIN FUNCTION IN DT
Strategic architecture	Strategy, architecture vision, goals, principles	Aligns DT with institutional direction
Business architecture	Business architecture, organization, product, business operation	Translates institutional strategy into organizational processes
Governance	Governance, accountability, constraints, decision mechanisms	Controls and coordinates transformation implementation
Information architecture	Information architecture, data, information	Supports integrated institutional data and decision-making
Application architecture	Application architecture, applications, digital platforms	Integrates institutional digital services and systems
Technology architecture	Technology architecture, technology, infrastructure	Provides technological foundations for transformation
Security architecture	Security architecture, cybersecurity-related components	Protects institutional information and digital infrastructure
Process transformation	Process transformation, operation, work process	Supports redesign and digitization of institutional processes
Human capability	People, stakeholders, leadership, skills	Strengthens human readiness and transformation capability
Organizational culture	Culture, behavior, motivation	Supports adaptation and reduces resistance to change
Digital capability	Digital capability, technology acceptance, innovation	Builds institutional readiness for sustained DT
Stakeholder experience	Customer experience, shared customer insight	Improves service orientation and stakeholder responsiveness

**Figure 8.** Factual DT needs of Indonesian PTS.

These needs correspond closely with the inhibiting factors identified from institutional data and previous studies. **Table 3** compares the transformation barriers identified in previous studies with the empirical barriers observed in Indonesian PTS. Financial constraints can restrict infrastructure development, limited human capability can reduce technology utilization, and resistance to change can delay organizational adoption. Strengthening ICT-related professional capability and curriculum-oriented technological competence is therefore important for supporting effective digital implementation within educational

institutions (Ayinde et al., 2026). Similarly, fragmented systems, cybersecurity concerns, weak coordination, and insufficient policy support can prevent digital initiatives from becoming institution-wide transformations (Aditya et al., 2021; Gkrimpizi et al., 2023). Factual needs and inhibiting factors should not be treated independently. A requirement for improved technology infrastructure, for example, must be connected with funding, governance, human competence, and institutional strategy. This interdependence supports the use of an architectural model capable of connecting multiple transformation dimensions.

Table 2. Factual DT needs of Indonesian PTS

FACTUAL NEED	INSTITUTIONAL ROLE	RELATED EADT DIMENSION
ICT infrastructure	Provides network, server, computing, and digital-service infrastructure	Technology
Academic information systems	Supports integrated academic and administrative processes	Technology and Business
Online learning platforms	Supports digital and hybrid learning activities	Technology and Business
Human-resource development	Strengthens digital competence and organizational readiness	People and Digital Capability
Funding and technology subsidies	Supports technology acquisition and transformation programs	Financial and Governance
Consultation and mentoring	Provides external expertise and transformation support	External Factor and Governance
Institutional policies and strategy	Establishes direction, priorities, and implementation guidance	Strategy and Governance
Research and community-service platforms	Supports digitally enabled academic missions beyond teaching	Technology and Business

Table 3. Comparison of DT barriers identified in previous studies and Indonesian PTS.

DIMENSION	Aditya et al. (2021)	Gkrimpizi et al. (2023)	FINDINGS FROM INDONESIAN PTS
Strategy and policy	Strategic plan, action plan, institutional policy	Strategic planning, holistic vision, action plan, institutional policy	Lack of internal policy support
Financial resources	Resources, funding, time	Budgetary constraints	Budgetary constraints
Technology	IT infrastructure, educational systems, IT support services, IT risk	IT infrastructure, system integration, security and privacy risks, data fragmentation, legacy and third-party systems	Uneven access to technology and facilities
Human resources	Digital skills and knowledge	Digital literacy, leadership, workload, IT support services	Lack of competent human resources in technology
Organizational factors	Coordination and institutional support	Organizational agility and interdepartmental coordination	Internal resistance from lecturers and staff
Culture and adaptability	Resistance to change, attitudes, beliefs, commitment	Resistance to change, attitudes, beliefs, bureaucracy	Resistance to organizational and technological change
Governance and environment	Government vision, policy, and economic environment	Regulatory, legal, and institutional environment	Limited institutional support and coordination
Leadership and vision	Leadership behavior and programs	Leadership and organizational direction	Need for clearer institutional vision and stronger leadership support

3.5. Contextual Relationship of EADT Components

The contextual relationship among factual needs, inhibiting factors, and EADT components is presented in **Figure 9**. The mapping demonstrates that the identified architectural components are functionally related to the institutional needs and transformation barriers experienced by Indonesian PTS, thereby providing the contextual basis for developing the final EADT model. Strategy and governance components address institutional direction and policy limitations, while technology, information, application, and security architectures respond to infrastructure, integration, data, and cybersecurity requirements. People, leadership, culture, and digital capability components address human-resource limitations, digital literacy, resistance to change, and organizational readiness. **Table 4** provides a more detailed mapping of representative institutional issues, their associated needs or barriers, the relevant EADT components, and the expected architectural contribution.

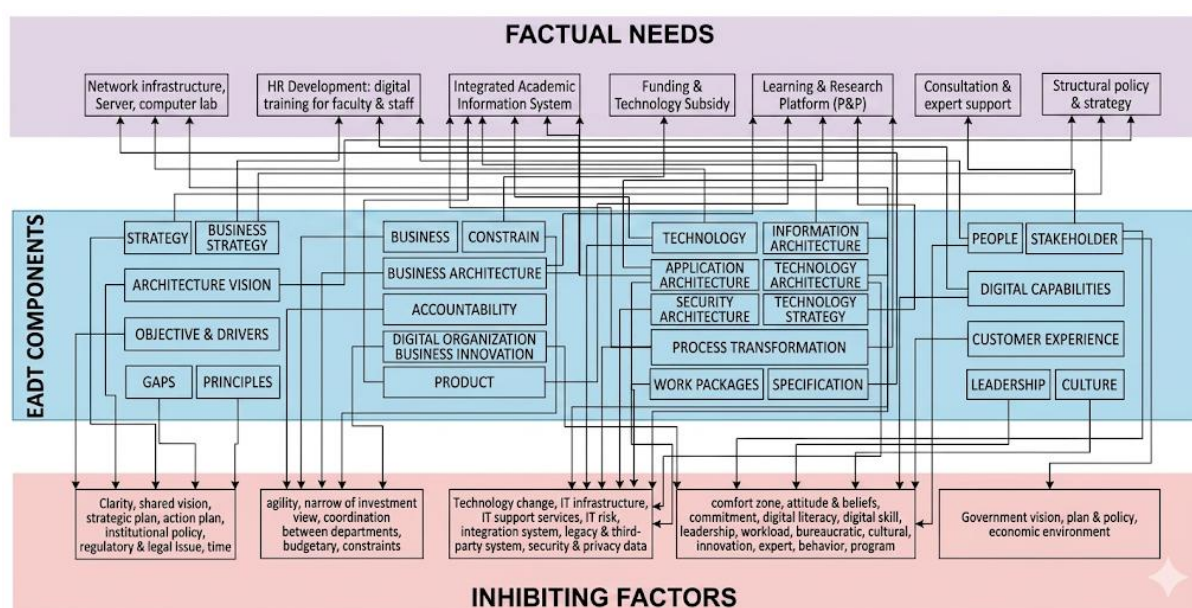


Figure 9. Contextual relationship among factual needs, EADT components, and DT inhibiting factors.

3.6. Development of the EADT Model

The development of the final architecture was based on the initial EADT conceptual model presented in **Figure 10**. The initial model established a broad hierarchical relationship among institutional strategy, business requirements, information, and technology, but remained relatively general and required more detailed architectural components to address specific technological and organizational-governance challenges in Indonesian PTS (Soegoto *et al.*, 2026). The conceptual model established the hierarchical relationship between institutional strategy, business requirements, information, and technological implementation. However, the initial model remained relatively broad and did not yet provide sufficient architectural detail for addressing specific information-technology and organizational-governance challenges in PTS (Soegoto *et al.*, 2026). Strategic dimensions occupy the upper level and provide institutional direction, while business architecture and governance translate these objectives into organizational structures and processes. Information, applications, technology, process transformation, and security provide the architectural foundation for

implementation. Human, leadership, culture, digital capability, and customer-experience dimensions support transformation across the architecture.

Table 4. Contextual relationship between institutional needs, barriers, and EADT components.

INSTITUTIONAL ISSUE	MAIN BARRIER OR NEED	RELEVANT EADT COMPONENTS	EXPECTED CONTRIBUTION
Fragmented information systems	Lack of integration across institutional units	Information Architecture, Application Architecture, Technology Architecture	Improves system and data integration
Weak Business-IT alignment	Separation between institutional and IT strategies	Strategy, Architecture Vision, Business Architecture	Connects institutional objectives with technology implementation
Limited technological infrastructure	Uneven access to infrastructure and facilities	Technology Architecture, Digital Platform	Strengthens technological capacity
Limited digital competence	Insufficient technological skills	People, Digital Capability, Leadership	Improves digital readiness and competence
Resistance to change	Cultural and behavioral barriers	Culture, Leadership, Motivation	Supports organizational adaptation
Budget constraints	Limited financial resources	Governance, Strategy, Constraints	Supports investment prioritization
Weak institutional policies	Insufficient strategic and regulatory support	Governance, Strategy, Principles	Strengthens policy and governance mechanisms
Cybersecurity and data risks	Security and privacy concerns	Security Architecture, Information Architecture	Strengthens data protection and digital trust
Limited coordination	Fragmented organizational responsibilities	Business Architecture, Governance, Stakeholders	Improves institutional coordination
Need for better academic services	Demand for integrated digital services	Application Architecture, Customer Experience, Digital Platform	Improves service quality and user experience

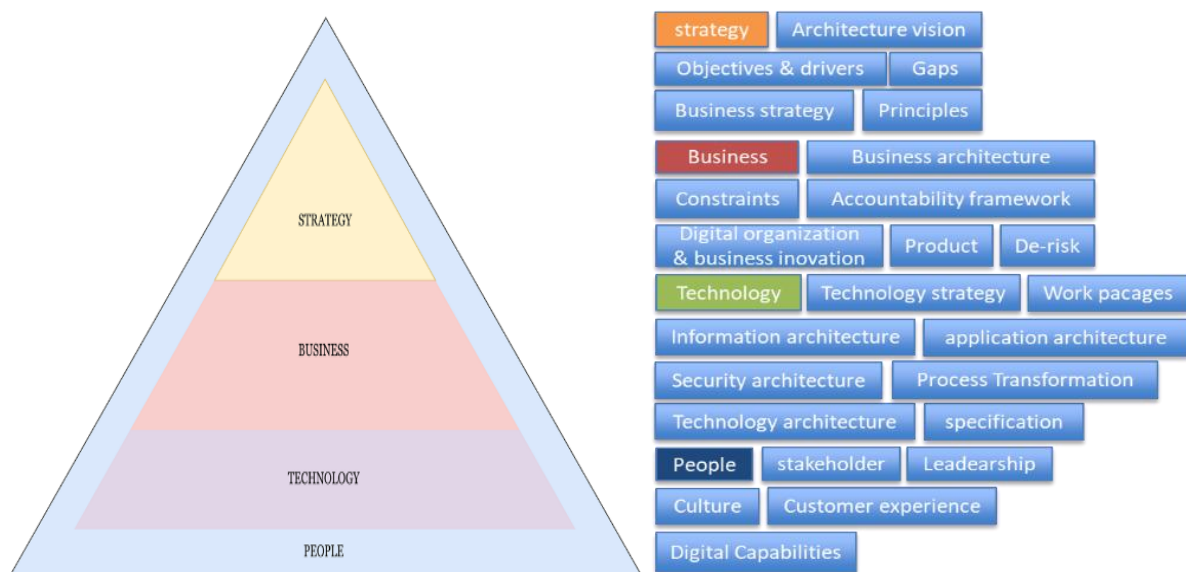


Figure 10. Initial conceptual model of EADT.

The developed model extends the initial EADT conceptual framework by providing more detailed components capable of addressing specific technological and organizational issues in PTS (Soegoto *et al.*, 2026). Based on the component synthesis and contextual mapping, the developed EADT model is presented in **Figure 11**. The model provides a more detailed hierarchical architecture that connects institutional strategy with business architecture, governance, information, applications, technology, security, process transformation, people, leadership, culture, digital capability, and stakeholder experience. The developed model extends the initial conceptual framework by introducing more detailed architectural and transformation components capable of addressing specific technological and organizational issues in PTS. The principal differences between the initial conceptual framework and the developed EADT model are summarized in **Table 5**. Strategic dimensions provide institutional direction, while business architecture and governance translate these objectives into organizational structures and processes. Information, applications, technology, process transformation, and security provide the architectural foundation for implementation, while people, leadership, culture, digital capability, and stakeholder experience support transformation across the architecture.

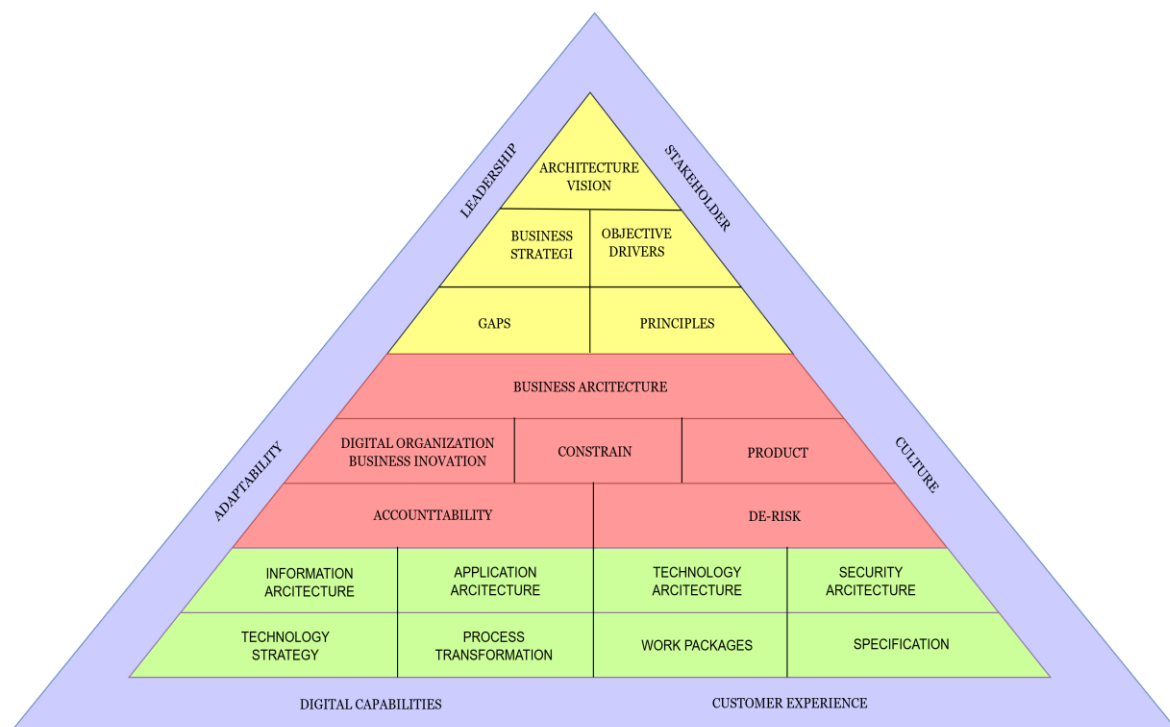


Figure 11. Developed EADT model for Indonesian PTS.

Table 5. Development from the initial EADT concept to the proposed EADT model.

ASPECT	INITIAL EADT CONCEPTUAL MODEL	DEVELOPED EADT MODEL
Main purpose	Provides a general conceptual hierarchy	Provides a more detailed architecture for implementation
Strategic level	General strategic direction	Strategy, architecture vision, goals, and principles
Business level	Broad business dimension	Business architecture, governance, organization, products, and operations

Information level	General information dimension	Information and application architectures
Technology level	Broad technological dimension	Technology architecture, process transformation, security architecture, and supporting platforms
Human dimension	General people-related consideration	People, stakeholders, leadership, culture, digital capability, and experience
Contextualization	Conceptual integration	Mapped against factual needs and inhibiting factors
Practical use	Conceptual reference	DT planning and Business-IT alignment

The model extends the initial conceptual framework by introducing more detailed architectural and transformation components capable of addressing specific technological and organizational issues in PTS. Strategic dimensions provide institutional direction, while business architecture and governance translate these objectives into organizational structures and processes. Information, applications, technology, process transformation, and security provide the architectural foundation for implementation, while people, leadership, culture, digital capability, and stakeholder experience support transformation across the architecture. The hierarchical structure connects institutional vision with operational and technological implementation, thereby strengthening Business-IT Alignment. Similar system-oriented perspectives in higher education emphasize that institutional structures, educational functions, research activities, innovation mechanisms, and cross-sectoral interactions need to operate as interconnected elements rather than isolated components (Glushchenko et al., 2026). The model consequently positions digital initiatives as interconnected elements of institutional transformation rather than independent technology projects. The previous conceptual model provided a general hierarchical structure, whereas the developed model introduces more detailed architectural components and relationships. The model also strengthens business-IT alignment by connecting institutional vision with business requirements and subsequent technological implementation. This structure enables digital investments to be interpreted as part of institutional transformation rather than independent technology projects. Such integration is particularly important for private universities where resource limitations require technology investments to be closely aligned with institutional priorities. The developed model was considered relevant and feasible for implementation. The model can therefore serve as a structured reference for developing IT strategic plans, strengthening digital governance, improving digital capability, and prioritizing technology investments. However, broader implementation across different categories of private universities remains necessary to further evaluate its applicability and effectiveness.

4. CONCLUSION

This study developed an EADT model tailored to Indonesian PTS. Fragmented systems, weak business-IT alignment, limited digital capability, governance constraints, and institutional barriers cannot be addressed through technology adoption alone. By integrating EADT components with factual institutional needs and inhibiting factors, the model provides a contextual structure linking strategy, business, information, applications, technology, governance, and people. Expert review indicated that the model was considered relevant and potentially feasible for implementation in Indonesian private higher education. The EADT model can therefore support more systematic, integrated, and sustainable DT planning in private universities.

5. ACKNOWLEDGMENTS

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper is free from plagiarism.

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