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A Service Reference Model for Higher Education

based on HERM, TBM, ITIL, and TOGAF

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Abstract

Enterprise Architecture (EA) in higher-education institutions increasingly adopts sector reference models such as Higher Education Reference Model (HERM) to align business capabilities with supporting data, application, and technology architectures, creating a layered view that connects institutional strategy with operational implementation. At the same time, HEI service catalogues remain technology-centric and insufficiently connected to architectural value streams. To address this gap, this paper proposes a Service Reference Model (SRM) for higher education that guides institutions in developing EA-aligned, service-oriented catalogues grounded in sector practices and societal values creation. Based on literature synthesis, sector artefacts, and established reference frameworks (HERM, TBM, ITIL v4, and TOGAF), guiding principles for a Service Reference Model have been derived. The proposed SRM adopts a matrix structure that combines a knowledge lifecycle with mission-relevant value streams to define outcome-oriented service groups anchored in institutional value. The SRM is mapped to HERM capabilities and external taxonomies to ensure traceability and comparability across institutions. However, it could provide a clearer picture of how the model can be applied in practice in higher education institutions to have a greater impact. Ultimately, SRM supports the structured organisation of services, enhancing interoperability and fostering a shared understanding of service offerings across institutions. Future work will involve implementing the SRM across EU higher-education institutions to validate its transferability and support the development of shared, sector-aligned service practices.

Keywords: Business Service, Enterprise Architecture, EAM, TOGAF, Higher Education Reference Models, HERM, Knowledge Lifecycle, TBM

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1 Introduction

1.1 Context: Enterprise Architecture in European HEIs

European higher education institutions (HEIs) are increasingly using Enterprise Architecture (EA) to improve cooperation and comparability. The Higher Education Reference Models (HERM) provide a sector-specific baseline across business, data, application and technology domains, and community practice continues to mature through shared artefacts [jeff kennedy et al., 2026]. European coordination is reinforced through EA community events that promote capability-driven HERM-aligned practice [EUNIS community, 2025].

Adoption across HEIs remains uneven. Leaders responsible for digital strategy, information technology, and academic services frequently encounter governance and resourcing constraints, and enterprise architecture can appear remote from the day-to-day provision of teaching and research services. Evidence from German and European projects on EA and IT governance in higher education (HE) indicates ongoing variation in institutional maturity and the sustained need for structured EA governance[Hartmann and von der Heyde, 2024]. Furthermore, many EA initiatives remain confined to the IT domain and thus fail to exploit EA's potential to bridge business and IT concerns at the enterprise level. This boundary is difficult to overcome, as many HEIs claim to have "no business" in the commercial sense and tend to regard themselves as unique, which impedes any reuse of common frameworks. However, previous studies have shown that reference frameworks such as The Open Group Architecture Framework (TOGAF®) and HERM can serve as a shared translation layer, enabling institutional exchange and common service modelling [Gerl et al., 2020, von der Heyde, 2022, von der Heyde and Hartmann, 2024]. This motivates the development of a coherent, value-oriented Service Reference Model (SRM) that can be adopted across diverse institutional settings.

The aim of this article is threefold: (1) to derive guiding principles from the literature; (2) to build a service reference model for HEIs based on these principles; and (3) to compare existing service models to demonstrate the new model's applicability and completeness.

1.2 Existing models

Regarding Service Management, two cross-sector frameworks are relevant: Technology Business Management (TBM ®) and the Information Technology Infrastructure Library (ITIL ®). TBM provides a shared taxonomy for IT costs and services, but leaves value streams to the strategy of each organisation [CIO Council, 2025, TBM Council Standards Committee, 2025]. Although ITIL provides generic service management guidance, it requires explicit Enterprise Architecture (EA) embedding to link services to applications and infrastructure [AXELOS, 2025, Beims and Ziegenbein, 2021, Braun and Winter, 2007]. For HEIs, these frameworks are necessary but not sufficient. Teaching and research require sector-specific capability structures that are specific to the sector that transcend the IT domain, and connect IT services with the businesses that depend on them. The SRM therefore defines a higher education specific model intended to be both applicable and complete, rather than a generic process framework. In the HEI context, we draw on four established service catalogues for comparison: UCISA; the EDUCAUSE IT Service Catalog; the Finnish Service Collection; and a German HEI analysis [Adizes Jacobs et al., 2019, von der Heyde and Hartmann, 2024]. However, these models have not yet been validated against each other and suffer from certain shortcomings overall.

1.3 Core Shortcomings Observed

HEI practice shows a persistent gap between sector reference models/catalogues and operational portfolios. The hypothesized core shortcomings motivating this work are:

1) **Business Service gap:** IT service catalogues seem common, but enterprise-level service models for teaching, research, and the third mission remain rare [Gerl et al., 2020, von der Heyde, 2022].
2) **Misunderstanding Business**: Many HEIs understand to have "no business" in the commercial sense — a stance that partly reflects a translation artefact, since in EA practice *business* denotes organised activity and value-creating processes rather than commerce.
3) **Under-defined value streams and products:** Without explicit value-stream or product anchors, services drift towards organisational structure and processes (organisational mirroring) - weakening comparability and stakeholder alignment.
4) **Weak cross-layer traceability:** Links from business services to data, applications, and technology are fragmented [von der Heyde et al., 2025].

These gaps motivate the SRM principles that are value-oriented, user-centric, and anchored in HERM.

1.4 Conceptual Approach

This paper proposes guiding principles for a sector-specific higher-education Service Reference Model (SRM). The approach combines EA traceability (services linked to business capabilities, data, applications, and technology), value-stream and product thinking, and HERM as the sector baseline for shared language and comparability [Ferrell et al., 2022, Le Strat et al., 2022]. Service groups are defined by outcomes and stakeholder value rather than by organisational units. We address the understanding of *products* and separate **design** from **consumption** to distinguish offering creation from value-in-use and to avoid conflating internal creation capabilities with service delivery [Beuren et al., 2017, Leinonen and Roto, 2023]. A societal-value framing and explicit renewal loops (quality assurance, accreditation, ethics) ensure that the model reflects HEI missions and continuous improvement [Salemans and Budding, 2022, Dolmans et al., 2003].

The remainder of the article presents the method (Chapter 2) and provide a summary of the methodological-approach in Figure 2. We discuss the application in Chapter 3 to demonstrate actionability. In conclusion, we provide a brief overview, name the core contributions, limitations, and provide outlook (Sections 4.1–4.3).

2 Method

2.1 Collecting principles

The aim of this step is to derive a compact, evidence-based set of principles that prevents HE service catalogues from reflecting organisational structures or becoming IT-centric lists of internal technologies and brands. The principles therefore must be outcome-oriented, stakeholder-readable, and traceable to business capabilities.

We synthesised requirements from three evidence strands: sector practice for HEI service catalogues (EDUCAUSE), ITSM/ITIL service-value guidance, and EA integration evidence (ITSM-in-EA and HERM/TOGAF-aligned modelling) [Braun and Winter, 2007, AXELOS, 2025,

von der Heyde et al., 2025]. Requirements were extracted, normalised, and mapped to the identified shortcomings to avoid those (IT-centricity, organisational mirroring, missing value streams, weak cross-layer traceability). A feasibility check against HEI constraints and HERM capability structures ensured the principles are applicable in practice.

This yields principles that explicitly prioritise outcomes, audience views, and cross-layer traceability, which directly counter the catalogues trap motivating this study.

2.2 Principles for a business service reference model in higher education

These principles are derived from the literature synthesis and act as the requirements baseline for the SRM. They are stated at the service-group level, while institutions instantiate target group specific services catagories which in turn contain their service offerings.

1) **Mission alignment.** Service groups align to the mission value streams used in this study (student lifecycle, curriculum lifecycle, research lifecycle, engagement/third mission) to enable cross-institutional comparability.
2) **Non-organisational reference structure.** The SRM provides stable service group templates and standard attributes without mirroring organisational units; ownership is recorded separately.
3) **Product anchoring.** Service groups are derived from value streams and product-like outcomes rather than internal functions, with a clear separation between (product-oriented) design and consumption where relevant [AXELOS, 2025].
4) **Traceability and governance.** Each service group is mapped to HERM BRM capability areas and embedded in a portfolio lifecycle with explicit review and renewal mechanisms [Braun and Winter, 2007, Le Strat et al., 2022].
5) **Outcome- and stakeholder-oriented definitions.** Service groups are defined by the outcomes and value delivered to stakeholders, in our case with explicit audience views for key groups (students, staff, researchers, external partners).
6) **Consistent abstraction level.** Service groups at the same hierarchy level are defined at comparable granularity; category levels are not mixed.
7) **Coverage of the domain.** The reference model aims for full domain coverage at the chosen level, with explicit rationale for any exclusions.
8) **Non-overlapping scope.** Service-group definitions are mutually exclusive where possible; naming and scope notes are used to minimise overlap.

The first four content based principles are complemented by conceptual model quality/validation criteria [Shanks et al., 2003]. The last four principles comply with the rationals of HERM, constrain the SRM structure, and guide the logic in the mapping chapter (Section 3.2).

2.3 Evidence sources and societal value framing

We identify mission-relevant value streams and products from the literature to anchor the SRM in societal value. The student lifecycle provides an end-to-end view of learning outcomes, the curriculum lifecycle frames educational design as a digital product, and research-data lifecycles provide a stable sequence for research services [Wayne et al., 2016, von der Heyde and Hartmann, 2023, Network of the National Library of Medicine, 2022]. The

research stream is discipline-agnostic; product anchors in the mapping are representative rather than exhaustive. HEI third-mission and engagement work extends the product view to public value outputs such as employability, innovation, and community impact [Trencher et al., 2014, Salemans and Budding, 2022, Marginson, 2011, Brewis and Marginson, 2025].

This societal value framing provides the product view used later to derive service groups (Section 2.6) and prevents the model from collapsing into internal IT or organisational structures. Products are further clustered by their dominant value stream (student, curriculum, research, engagement). This avoids organisational mirroring and keeps the SRM aligned to end-to-end value creation. Across clusters, the shared core is the codified representation of knowledge (curricula, datasets, publications, policy artefacts), which provides a stable cross-stream anchor for service group design [OECD, 2015].

2.4 Knowledge lifecycle and renewal loops

We adopt a knowledge lifecycle (see Figure 1) for deriving service groups: generation → validation → transfer → co-creation/engagement → application → retention → renewal. Knowledge-management literature supports this recurring sequence, and research data management emphasises retention and reuse as essential stages [Evans et al., 2014]. HE knowledge-management literature supports the need for shared knowledge frameworks and lifecycle thinking in institutional practice [Kidwell et al., 2000]. The co-creation/engagement stage captures participatory collaboration with external stakeholders and public-value partners; it is distinct from one-way transfer and from the engagement/third-mission value stream itself [Trencher et al., 2014, Prahalad and Ramaswamy, 2004]. Governance, ethics, and quality assurance are treated as renewal loops triggered by retention: after knowledge is preserved a periodic review determines whether it remains current. If not, the renewal loop re-enters at generation (full rework) or at validation (re-check only). The direct cycle (retention → generation) is the unreviewed fast path that bypasses renewal [Dolmans et al., 2003].

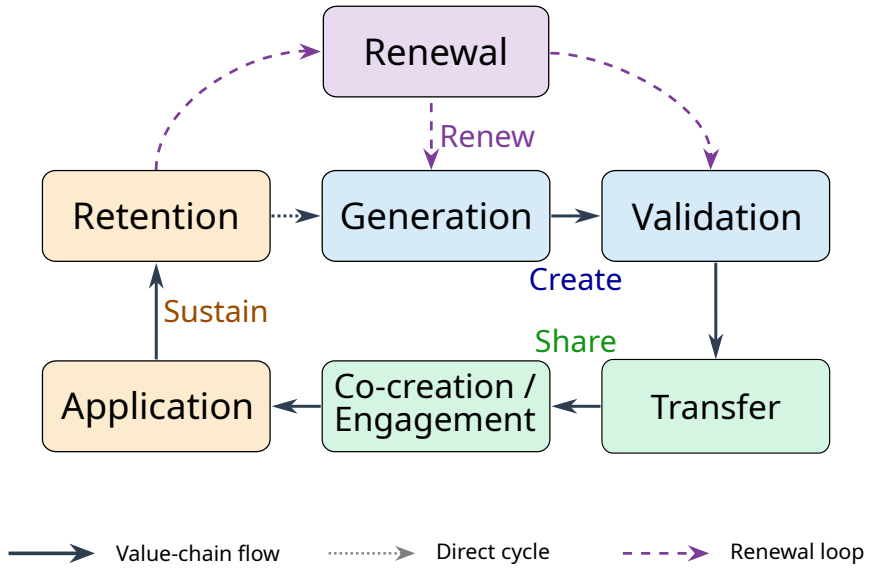


Figure 1: The knowledge lifecycle spans two layers. The core value chain flow-oriented cycle is extended by the renewal loop.

2.5 Mapping logic and capability grounding

For each product or value stream, we derive paired service groups that separate **design** (establishing and validating the offering) from **consumption** (delivering value-in-use). This reduces organisational mirroring and keeps the model generic across HEIs [Beuren et al., 2017]. Design aligns primarily with **generation** and **validation**, while consumption aligns with **transfer**, **co-creation/engagement**, and **application**. Retention and renewal activities can appear in either phase depending on whether they establish governance mechanisms or operate them in practice. Internal infrastructure and internal governance services are documented for completeness but are not necessarily product-anchored; external governance can be product-anchored where the governing body is outside the institution. Where a service group both establishes and operates the offering (e.g., co-creation or validation at the point of use), we denote it as spanning **Design → Consumption**. Service-design methods such as blueprinting and experience-centric service design provide the translation from offerings to service-group structure [Zomerdijk and Voss, 2010]. In addition, each service group is mapped to HERM BRM capability areas to ensure traceability, cross-institutional comparability, and alignment.

2.6 Deriving service groups from the knowledge lifecycle

Service groups are derived using a lifecycle × value-stream grid. For each intersection, we define a small number of stable service groups that represent outcomes rather than organisational units. We position stewardship as an internal support layer to make internal value contributions visible while keeping the primary value streams focused on mission delivery. The lifecycle stages follow the sequence defined in Section 2.4.

Renewal services explicitly feed back into earlier stages. For example, Continuous Improvement & Accreditation feeds back into Curriculum Design & Accreditation; Review Execution & Feedback feeds back into Review Workflow & Criteria Configuration; and stewardship renewal services (performance, compliance, governance) feed back into design and validation decisions across all value streams.

Each service group is documented with a short template capturing purpose and outcome, value-stream anchor, lifecycle stage(s), primary stakeholders, HERM BRM capability mapping, and a governance/renewal hook. This keeps the SRM at the reference level while enabling local instantiation without organisational mirroring.

The SRM therefore yields a lifecycle × value-stream grid of service groups, as well as a capability-anchored mapping to HERM BRM areas. These outputs stabilise service group definitions across student, curriculum, research, engagement, and stewardship contexts, and enable cross-institutional comparison. The full template, derivation grid, and traceability checklist are provided in the external appendix [von der Heyde et al., 2026].

2.7 Completing the SRM with Application and Technology Services

We extend the business service groups derived in chapter 2 and the previous section by adding application and technology service groups from the HERM Application Reference Model (ARM) and Technical Reference Model (TRM). This step is a mechanical adoption of the existing grouping layers, with definitions refined to emphasise services and product-oriented outcomes rather than process descriptions. The resulting SRM therefore comprises Business, Application and Technology services, aligned across EA layers to deliver products and enable institutional capabilities [jeff kennedy et al., 2026, von der Heyde et al., 2025]. Summary of the methodological approach for constructing the SRM is presented in Figure 2.

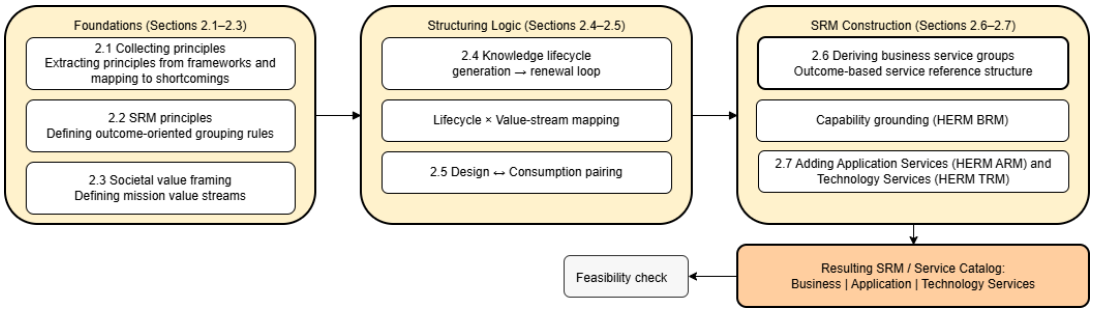


Figure 2: Summary of the methodological approach in SRM development.

3 Application

3.1 Case Study: Developing a NTNU Service Catalogue

The development of the NTNU Service Catalogue illustrates how a practical, iterative, and bottom-up approach revealed the very core challenges addressed by the SRM. Initially, the university needed to move beyond local, owner-centric mappings to a unified framework, while facing significant cultural resistance towards standardization and "business thinking". This practical friction validates the need for a common SRM, not just as a technical tool, but also as a catalyst for organisational development, shifting the focus from internal processes to front-stage user services. NTNU's need to develop capabilities for comprehensive governance and resource planning further propelled the need for a common framework combining business, application, and technical services.

To bridge the Business Service gap, NTNU expanded beyond the EDUCAUSE IT framework to establish an enterprise-level service portfolio. By anchoring this work in the HERM, the university has attempted to harmonise high-level architectural standards with the practical delivery of mission-critical services in teaching, research and enabling activities. To prevent organisational mirroring, NTNU's catalogue aims to transition from an "owner-oriented" view to a user-centric structure and methodology based in service design. A pilot in the Department of Education utilized the "student journey" as a value-stream anchor (e.g., from "Prospect" to "Alum") to define services that span across hierarchical levels. This exploration confirmed that without such anchors, services drift toward internal departmental silos, weakening comparability and user value. A standardized SRM will further facilitate a transition to common service groups that are not dependent on the interest or commitment of individual service owners.

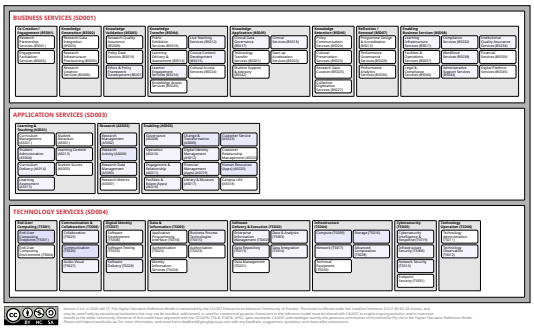
Finally, to ensure cross-layer traceability, the Service Catalogue explicitly links user-facing services to internal processes and technical systems. In practice, this allows the university to map how a business service like "Examination" depends on both specific work processes and enabling technology. The overall SRM will further aid in identifying missing or insufficiently covered service areas in the catalogue. NTNU's experience demonstrates that this multi-layered visibility is essential for strategic prioritization and effective resource management within a complex university ecosystem.

3.2 Mapping External Models to the SRM

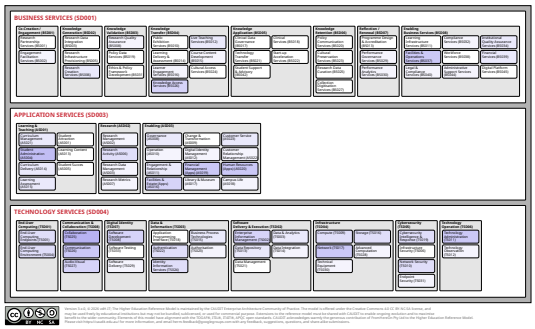
To demonstrate actionability, we map entries from existing service models onto the SRM. For the initial mapping exercise, we use the four catalogues introduced in Section 1.2. Each

entry is analysed and, where it constitutes a service in the SRM sense, assigned to the most appropriate service group. Where entries are clearly not services, we document the rationale for exclusion. Where an entry could plausibly map to multiple service groups, we record the alternatives and treat these cases as evidence of semantic overlap. This mapping therefore acts as both a validation of completeness and a diagnostic tool for refining the boundaries between service groups.

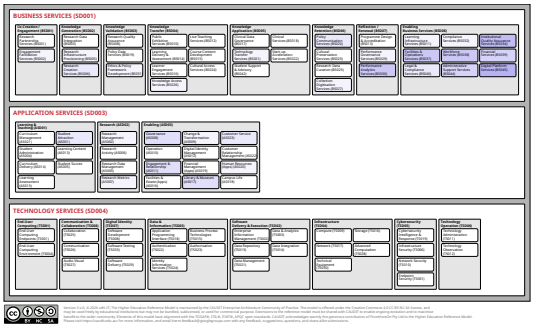
EDUCAUSE Service Catalog



German IT-Service Survey



Finnish Collection of Services



Services by UCISA / King's College

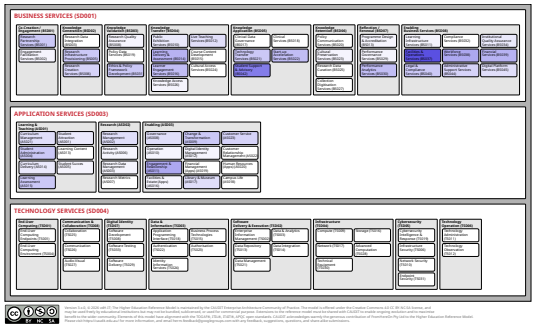


Figure 3: Overview of LLM-based automatic mapping between the SRM and other models. Purple intensity indicates differences in coverage of elements. The figure highlights that the SRM, alongside UCISA services, covers a larger share of business services than other models, while none fully covers the SRM.

The mapping displayed in Figure 3 enables a visual comparison to be drawn between all four models and the SRM. For each line in the other models, the service group in the SRM to which the given service could belong was identified by the LLM. Reversing this mapping using a python script demonstrates where the model entries in the SRM are matched.

Essentially, we observe that the EDUCAUSE and German models more accurately capture IT services than the Finnish and UCISA collections, neither of which matches any technical service group. Furthermore, the latter display far broader coverage of business services. However, the Enabling Business Services place a major emphasis on the use of IT for internal support rather than demonstrating the business case for the public.

The detailed mapping, along with further implementation details, can be found in [von der Heyde et al., 2026]; the manuscript includes only representative excerpts for orientation.

3.3 Evaluation of a SRM to TBM Mapping

When adopting ITSM or EAM, many HEIs must conform to industry standards, particularly when implementing industry-standard tools. However, vendor consultants and tool communities often lack familiarity with the structural characteristics and historical development of universities. This can render tool configuration difficult or even infeasible.

We therefore evaluated the SRM within the Technology Business Management (TBM) v5.0 framework. The mapping exposes a fundamental structural difference: TBM is an industry-wide standard developed outside the HE context. Although SRM business services can be mapped to TBM solution categories, the distinct organizational logic and structural particularities of HEIs remain evident.

These findings highlight the importance of architectural alignment and structural reconciliation when implementing industry standards in universities. Comparable mapping efforts will likewise be required for the successful adoption and configuration of ITSM or EAM tools.

The following key findings emerged from the mapping analysis:

- **Contextual permeation of core business logic into technical infrastructure:** As illustrated by Research Infrastructure (BS005) and Learning Infrastructure (BS011), HEIs integrate their core business domains directly into their technical architecture. These service categories are explicitly aligned with the institutional missions relating to research and teaching. In contrast, TBM uses a context-neutral, solution-oriented classification system. While SRM categorises infrastructure according to mission-specific domains, TBM is independent of sectoral structures. This distinction highlights a key structural feature of HEIs: the close relationship between their academic mission and IT architecture. When adopting TBM, careful consideration must be given to this embeddedness to ensure adequate representation of mission-driven services.

- **Ambiguity in business–IT delineation:** The SRM differentiates between business services that can be provided without IT mediation, such as Learning Delivery (BS014), and those that constitute digital service provision by their very nature, such as Digital Platforms (BS045). This distinction reflects the evolving role of IT in HEIs, where it operates as both infrastructural support and as a constitutive element of institutional value creation.

- **Intangible HEI products:** Services such as BS006, BS010, and BS012, among others, may be interpreted not merely as operational activities but as distinct—albeit intangible—products of HEI. Although universities traditionally do not conceptualise their outputs in product terms, several SRM service categories correspond to TBM's notion of product delivery, not as enabling solutions but as the value-bearing offerings themselves. This perspective introduces a product-oriented view of academic service provision, shifting the focus from internal process structures to externally realized value creation. Within a TBM framework, it suggests that certain academic services can be understood as institutional products, despite being non-material and mission-driven in nature. This interpretation does not imply commercialisation but rather provides an analytical lens through which to understand how HEIs structure and deliver value.

Our observations underscore the mission-driven nature of universities architecture, in which IT is not merely a supporting function, but is structurally embedded within core academic processes. Future work should address issues such as architectural compatibility, abstraction alignment, and conceptual integration in order to facilitate the adoption of standardised management frameworks within the HE sector.

4 Summary

4.1 Overview

This paper presents a Service Reference Model (SRM) for higher-education institutions, which bridges HERM-aligned EA practice and operational service portfolios. Our contribution is a sector-specific SRM that delivers an outcome-oriented service-group catalogue anchored in mission and value streams, expressed as a lifecycle × value-stream grid. These are operationalised through a design/consumption phase split and product-to-service mapping. These elements address issues such as IT-centric catalogues, under-defined value streams and products, organisational mirroring, and weak cross-layer traceability for the first time in HE.

4.2 Limitations and Open Issues

The method remains a conceptual synthesis and should be read with the following caveats: **Evidence scope:** The principle set and mapping logic rely on a curated literature and sector artefacts set, which may over-represent European HEI contexts and should be validated in other regions. **Judgement in derivation:** Service-group derivation and capability mapping require expert judgement. Reproducibility and inter-rater agreement have not yet been empirically tested. **Version dependence:** The mappings are anchored to HERM BRM 3.2.0; future updates to HERM will require realignment and may affect traceability links. **Operational completeness:** Product-to-service mappings use exemplar products. Coverage across full institutional portfolios and the impact on operational performance impacts have not yet been evaluated in practice.

4.3 Future Work

Next steps are operational validation and refinement of the service-group set. This includes testing the lifecycle × value-stream grid in practice, verifying HERM capability mappings with institutions, and compiling offering examples in an expanded catalogue. We also plan to evaluate the robustness of the design/consumption split and the knowledge-lifecycle framing in various HEI contexts and update mappings as HERM evolves [Beuren et al., 2017, Evans et al., 2014].

4.4 Acknowledgements and Contributions

AI use disclosure. OpenAI Codex 5.3 was used to develop the argument and enforce the mappings. An AI-assisted reviewer (Anthropic Claude Sonnet 4.5) scanned the manuscript for structural consistency and completeness, recording the review findings. The final wording was checked using DeepL Write. The authors made all content decisions and interpretations and are responsible for the accuracy of the final text.

Authors contributions. MvdH led the development of the SRM, structured the paper draft, and conducted the primary literature review. MN developed and implemented the NTNU use case. AH carried out the TBM mapping. SR prepared the method overview section. All authors contributed to paper revisions, discussions, and refinement of the literature review. The authors also gratefully acknowledge the extensive and highly valuable feedback provided by jeff kennedy (University of Auckland), which significantly strengthened the manuscript.

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