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From Libraries to Data-Driven Institutions: A Process-Based Model of Business Intelligence Adoption in Malaysian Academic Libraries

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ABSTRACT

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This study develops a process-oriented conceptual model of Business Intelligence (BI) adoption in academic libraries by explaining how institutional readiness, behavioural intention, system usage, operational practices, and organisational outcomes are structurally connected. Existing research on BI adoption in libraries remains fragmented, often focusing on determinants without explaining how adoption is translated into organisational value. Drawing on the Technology–Organization–Environment (TOE) framework, the Technology Acceptance Model (TAM), and the Unified Theory of Acceptance and Use of Technology (UTAUT), this study integrates these perspectives into a unified analytical structure that captures the progression of adoption from institutional conditions to behavioural enactment and operational impact. The study advances three contributions. First, it reframes BI adoption as a process of capability development rather than a discrete acceptance outcome. Second, it introduces an operationalisation stage that explains how system usage is translated into analytical practices such as data-driven decision-making, real-time monitoring, and user engagement. Third, it provides a context-specific conceptual foundation for understanding academic libraries as data-driven institutional actors. The model offers a structured basis for future empirical validation and strengthens theoretical explanations of technology adoption in knowledge-intensive environments.

1. Introduction

Academic libraries generate increasing volumes of institutional data. Continued reliance on manual reporting practices and loosely integrated systems indicates that this growth has not translated into stronger decision-making, reflecting a persistent gap between data generation and its practical use [1]. The expansion of data-driven infrastructures across higher education has altered how decisions are constructed, justified, and institutionalised, positioning analytics as a central mechanism of strategic action within universities, with Business Intelligence (BI) shaping how organisational data is structured, interpreted, and translated into decision-relevant insights Gaftandzhieva *et al.*, [2]. Within this transformation, academic libraries operate in a structurally

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complex environment characterised by continuous data generation through digital systems, user interactions, and service platforms.

Owusu, A., *et al.*, [3] document the scale of data produced within library contexts, while Xu, Z. [4] highlights increasing the demands for research data management and data literacy, reflecting the growing complexity of managing and utilising such data. The findings further identify ongoing challenges in translating this data into structured analytical practices, highlighting a persistent gap between data availability and its effective mobilisation in organisational decision-making [5,6]. The implications of this condition extend to institutional performance and strategic alignment. Continued reliance on manual reporting practices and loosely integrated systems reflects limited analytical capability within operational environments. This condition is situated within organisational capacity, behavioural readiness, and institutional alignment, emphasising that analytics becomes meaningful through its enactment within organisational processes [7].

At the level of implementation, engagement with analytics is understood conceptually, while application remains concentrated within descriptive functions. The findings indicate limited progression toward predictive and prescriptive analytics, constraining the role of data in informing strategic decisions such as collection development, space optimisation, and service redesign [7,8]. Alignment with broader university analytics ecosystems remains uneven, reflecting limitations in system integration and institutional coordination. Cox *et al.*, [1] identify emerging integration efforts, while Subuhpoto *et al.*, [9] highlight structural constraints, including fragmented data infrastructures, limited data literacy among librarians, and weak integration with institutional analytics units.

Data-driven decision-making is increasingly recognised as a strategic approach that enhances organisational efficiency and reduces uncertainty through evidence-based practices. However, its effective adoption remains constrained by fragmented data environments, limited analytical capabilities, and organisational readiness challenges [10]. Despite the expansion of analytical infrastructures, the ability to translate data into actionable insights remains uneven, limiting the strategic contribution of academic libraries. In this context, BI emerges as a critical capability that enables the integration, interpretation, and application of organisational data in supporting decision processes. It facilitates the transformation of dispersed data into structured insights that inform planning, resource allocation, and service development, strengthening the role of libraries in contributing to institutional performance [11].

Despite this potential, the application of BI within academic libraries remains shaped by organisational constraints and varying levels of analytical readiness [12,13].

BI adoption, therefore, extends beyond technological deployment and requires alignment between institutional structures, user engagement, and analytical practices. This condition raises a central question regarding how BI is enacted within organisational contexts and how it contributes to decision-making outcomes.

Theoretical perspectives on technology adoption provide partial insight into these conditions. This study examines adoption within academic libraries in relation to service delivery and reporting functions [14,15], while another study establishes the relevance of the Technology–Organisation–Environment (TOE), Technology Acceptance Model (TAM), and Unified Theory of Acceptance and Use of Technology (UTAUT) in explaining adoption behaviour [16,17]. These frameworks capture key dimensions of adoption, while interactions across organisational levels and processes remain less clearly articulated, particularly in knowledge-intensive environments where technological, organisational, and behavioural conditions evolve simultaneously.

Understanding how analytics adoption progresses toward organisational outcomes remains insufficiently developed. The study highlights the growing relevance of data analytics within academic libraries [7,11,18], while other authors argue that the translation of adoption into

performance and strategic value requires further conceptual clarification [19,20]. Although academic libraries generate substantial volumes of operational data through circulation systems, electronic resource usage, and digital services [18,21,22], these data remain distributed across systems and are primarily used for periodic reporting rather than integrated analytical decision-making [7,18]. This limitation becomes more evident in contexts where coordinated decision-making is critical, as illustrated by gaps in policy integration, risk management, and response coordination in Malaysian academic libraries [23].

While such conditions point to the potential role of BI analytics in supporting coordinated decision processes, existing research explains BI adoption primarily through factors such as technological infrastructure, organisational support, and user perception. However, these perspectives do not explain how system usage is translated into analytical practices such as linking datasets across services, generating real-time insights, or supporting coordinated decision-making. This limitation becomes more evident in data-intensive environments where real-time data integration and analytics require coordinated infrastructure, data quality management, and continuous processing capabilities [24]. As a result, BI adoption is frequently treated as system implementation rather than as an ongoing process through which analytical capability is enacted within academic library environments. Recent reviews reinforce this limitation, highlighting that existing research provides limited guidance on how analytics is translated into decision-making practices and organisational value despite increasing attention to its adoption in academic libraries [7]. These conditions call for a process-based explanation that connects organisational conditions, user engagement, and system utilisation within a unified analytical perspective, particularly in environments where organisational and process data remain fragmented and require integration to support evidence-based BI [25].

The integration is framed within a unified analytical structure that reflects the broader role of BI in strengthening data-driven decision-making across organisational contexts [26]. Within this structure, TOE explains adoption through institutional conditions that shape how organisations evaluate and implement systems, while evidence from university library contexts demonstrates that organisational, technological, environmental, and human factors jointly influence adoption outcomes [27]. At the behavioural level, UTAUT explains how performance expectations, effort considerations, social influence, and facilitating conditions shape librarians' intention to adopt and use technologies [28]. Building on these perspectives, recent studies further extend this analytical direction by integrating TOE, TAM, and UTAUT to explain how organisational conditions and user behaviour interact in shaping adoption processes across complex technological environments [29]. The combination of these frameworks enables the analysis to capture how technological, organisational, and behavioural conditions interact across levels, providing a structured basis for explaining adoption as a multi-stage process.

This study develops a process-based conceptualisation of BI adoption within academic libraries by integrating institutional readiness, behavioural engagement, system usage, operational practices, and organisational outcomes within a unified analytical structure. This conceptualisation advances BI adoption as an evolving capability and provides a structured basis for explaining how data-driven decision-making is enacted and sustained within academic library contexts, addressing limitations in existing studies that primarily focus on functional adoption without fully theorising how analytical practices are embedded within organisational processes [30].

The remainder of this paper is structured as follows. Section 2 reviews the literature on Business Intelligence in organisational decision-making, BI adoption in academic libraries, and the theoretical foundations of technology adoption, culminating in the integration of TOE, TAM, and UTAUT. Section 3 presents the proposed research model and hypothesis development, outlining the process-based

structure of BI adoption from institutional readiness to organisational outcomes. Section 4 discusses the theoretical and practical implications of the model. Section 5 outlines the limitations of the study and directions for future research. Finally, Section 6 concludes the paper by summarising the key contributions and positioning BI adoption as a process of institutional transformation in academic libraries.

2. Literature Review

2.1 Business Intelligence in Organisational Decision-Making

Decision-making within contemporary organisations is shaped by the capacity to interpret and mobilise large volumes of organisational data. Digital systems, transactional platforms, and service infrastructures continuously generate data that reflect organisational activities, user behaviour, and institutional performance. Within these data-intensive conditions, BI functions as an analytical capability that transforms raw data into structured insights, shaping how organisational information is interpreted, prioritised, and translated into managerial and strategic action [31].

BI encompasses a set of technologies, analytical tools, and organisational processes designed to collect, integrate, and analyse data originating from multiple operational systems. Techniques such as data warehousing, data mining, dashboards, and visual analytics support the interpretation of complex datasets and enable the production of timely information for organisational planning and performance monitoring [11]. Through these mechanisms, organisations identify patterns, evaluate performance trajectories, and recognise emerging trends that inform strategic direction and guide organisational responses.

BI also operates as an organisational capability that strengthens evidence-based decision-making. The integration of data across operational units reduces fragmentation and develops a more coherent understanding of institutional performance. Prayogo *et al.*, [32] demonstrate that this capability enhances managerial responsiveness, supports resource optimisation, and strengthens alignment between operational activities and strategic objectives. BI becomes embedded within organisational decision processes as data-driven practices are enacted within decision routines, shaping how analytical insights are translated into coordinated organisational action. Managerial practices, institutional support, and user engagement collectively configure how BI functions within these processes.

In knowledge-intensive environments, BI assumes a central role as organisational effectiveness depends on the ability to transform information resources into actionable knowledge. The organisations that embed BI within operational processes demonstrate stronger analytical capacity, greater transparency in performance evaluation, and clearer alignment between operational execution and institutional objectives [11,33]. The institutionalisation of BI, however, varies across organisational contexts, where implementation depends on the alignment of infrastructure, organisational readiness, analytical competencies, and supportive institutional practices. This configuration positions BI adoption as a multi-dimensional process that evolves through interaction across technological, organisational, and behavioural domains, providing a basis for understanding how BI is evaluated, implemented, and integrated within institutional environments [34].

2.2 Business Intelligence Adoption in Academic Libraries

Academic libraries record circulation transactions, electronic resource access, repository downloads, and reference service interactions through multiple operational systems. These records are stored across separate platforms, where usage statistics and service logs are compiled for

reporting cycles without consolidation across systems. Data remains distributed, formatted differently, and rarely connected at the point where decisions are formed. Under these conditions, BI functions as an analytical capability that consolidates dispersed records and organises them into decision-relevant structures, enabling library activities to be interpreted as coordinated institutional inputs [14,15].

Library analytics practices centre on tracking resource usage, summarising service performance, and producing institutional reports tied to administrative requirements. Amanullah *et al.*, [14] describe how these practices support visibility of usage patterns and user demand, while their application remains anchored in descriptive outputs. Reporting outputs are generated, circulated, and archived, while links across datasets remain weak at the stage where planning decisions are made. BI introduces the possibility of connecting these datasets across systems, allowing patterns to be traced across services and time, and enabling decisions to draw from integrated rather than isolated records.

Implementation patterns reveal uneven uptake across institutions. Aziz *et al.*, [15] report continued reliance on spreadsheet-based reporting and manually compiled statistics, limiting the use of integrated analytical systems capable of supporting advanced analytics and real-time decision support. Mustafa, A'Dillah *et al.*, [35] describe variations in system integration, organisational commitment, and analytical competencies that shape how libraries engage with digital information resources. Libraries accumulate detailed operational records, while integration across platforms and analytical interpretation remain partial, restricting the translation of these records into actionable insights and constraining the role of BI in decision processes.

Scholarship on library technology has largely prioritised ICT systems and digital infrastructure, foregrounding system integration and service optimisation. Adoption within library contexts unfolds as a decentralised and multi-stage process shaped by interactions across institutional, organisational, and practitioner levels, illustrated in analyses of linked data diffusion [36]. This process-oriented understanding remains largely confined to specific technologies, leaving how Business Intelligence BI is adopted and enacted within librarians' practices insufficiently articulated. A process-oriented behavioural perspective conceptualises adoption as an interaction across technological, organisational, and behavioural domains Poba-Nzaou *et al.*, [16], although its empirical articulation in academic library settings remains underdeveloped. This study advances a conceptual explanation of BI adoption in academic libraries by integrating these domains into a unified analytical perspective, clarifying how BI is enacted within decision processes and how it contributes to institutional decision-making outcomes.

2.3 Technology Adoption Frameworks in Information Systems Research

Technological adoption in organisational settings develops through ongoing interaction across system configurations, organisational arrangements, and user practices rather than a single implementation decision. Systems enter organisational environments through stages of evaluation, adjustment, and use, where technical features intersect with existing workflows and institutional routines. Foundational frameworks such as TOE, TAM, and UTAUT provide structured explanations of these processes, capturing how adoption is formed across institutional conditions and individual engagement [17,37], with subsequent work extending these models to account for the complexity of digital and analytics-driven environments [38].

UTAUT explains system use through performance expectations, effort considerations, social influence, and facilitating conditions that shape how individuals engage with systems in organisational settings [17]. Extend this explanation by demonstrating how organisational culture and leadership practices influence the incorporation of systems into existing workflows, shaping how technologies are enacted in daily operations. System use therefore develops through interaction between user expectations and organisational conditions, where engagement is shaped as much by institutional context as by system design.

Work in AI-related contexts introduces additional conditions that shape adoption trajectories. Hossain *et al.*, [39], together with Bosbach *et al.*, [40], identify digital trust, institutional readiness, and employee maturity as factors that influence how systems are interpreted and engaged in organisational routines. These conditions illustrate how adoption unfolds through alignment between technical systems and the organisational environments in which they are introduced, where interpretation, trust, and capability influence how systems are incorporated into practice.

TOE explains adoption through institutional conditions that shape how organisations evaluate and implement systems. Technological characteristics such as compatibility and complexity influence evaluation processes, organisational conditions shape implementation feasibility, and environmental pressures influence institutional responses to technological change. TAM explains adoption through user perception, where perceived usefulness and perceived ease of use influence behavioural intention and participation in work practices [17,37]. UTAUT extends this explanation by positioning system use as the outcome of interacting expectations, social dynamics, and organisational support structures [37].

These frameworks collectively describe adoption across multiple analytical layers, while each maintains a distinct focus. TOE foregrounds institutional conditions, whereas TAM and UTAUT account for user-level engagement and system use. This separation introduces an analytical gap, where organisational structures and user practices are explained independently, even though they unfold simultaneously in operational settings. Adoption in practice involves continuous interaction between system configuration, institutional conditions, and user engagement, particularly in environments where data interpretation and decision processes are closely linked. This paper integrates TOE, TAM, and UTAUT to develop a unified analytical explanation of BI adoption, positioning adoption as an interaction across technological conditions, organisational arrangements, and behavioural engagement, and clarifying how these dimensions shape decision-making processes in academic libraries.

2.4 Integrating TOE, TAM, and UTAUT in Technology Adoption Studies

Technology adoption in information systems is examined through established frameworks that explain how organisations and individuals engage with new systems. TOE, TAM, and UTAUT provide

structured accounts of this process from distinct analytical positions. TOE captures adoption through institutional conditions, including technological readiness, organisational capability, and environmental pressures, while previous studies further explain how these conditions influence implementation feasibility [10]. Davis [37] positions TAM at the level of user perception, where perceived usefulness and perceived ease of use shape how systems are interpreted in work practices. Venkatesh *et al.*, [17] extend this perspective through UTAUT by incorporating performance expectancy, effort expectancy, social influence, and facilitating conditions as drivers of system use.

Applications of these frameworks have progressed along separate analytical trajectories. Organisational conditions are addressed through TOE, while user engagement is examined through TAM and UTAUT. Venkatesh *et al.*, [17] frame behavioural intention as central to system use. These accounts operate across different analytical levels, where institutional arrangements and user engagement are articulated independently, even as they intersect during implementation and use. Such separation constrains the ability to explain how adoption unfolds in operational settings, where decision processes, system interaction, and organisational conditions evolve concurrently.

Poba-Nzaou *et al.*, [16] describe how studies on analytics systems and BI adoption combine organisational and behavioural perspectives to account for interacting conditions. This analytical direction expands the explanatory scope of adoption by situating it across interdependent conditions rather than isolated variables, enabling a more nuanced interpretation of how technologies are engaged in decision processes.

Integration, however, extends beyond combining constructs across frameworks. Alignment across analytical levels becomes necessary to account for how institutional conditions, behavioural engagement, and system use develop across implementation and use. Adoption unfolds as a process in which organisational readiness, user interpretation, and system interaction evolve through continuous alignment. Explanations that isolate these dimensions risk overlooking how decisions are shaped through their interaction in practice.

BI adoption reflects this interaction through the interplay between institutional conditions and professional engagement with analytics systems. Infrastructure provision, leadership direction, and policy alignment influence how systems are introduced, while perceived usefulness, ease of use, and social influence shape how analytics tools are engaged in daily practice. Amanullah, S. W. *et al.*, [14] describe how institutional arrangements influence engagement with BI systems. Aziz, A. A., *et al.*,

Fehsenfeld [2] emphasises the role of organisational support in shaping analytical use. Poba-Nzaou *et al.*, [16] position adoption as an outcome of coordinated interaction between structural conditions and user practices. System use develops through alignment across these conditions, shaping how BI contributes to decision processes.

Building on the preceding theoretical discussion, this study advances an integrated TOE–TAM–UTAUT framework as a structured analytical foundation for explaining BI adoption in academic libraries. The integration repositions these frameworks within a layered explanatory logic that captures how adoption develops across institutional conditions, cognitive evaluation, and behavioural enactment. TOE frames the structural conditions that shape adoption feasibility, TAM captures how librarians interpret the functional value and usability of BI systems, and UTAUT explains how behavioural intention is formed and translated into actual system use within socially embedded environments. This configuration clarifies BI adoption as a staged and interdependent process shaped by institutional readiness, individual evaluation, and organisational dynamics.

Table 1
 Integrated theoretical foundations for BI adoption in academic libraries

| Framework | Key Constructs | Analytical Contribution | Role in Integrated Model |
|-----------|--|--|--|
| TOE | Technological context, organisational context, environmental context | Establishes the structural and institutional conditions that enable or constrain adoption, including infrastructure readiness, organisational capability, and external pressures | Functions as the foundational layer that conditions the feasibility of BI adoption by structuring institutional readiness, resource alignment, and external pressures that shape adoption pathways |
| TAM | Perceived usefulness, perceived ease of use | Explains how librarians cognitively evaluate BI systems in relation to task performance, efficiency, and decision-making value | Operates as the evaluative mechanism through which institutional conditions are interpreted, shaping perceived value and usability that influence acceptance decisions |
| UTAUT | Performance expectancy, effort expectancy, social influence, facilitating conditions | Extends the analysis to behavioural intention and social dynamics, including peer influence, organisational support, and enabling conditions for use | Acts as the enactment layer that translates evaluative judgments into behavioural intention and actual BI usage through social reinforcement and enabling conditions |

The synthesis presented in Table 1 advances a more precise understanding of BI adoption by positioning each framework within a distinct but interdependent analytical layer. This integration restructures the explanatory roles of TOE, TAM, and UTAUT into a process-based sequence, clarifying how BI adoption develops from institutional feasibility to behavioural enactment and subsequently to operational outcomes within academic library environments. TOE establishes the structural baseline that determines whether adoption is viable, TAM explains how that potential is interpreted at the individual level, and UTAUT captures how these evaluations are reinforced or constrained within organisational and social contexts. This layered configuration clarifies that BI adoption does not occur through isolated determinants but through a sequence of linked processes moving from institutional readiness to cognitive evaluation and behavioural enactment.

This perspective shifts the analysis from identifying factors to explaining their interaction across stages, allowing BI adoption to be understood as a process rather than a static outcome. It provides a clearer articulation of how organisational conditions shape individual perceptions, how these perceptions influence intention, and how intention is operationalised through system use and organisational impact. Building on this structured integration, the following section presents the proposed research model, which consolidates TOE, TAM, and UTAUT constructs into a unified framework that explains BI adoption as a staged and interdependent process within academic library environments.

3. Proposed Research Model and Hypothesis Development

3.1 Proposed Research Model

The proposed research model integrates constructs derived from the TOE framework, the TAM, and the UTAUT to explain BI adoption in academic libraries as a structured, process-based sequence. The model captures how adoption develops from institutional readiness to behavioural intention, system usage, and organisational outcomes within a single analytical framework.

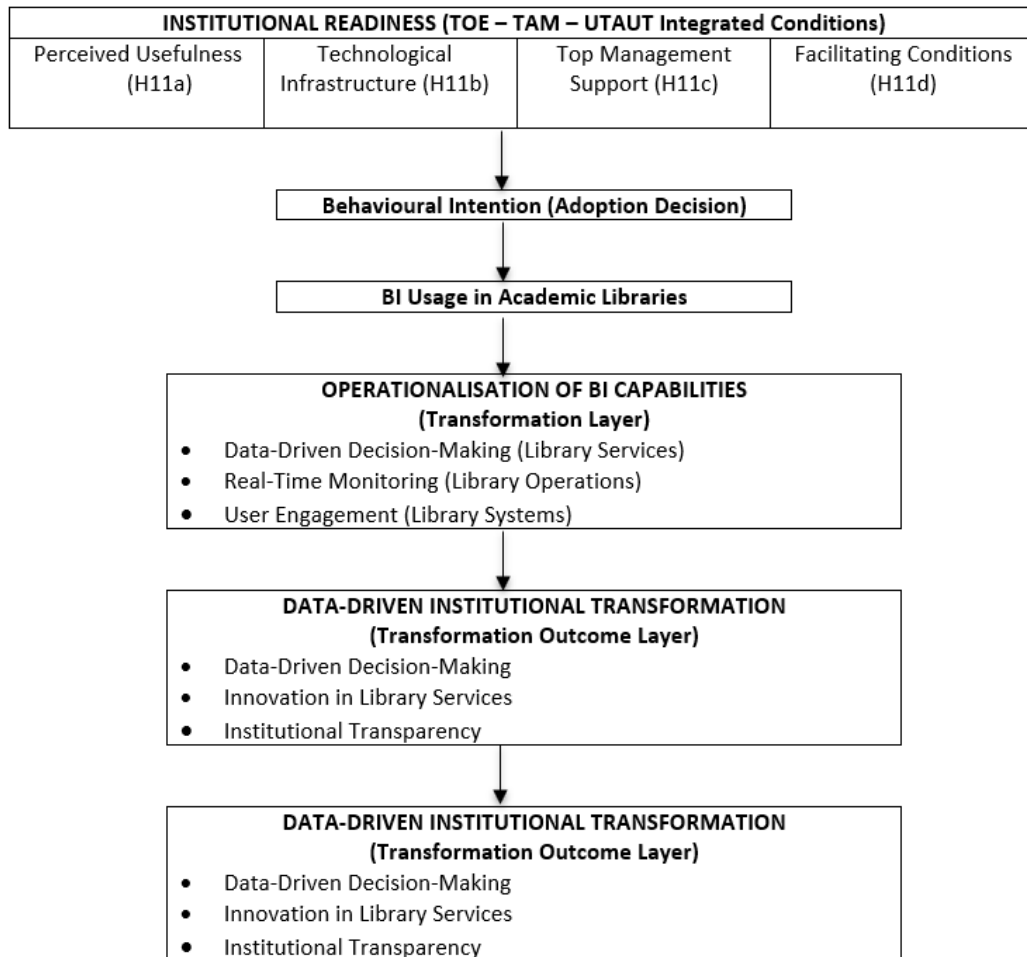


Fig. 1. A process-based conceptual framework of Business Intelligence adoption and data-driven institutional transformation in academic libraries

The framework positions institutional readiness as the initial condition shaping BI adoption, represented through perceived usefulness, technological infrastructure, top management support, and facilitating conditions. These factors collectively influence how librarians evaluate the feasibility, value, and usability of BI technologies within their organisational environment, forming the basis for behavioural intention. Behavioural intention functions as the central mechanism that translates evaluation into adoption and drives BI usage, reflecting the transition from cognitive readiness to operational implementation in academic library settings.

The novelty of this model lies in the explicit introduction of an operationalisation stage, where BI usage is translated into structured analytical practices. This stage clarifies how adoption progresses beyond system use to produce measurable organisational outcomes. At the operational stage, BI usage is expressed through data-driven decision-making, real-time monitoring, and user engagement, capturing how BI capabilities are embedded in library practices. These dimensions

represent the operationalisation of BI adoption, indicating the depth and maturity of system utilisation within institutional contexts. These operational processes extend to broader organisational outcomes, including improved decision-making, innovation, and transparency, reflecting the transformation of academic libraries into data-driven institutions. Overall, the model conceptualises BI adoption as a multi-stage and interdependent process linking institutional conditions, user evaluation, system utilisation, and organisational value creation.

3.2 Hypothesis Development

Building on the proposed research model, this study formulates a set of hypotheses to explain the relationships between institutional readiness, behavioural intention, BI usage, and organisational outcomes in academic libraries. The model positions perceived usefulness, technological infrastructure, top management support, and facilitating conditions as key antecedents that influence librarians' intention to adopt BI technologies.

Behavioural intention functions as the immediate driver of BI usage, reflecting the transition from evaluation to implementation. BI usage is further operationalised through data-driven decision-making, real-time monitoring, and user engagement, which represent the application of BI capabilities within library environments. These operational dimensions extend to organisational outcomes, including improved decision-making, innovation, and transparency, reflecting the transformation of academic libraries into data-driven institutions.

Table 2

Hypothesised relationships

| Code | Construct Relationship | Analytical Justification | Hypothesis Statement |
|------|--|--|---|
| H1a | Perceived Usefulness → Behavioural Intention | When BI technologies are interpreted as enhancing decision quality and task performance, librarians develop a greater intention to adopt and integrate these systems into their work practices | Perceived usefulness positively influences behavioural intention to use BI technologies in academic libraries |
| H1b | Technological Infrastructure → Behavioural Intention | The availability of robust ICT systems and integrated data environments enhances adoption feasibility and accessibility, encouraging librarians to engage with BI technologies | Technological infrastructure positively influences behavioural intention to use BI technologies in academic libraries |
| H1c | Top Management Support → Behavioural Intention | Leadership commitment through strategic direction and resource allocation reinforces organisational confidence and encourages adoption behaviour among librarians | Top management support positively influences behavioural intention to use BI technologies in academic libraries |
| H1d | Facilitating Conditions → Behavioural Intention | The presence of technical support, training, and system compatibility reduces usage barriers and enables effective engagement with BI technologies | Facilitating conditions positively influence behavioural intention to use BI technologies in academic libraries |
| H2 | Behavioural Intention → BI Usage | Behavioural intention functions as the direct driver of system adoption, translating cognitive readiness into actual engagement with analytics systems | Behavioural intention positively influences BI usage in academic libraries |
| H3a | BI Usage → Data-Driven Decision-Making | Active use of BI technologies enables librarians to rely on empirical data in planning and decision processes, strengthening analytical capability | BI usage positively influences data-driven decision-making in academic libraries |

| Code | Construct Relationship | Analytical Justification | Hypothesis Statement |
|------|--|--|---|
| H3b | BI Usage → Real-Time Monitoring | Continuous system usage supports real-time tracking of performance indicators, enhancing responsiveness to operational conditions | BI usage positively influences real-time monitoring in academic libraries |
| H3c | BI Usage → User Engagement | Interaction with BI technologies facilitates deeper involvement in analytical and service-related activities, strengthening system utilisation depth | BI usage positively influences user engagement in academic libraries |
| H4a | Data-Driven Decision-Making → Improved Decision-Making | Evidence-based practices enhance the accuracy and effectiveness of organisational decisions | Data-driven decision-making positively influences improved decision-making outcomes in academic libraries |
| H4b | Real-Time Monitoring → Innovation Outcomes | Continuous performance visibility enables the identification of improvement opportunities and supports service innovation | Real-time monitoring positively influences innovation outcomes in academic libraries |
| H4c | User Engagement → Transparency | Active engagement with BI systems enhances process visibility and strengthens accountability within organisational practices | User engagement positively influences transparency in academic libraries |

The hypothesised relationships presented in Table 2 provide the empirical basis for examining the multi-stage process of BI adoption in academic libraries.

4. Discussion

This study advances a process-based understanding of BI adoption in academic libraries by repositioning adoption as a structured progression shaped through the interaction of institutional conditions, user evaluation, system usage, and organisational transformation. This positioning departs from reductionist views of adoption that privilege technological readiness alone, and instead foregrounds the interdependence between infrastructure, organisational intent, and professional practice within academic library environments. Such an interpretation is consistent with prior work that recognises technology adoption in higher education as a multi-dimensional process rather than a purely technical decision [3,41].

From a theoretical standpoint, the study extends existing adoption research by integrating TOE, TAM, and UTAUT within a single process-oriented analytical structure. While these frameworks have been widely applied, they are often operationalised as parallel explanatory lenses, resulting in fragmented accounts of adoption behaviour [3,6]. This study departs from that approach by structuring these dimensions sequentially, where institutional readiness shapes cognitive evaluation, evaluation informs behavioural intention, and intention is enacted through system usage. This reconfiguration provides a clearer account of how adoption unfolds across stages rather than treating determinants as isolated predictors.

More critically, the study introduces a conceptual shift by reframing BI usage as a transitional mechanism rather than a terminal outcome. Conventional adoption models typically conclude at system use, implicitly assuming that usage signifies success. In contrast, this study positions usage as an intermediate stage through which analytical capabilities are enacted and translated into operational practices. Empirical work has established that BI systems enable data-driven decision-making, real-time monitoring, and user engagement in higher education contexts. However, these

practices are rarely theorised as the mechanism through which adoption produces institutional value. By explicitly modelling this transition, the study clarifies how BI capabilities move from technical potential to organisational relevance.

This reconceptualisation enables a more precise articulation of how BI adoption contributes to institutional transformation. Rather than treating outcomes such as improved decision-making, innovation, and transparency as direct effects of adoption, the study frames them as cumulative results of sustained operationalisation. This distinction is important because it explains why the presence of BI technologies does not automatically lead to meaningful organisational impact. Prior studies have noted the association between BI usage and organisational outcomes but have not sufficiently clarified the process through which such outcomes emerge. The present framework addresses this gap by linking usage to practice and practice to institutional value, thereby extending the explanatory boundary of adoption research.

At the same time, the analysis underscores the constraints that continue to shape BI adoption in academic libraries. Limitations in technological infrastructure, gaps in analytical competencies, and insufficient training remain persistent barriers to effective implementation [22]. These constraints reinforce the argument that adoption is not determined by access to technology alone, but by the alignment between system capability, organisational commitment, and professional readiness. Without such alignment, BI initiatives are likely to remain confined to operational reporting rather than evolving into strategic tools.

From a practical perspective, the study highlights that meaningful BI adoption requires more than technological investment. Academic libraries must embed BI technologies within existing workflows, decision processes, and service structures to ensure sustained engagement. Leadership support plays a decisive role in this process, as resource allocation and strategic direction influence whether BI initiatives become institutionalised or remain peripheral [42]. In parallel, the development of professional competencies in data analysis, interpretation, and visualisation is necessary to enable librarians to translate analytical outputs into actionable insights.

The study also points to a broader institutional shift in the role of academic libraries. BI adoption positions libraries as active contributors to institutional decision-making rather than passive service providers. This transition reflects a movement toward data-driven institutional environments, where libraries participate in shaping organisational knowledge processes through analytics-enabled insights [14]. In this context, BI adoption becomes a mechanism through which libraries redefine their strategic relevance within universities.

This study advances a distinct conceptual contribution by repositioning BI adoption as a process of institutional transformation rather than a discrete acceptance outcome. Existing technology adoption models typically conclude at behavioural intention or system usage, providing a limited explanation of how adoption translates into organisational value. The present framework extends this boundary by introducing an intermediate operationalisation layer, where BI usage is enacted through data-driven decision-making, real-time monitoring, and user engagement.

This extension provides a more precise account of how analytical capabilities are transformed into institutional practices, thereby linking adoption to value creation within academic libraries. By structuring adoption as a multi-stage and interdependent process, the study contributes a more comprehensive explanatory model that integrates institutional, behavioural, and operational dimensions within a single analytical sequence.

Table 3
 Core conceptual contribution of the study

| Dimension | Conventional Understanding | Limitation in Prior Studies | Contribution of This Study | Resulting Advancement |
|-----------------------------|---|---|--|--|
| Adoption Boundary | Adoption is explained up to the intention or system usage | Fails to explain how adoption produces organisational impact | Extends adoption beyond usage to operationalisation and institutional outcomes | Positions adoption as a transformation process |
| Role of BI Usage | BI usage is treated as an outcome | Overlooks how usage is enacted in practice | Repositions BI usage as a transitional mechanism linking adoption to practice | Clarifies how usage leads to value creation |
| Analytical Structure | TOE, TAM, and UTAUT applied separately | Produces fragmented explanations across organisational and behavioural levels | Integrates TOE–TAM–UTAUT within a process-based sequence | Provides a unified multi-stage explanatory framework |
| Mechanism of Value Creation | Outcomes assumed as direct effects of adoption | Lacks explanation of intermediate processes | Introduces the operationalisation layer as a mechanism | Explains how capabilities translate into institutional practices |
| Contextual Positioning | Technology adoption is studied in generic organisational settings | Limited focus on knowledge-intensive institutional environments | Applies the model to academic libraries as data-driven institutional actors | Expands adoption theory into the institutional knowledge context |

5. Limitations and Future Research

This study offers a structured account of BI adoption in academic libraries through a process-based perspective, although several constraints shape the scope of its interpretation. The use of a cross-sectional design captures adoption at a specific point, which limits the ability to trace how BI practices mature as institutions deepen their engagement with analytics. BI adoption develops alongside organisational learning and digital transformation, indicating the value of longitudinal research in capturing shifts in adoption trajectories over time.

The paper focuses on professional academic librarians in public universities in Peninsular Malaysia, providing a contextually grounded perspective on BI adoption. Institutional environments differ in governance structures, resource allocation, and digital maturity, which shape how analytics capabilities are developed and enacted. Extending future research across diverse higher education settings, including private institutions and specialised research environments, would strengthen comparative insights into BI adoption across institutional contexts.

The reliance on self-reported survey data captures perceptions and behavioural intentions associated with BI adoption, while offering limited visibility into actual system usage and depth of analytical practice. Differences in professional roles, levels of technical expertise, and organisational responsibilities influence how BI technologies are interpreted and applied. Future research can extend this perspective through mixed-method approaches that combine quantitative modelling with qualitative inquiry, enabling a deeper examination of how BI capabilities are enacted in practice.

The analytical focus of this study centres on technological, organisational, and behavioural determinants, while broader institutional dimensions remain open for further exploration. Institutional analytics strategies, data governance structures, and the evolving professional roles of librarians in data-driven environments represent additional layers that shape BI adoption and its outcomes. Prior studies highlight the increasing influence of these institutional dynamics in higher education contexts [14], indicating the need for future research to incorporate these dimensions into a more comprehensive analytical framework.

6. Conclusion

This study develops a process-based model of BI adoption in academic libraries by positioning adoption as a structured pathway to institutional readiness, behavioural intention, system usage, and organisational value creation. BI adoption is framed as an evolving process shaped through the alignment of technological capability, organisational direction, and professional engagement within academic library environments. The analysis clarifies that BI usage represents a transitional stage through which analytical capabilities are enacted in practice. Data-driven decision-making, real-time monitoring, and user engagement operate as mechanisms that translate system utilisation into operational activity, forming the basis for improved decision quality, innovation, and transparency. This framing extends the understanding of BI adoption beyond system use and establishes a clearer linkage between adoption and institutional outcomes. A central insight emerging from this study lies in the role of alignment in shaping BI effectiveness. Technological infrastructure establishes the foundation for adoption, while organisational commitment and professional capability determine how effectively BI tools are embedded within everyday practices. Academic libraries that achieve this alignment strengthen their capacity to contribute to evidence-based decision-making and enhance their role in institutional knowledge processes. This perspective reflects a broader transition from libraries as service-oriented entities toward data-driven institutional actors. BI adoption enables academic libraries to move beyond traditional functions and participate actively in shaping

organisational intelligence through analytics-enabled insights. In this configuration, libraries function as contributors to institutional strategy, where analytical capabilities support both operational performance and long-term decision-making. By structuring BI adoption as a multi-stage and interdependent process, this study advances a distinct conceptual contribution that extends existing technology adoption models beyond behavioural intention and system usage. The framework introduces an operationalisation layer that clarifies how analytical capabilities are transformed into institutional practices and value. In doing so, the study provides a more precise theoretical foundation for understanding BI adoption in knowledge-intensive environments. Overall, the study supports the conceptualisation of academic libraries as data-driven institutions, where BI adoption functions as a structured mechanism linking technological capability to institutional transformation. This positioning offers a clear direction for future empirical validation and strengthens the role of academic libraries within data-driven higher education ecosystems.

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