Exploring a Holistic Framework for Digital Transformation in the AECO Industry

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Abstract
This study investigates the impact of digital technology and explores a holistic framework to guide the development, integration and implementation of digital transformation strategies, products, and services in the Architecture, Engineering, Construction and Operations (AECO) industry. The study adopts an abductive and qualitative approach to data collection and analysis through a review of 78 journal articles and four semi-structured interviews with AECO experts. The findings suggest that transitioning from siloed to systems-based thinking, push to pull service models, and product-focused to integrated stakeholder-driven approaches would facilitate the strategic and efficient utilisation of digital technologies. The findings present a preliminary conceptual framework that advocates for a platform perspective in implementing digital initiatives to integrate digitally-enabled deliverables, services, and products. The study improves the understanding of factors that facilitate the successful implementation of digital transformation initiatives in the AECO industry, paving the way for better utilisation of machine-readable and interpretable building information.

Keywords: Digital Transformation, Information Management, Integration, Implementation, BIM, Platforms

1 Introduction

Significant developments in the Architecture, Engineering, Construction, and Operations (AECO) industry, mainly through Building Information Modeling (BIM), Artificial Intelligence (AI), Internet of Things (IoT), and Extended Reality, have enabled digitally-enabled approaches that remain challenging for organisations to adopt and for stakeholders to implement, leading to the limited value realisation of structured data (raw, machine-readable and machine-interpretable data). This paper argues that the low utilisation of data for decision-making in the AECO industry is not due to the diversity of digital tools but in the approach to integrating these technologies into new and existing services in a largely fragmented market. AECO firms often operate with disparate systems and siloed practices with pushed products and services that limit the value derived from digital tools. Also, organisations in the AECO industry lack holistic strategies for DT integration, overly focus on quantitative metrics, and ignore the qualitative measures that focus on value, user satisfaction, and quality. Hence, the need for adaptive, flexible approaches that consider both theoretical insights and practical constraints across all stakeholders. This study seeks to draw insights from various sectors to consolidate knowledge areas and develop a holistic framework as a guide for the AECO industry.

Building Information Modelling (BIM) is defined as the digital representation of a facility that enables stakeholders to exploit building and construction-related data during the design, construction, operation and end-of-life of an asset. One of the significant challenges in digital transformation in the AECO industry is the ability to realise value from the BIM process (Munir et al., 2019). However, to achieve this, stakeholders must look at the value of specific deliverables beyond the perspective of their immediate organisations. The AECO industry would only be able to exploit the potential of data in the AECO by developing and understanding the diverse stakeholder value streams that are mapped to intersect desired business objectives and models. In this regard, this study argues that the AECO industry may require a guide similar to the "*Michelin Guide*" in hospitality to explicate to stakeholders how to enable the integration and implementation of Digital Transformation (DT) strategies, products, and services as well as a novel purpose for improved information management and utilisation, similar to the guide did for Michelin and their products. As such, how can the AECO industry drive novel value derivation by connecting purpose to data-driven decision-making?

Current approaches to delivering data, products and services in the AECO industry necessitate a paradigm shift from a siloed and linear approach to systems-based thinking that considers the constituent parts of a project as interrelated and interdependent. The justification for this study is entrenched in the status quo, the prevalence of push strategies, where existing digital tools in the market define and drive the purpose of data and utilisation in silos within organisations, projects, and assets. This approach creates significant bottlenecks and challenges to organisational and project-level implementation of DT strategies. In contrast, a pragmatic approach would be to move to a pull strategy, where the project needs to define the purpose of digital tools, driving their implementation and adoption. This requires a collaborative approach incentivising holistic thinking to achieve a purpose-driven approach.

With that said, the study is based on a four-part rationale. First, the imperative is to break down siloed-based thinking and transition to a more holistic, systemic, and integrated stakeholder approach that enhances communication and collaboration across various project phases. Second, the necessity to transition the AECO industry to a pull strategy based on user needs as opposed to pushing services based on assumptions of stakeholder demand. Third, it is important to shift focus from mainly quantitative metrics to qualitative measures that focus on decision-making, value, user satisfaction, and quality. Fourth, a need to address the discrepancies in idealised academic models to adopt a pragmatic approach based on practical realities faced by practitioners. The study seeks to address the following research questions: Q1 – What is the current perspective on BIM-based services in the AECO industry? Q2 – How can the situation be improved? Q3– What is the missing part in increasing the development and implementation of stakeholder-focused value delivery? Therefore, the study aims to propose initial ideas for a holistic framework to guide industry stakeholders around the complexities of DT and enable the shift from theoretical idealisations to pragmatic systemic implementation approaches.

2 Literature Review

2.1 Systems Thinking Perspective

Systems thinking conceptualizes elements of a system with principles, procedures and mechanisms for specific actions that highlight their interactions that are consistent with a collective purpose. In other words, a system is an interrelated component and interdependent with others, making it an integral part of the whole. A system can be in one of four states: stasis (lack of activity), order (predictable behaviour), complexity (intermediate state), and chaos (random but ordered) (Tillmann et al., 2013). Systems in the AECO industry are generally loosely coupled and often fall into these states(Arango-Vazquez and Gentilin, 2021). Additionally, human, organisational, and social factors influence DT and the implementation of information systems (Mumford, 2000). Organisational attitudes towards innovation are not only shaped by technical factors but also by social factors such as coercive (constraining), normative (learning), and mimetic (emulating) mechanisms (Powell and Di Maggio 1992). Coercive mechanisms often make organisations conform to laws, rules, and sanctions set by institutional actors in seeking legitimacy and external validation. Normative mechanisms evaluate whether an organisation fulfils its role competently. Mimetic intuition drives organisations to emulate counterparts for positive evaluations. These social mechanisms could sometimes lead to the overshadowing of stakeholder needs in project delivery. Hence, this reveals a gap in understanding socio-technical factors in implementing DT in the AECO industry.

2.2 Information Transactions in the AECO Industry

Traditionally focused on design and construction, the AECO industry now emphasises asset operations and end-of-life phases. Information is defined as data that has been processed and organised into a format that is meaningful to the recipient or serves a specific purpose, thereby adding context and significance (Englesman, 2007). Knowledge, on the other hand, is the capability to utilise this information to accomplish a specific strategic goal. Data, information, and knowledge flow in the AECO industry across many different layers of business processes, including inter-organisational flows (design reviews), intra-organisational flows (design coordination meetings), inter-phase flows (design-construction-operations), and inter-market flows (sectorial interactions).

Effective information transactions are crucial, but the industry is segmented into different disciplines and lifecycle phases. The information transactions (generation, analysis, management and utilisation of data) in the AECO industry have never been more fuzzy. Integrating these perspectives and implementing the “as-a-service” model can improve data integration across project phases, addressing existing barriers (Wildenauer et al., 2022). Hence, there is a need to explore the barriers to the integration of data, products, and services in the AECO industry.

2.3 Implications of Push-Pull Systems for Data, Products and Services

Push systems are rooted in traditional mass-production manufacturing techniques where products are manufactured based on forecasted demand and pushed through the production process to the customer or client. In contrast, pull systems are grounded in lean thinking and lean-production manufacturing techniques, which are based on actual customer demand (Womack and Jones, 2013). In a pull system, service delivery or production processes are prompted by actual customer demand rather than forecasted demand or predetermined schedules. This means that each activity produces precisely what is needed for the next stage, reducing the likelihood of overproduction and waste in the production process.

In context, current structures in the AECO industry are characterised by push-based business models that lack systematic feedback loops from end-users, leading to inefficiencies and data overload. By pushing data out, construction projects can ensure that all stakeholders have access to information as soon as it is available without the need for continuous input from clients. This perspective results in the AECO industry mainly perceiving data as a by-product of the project lifecycle process for realising the physical artefact rather than a prime deliverable that requires a multi-stakeholder approach to improve the quality of business processes and, in turn, the physical artefact. The oversight of the crucial role of data in information transactions in the effective delivery of products and services represents a significant blindspot within the industry. Consequently, since data is pushed out without considering the specific needs and preferences of all stakeholders, it often leads to ineffective data utilisation, information overload, and difficulty in extracting relevant insights, thereby representing a blocker of progress in the AECO industry. This persistent challenge underscores the need to ensure data integrity by delivering the right data to the right stakeholder, of the right quality, at the right time, and in the right amount.

The implementation of information systems in the AECO industry has been chaotic and lacks strategic business alignment (Munir, 2019). For instance, the 2011 UK BIM mandate was push-based and primarily driven by regulatory pressure rather than business needs. While push-based systems are not inherently negative, this mandate prompted significant progress in digital technology adoption and enhanced AECO industry capabilities. However, that created an additional problem of lack of harmonisation as the industry struggles to reach the plateau of productivity for BIM implementation across all project lifecycle phases, with design and construction phases ahead but operations and circular economy processes lagging. Figure 1 considers BIM implementation in the context of the Gartner hype cycle (Fenn and Raskino, 2008). It is important to note that technology adoption without stakeholder involvement can hinder efficiency and collaboration, as push-based implementation strategies may lead to incongruities between human capability, process standardisation, and technology maturity, whereas evaluating strategies and processes prior to implementation creates a *"Pull"* impact that aligns with business processes and supports socio-technical infrastructure, thereby maintaining the coherence of DT initiatives across the project lifecycle.

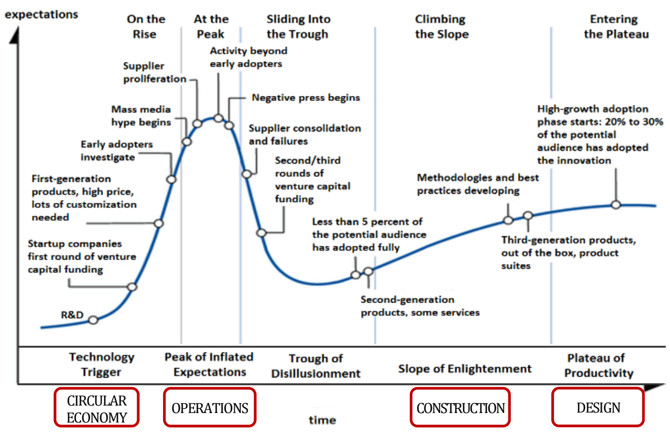

Figure 1: Gartner Hype Cycle Highlighting the Maturity of the different phases across the Project Lifecycle

In contrast, pull systems, driven by actual demand, enhance data quality and purpose through active stakeholder engagement. Currently, the AECO industry struggles to ensure sufficient and complete data requirements. Stakeholder interaction can foster innovative solutions that address the complexities of organisational and project dynamics in the AECO industry, resulting in improved project outcomes. However, the implementation of pull-based systems are not without drawbacks in supporting human capability, process standardisation and system maturity to execute business processes in the AECO industry. The industry lacks consistent approaches for stakeholder engagement and interaction, data customisation and requirements, and completeness of data to enable organisations and projects to *"Pull"* the right data. Therefore, transitioning to a pull-based approach requires addressing these challenges to support human capability, process standardisation, and system maturity in the implementation of DT initiatives.

2.4 Model and Platform Based Systems in the AECO Industry

The AECO industry is primarily dominated by model-based systems that focus on specific data structures. However, platform-based systems have the potential to offer more flexibility, supporting different purposes for various stakeholders. The main difference between platform and model-based is the central emphasis given to the object-based definition of data structure in model-based systems (Estefan and Weilkiens, 2023). While both model-based and platform-based systems function as databases, model-based systems organise data around specific entities like construction products, whereas platform-based systems vary their structure based on intended use, supporting significant differentiation to meet the diverse needs of different stakeholders across the project lifecycle. Platforms can improve efficiency, enhance productivity and reduce transaction costs, particularly in multi-stakeholder business environments (Munir et al., 2019). The AECO industry has seen the increased adoption of Common Data Environments (CDEs) together with various systems and products that consider diverse data perspectives.

The use of platform-based systems to deliver customer value is well-established and widespread, with some studies on their role in transforming inter-organisational networks and enabling value generation across various industries (Parker et al., 2016; Estefan and Weilkiens, 2023). Platforms can be categorised into four types: organisational, product family, market intermediary, and platform ecosystem, all of which vary in terms of openness and purpose (Thomas et al., 2014). The platform ecosystem is the most open type, followed by market intermediaries, product families, and organisational platforms. Also, as the network expands with new stakeholders, it tends to experience positive network effects (Katz and Shapiro, 1994). However, implementing platform ecosystems requires a gatekeeper to engage stakeholders and harness network effects for value generation (Laine et al., 2017). This point highlights the complexity and significance of an improved understanding of the connections between system models, purposes, transactions, and data across the project lifecycle.

Principally, platform and sharing systems have the potential to create new efficiencies by aggregating unorganised markets, such as the AECO industry, which typically lack structured and integrated approaches (Alhava et al., 2017). Platform-based systems excel in two-sided markets by enabling direct producer-consumer interactions that foster value creation. Their scalability, facilitated by digital technology with near-zero marginal costs, offers a strong value proposition and the potential to impact market dynamics positively. The concept presented in this paper is broadly relevant and applicable to various data types contained within both model-based and platform-based systems, highlighting the significance of improved awareness in overcoming the barriers to the integration of data, products, and services in the AECO industry.

3 Research Methodology

The study adopts an abductive approach and exploratory research strategy. This approach and strategy are suitable for answering the "what" and "how" research questions (Patton, 2002). It also adopts a qualitative approach through extensive literature reviews and semi-structured interviews, which were carried out in two phases. The first phase is the literature review, where the study explores existing research on digital transformation in the construction industry, with a particular focus on Building Information Modeling (BIM), Products, Services and Platforms and Lean principles. The literature review was conducted with the following search criteria: "Data" AND "Integration" AND "Construction Industry" AND "BIM" AND "Framework". Categorisations were done by reviewing abstracts and titles (Table 1 and Figure 2).

A total of 78 journal articles were reviewed from Scopus, Web of Science, and Google Scholar, with titles, abstracts, and full texts screened for inclusion criteria. The selection considered research quality, impact, and diversity of model and platform-based perspectives. Thematic analysis of the data identified common themes, informing the development of the conceptual framework detailed in Section 4.1. The themes used in the categorisations are shown in Figure 2.

Table 1: Literature Search

Theme	Number Of Occurrences	% Of Papers (N=53)	% Total Number Of Occurrences (N=104)
Data	16	30.19%	15.38%
Data Service	13	24.53%	12.50%
Products	39	73.58%	37.50%
Transactions	18	33.96%	17.31%
System Models	6	11.32%	5.77%
Purposes	12	22.64%	11.54%

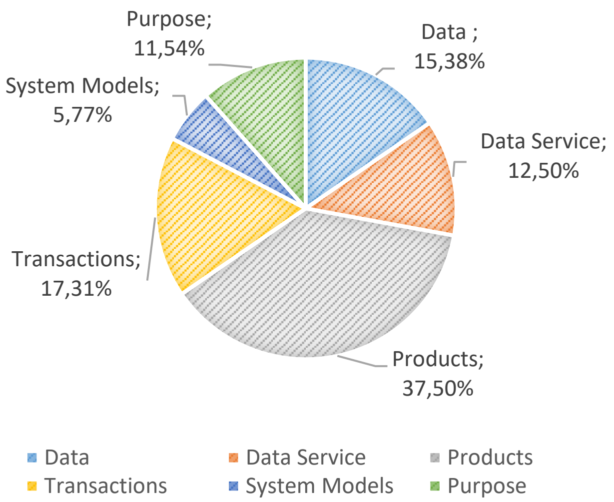

Figure 2: Literature Review Criteria-Themes

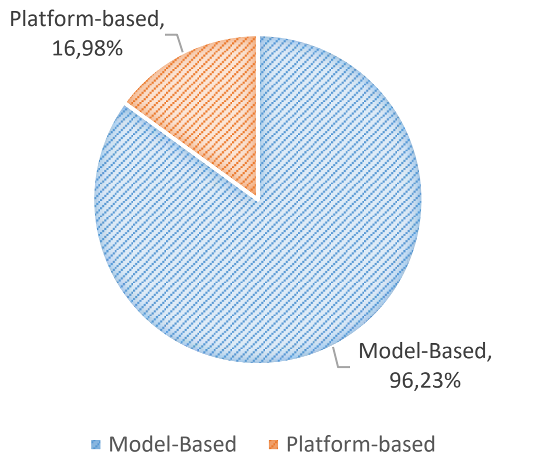

Figure 3: Literature Review Criteria-Perspectives

The second phase involved face-to-face semi-structured interviews with four construction industry experts. These interviews provided an in-depth understanding of current practices and identified gaps in effectively integrating digital tools. The study used purposeful sampling to select a small, targeted group of respondents (Patton, 2002). Criteria for selection included BIM experience, management level, expertise and involvement in DT implementation. The semi-structured interviews were analysed based on the themes established in the literature phase, which enabled further evidence to be collected. The research methodology is shown in Figure 4:

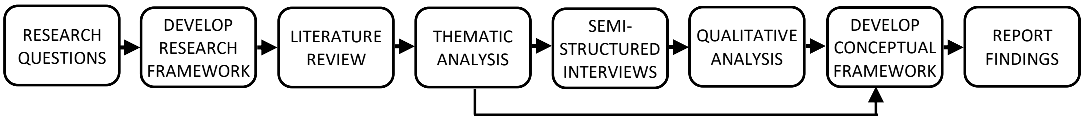

Figure 4: Research Methodology

4 Results and Discussion

4.1 Thematic Analysis

The thematic analysis of literature in the first phase identified six key factors influencing data-driven DT initiatives: purpose, system models, transactions, products, data service, and data.

4.1.1 Purpose

This theme addresses the overarching goals, standards, and regulatory requirements guiding processes in relation to data utilization in the AECO industry. It includes the motivations and requirements of various stakeholders in construction projects. The theme of "Purpose" is fundamental in any discussion of DT as it guides the strategies and technologies that stakeholders choose to implement. The *"Purpose"* of DT initiatives often reflects the main goals of enhancing efficiency, reducing waste, improving safety, and increasing the quality of outcomes in the AECO industry (Sawhney et al., 2022), including the growing need for a more sustainable society with data-driven decision making. An example of this growing need is representative of the recent changes to the Construction Product Regulations. Furthermore, understanding the *"Purpose"* and developing requirements for data, products, and services is essential for effective utilisation. Wijekoon et al. (2020) highlight a misalignment between required and available information in the project lifecycle phase, suggesting that data and product requirements must align with the purpose in order to drive technology adoption and integration in the AECO industry.

4.1.2 System Models

This theme consists of the frameworks and structures for organising, managing, and executing construction projects, including business and procurement models, which affect the way stakeholders collaborate and exchange value in the AECO industry. It highlights how operating models influence the adoption of traditional or innovative project delivery methods like BIM or Lean Construction. System models Systems models influence the use of digital tools by emphasizing collaboration, early stakeholder involvement, and requirements for data integration (Mutis and Mehraj, 2022). These models impact project financing, delivery, and motivations, underscoring the need to align business models with technology use. Wildenauer et al. (2022) highlight the need to redesign business models for building users to benefit from data services.

4.1.3 Transactions

This theme involves the collaborative interactions and exchanges of information, knowledge, and resources among stakeholders in the AECO industry that system models primarily influence. It emphasises information transactions and flows, including the roles of different parties in the project lifecycle. It emerged due to the reliance on the success of the implementation of DT initiatives in effective communication, data exchange, and information management. Samuelson and Stehn (2023) identify factors influencing DT, including structural organisational changes that facilitate knowledge, skills, and collaboration to leverage digitalisation. This highlights the importance of considering information flow, transaction nature, and stakeholder roles and relationships throughout all lifecycle phases as they impact project outcomes.

4.1.4 Products

This theme relates to the outputs and deliverables generated from data processing and analysis. This category includes various tools and technologies used to create, analyse, and manage construction and asset-related data. It includes typologies such as data authoring, data analysis, data federation, and generative data products and deliverables. Mutis and Mehraj (2022) discuss BIM not just as a model-based tool but as a cloud-based platform for generating data and providing services across all project lifecycle phases.

4.1.5 Data Service

This theme covers the infrastructure and frameworks for storing, managing, and processing construction-related data. It includes physical and digital resources like hardware, data lakes, data warehouses, data mesh, and data fabric. This theme emanated from the focus on the adoption of big data, cloud computing and data analytics in the AECO industry (Mutis and Mehraj, 2022; Larbi et al., 2024). The review found limited literature on data services in construction management, BIM, or built environment data, with only 15% focusing on these services. Similarly, infrastructure for storing and processing the vast amounts of data generated by digital tools, including scalability, accessibility, and security, is critical to the success of the implementation of DT strategies (Parker et al., 2016).

4.1.6 Data

This theme represents the raw data collected, stored, and processed to support construction activities, distinguishing between different data formats and their accessibility. It includes both open and proprietary data formats. The theme emerged from studies focused on data formats and their impact on accessibility, interoperability, collaboration, and integration in contexts like blockchain and digital twin technology (Teisserenc and Sepasgozar, 2021), design and planning processes (Larbi et al., 2024), and single organisation digitalisation (You and Wu, 2019). Also, standardising data formats is crucial for enabling interoperability and seamless integration of digital tools throughout the project lifecycle (Golzarpoor et al., 2018). Furthermore, Boiko (2024) highlights the impact of open and proprietary data formats on information transactions and management across different systems and stakeholders in the project lifecycle.

4.2 Semi-Structured Interviews

Identifying themes in the literature review enabled further exploration of their impact on DT implementation through semi-structured interviews. The data analysis is presented in Table 2.

Table 2: Summary of interviews

	Case - Interview	Purpose	System Models	Transactions	Products	Data Service	Data	Perspective
1	A senior leader of an organisation providing product information for mechanical, electrical and plumbing elements.	Reporting of production and specification of product performance	Organisational Platform	Industry/ Project specific	BIM objects	No CDE No Market Integration	Specifications Standards Compliance	Push The data services were developed for control in one part of production but were not reliable for scalability and often required manual processing.
2	An executive of an organisation providing products to integrate product information for various purposes	Ensuring reliable product information for the construction industry stakeholders	Market Intermediary Platform	Manufacturer	Data Dictionary	CDE and Market Integration	Standards	Push The software product development aimed to provide logistics information but faced scaling issues due to the lack of a unified language, resulting in the service being launched without harmonised data.
3	A senior leader of a large firm specializing in building products, standardised design, logistics operations, and in-house data service development.	Reliability of product information	Organisational Platform	Industry/ Project specific	Data Dictionary	CDE No Market Integration	Specifications Standards Compliance	Push Building kits and turnkey recreational homes, including building materials, are pushed to customers.
4	A senior leader of a roofing manufacturer aiming to develop in-house data service expertise.	Reliability of product information	Organisational Platform	Industry/ Project specific	Product Data	CDE No Market Integration	Specifications Standards Compliance	Push Insulation, energy efficiency and humidity protection materials are pushed to customers.

The data analysis suggests that data service providers employed a push strategy. As highlighted by one of the respondents, scalability with a push strategy was limited due to the lack of harmonised data structure definitions. However, the interviewee realised the need to harmonise data, which resulted in the reconsideration of the current approach to a new one facilitated by the use of data dictionaries. This underscores the major shortcoming of the push-based strategy, which is the constraint of not being able to provide a missing link between "Data" and "Purpose". The industry focuses on generating an increasing amount of data, as is demonstrated by the increased illustration of property sets. As a result, data is either in the wrong place or not defined in a way that limits data utilisation, mainly for a single purpose and not reused for multiple purposes that serve a variety of actors and other market segments.

The push strategy assumes that creating more data will support better project delivery, and the final result will be multiple new data-driven services that may enhance collaboration. However, system models influence actors, meaning that motivation does not align with the value generated. In addition, the analysed data suggests that the push-based approach dominates the AECO industry, which validates the initial assumption of this study that push-based system models characterise the AECO industry. The *"Data Services"* (available project infrastructure) are pushed to oversimplified and fragmented *"Purpose"* from the perspective of stakeholders (in terms of what data gets delivered to them and what they can do with it), leading to stakeholders identifying and determining the nature of *"Transactions"* (business processes) based on these limitations, which are mirrored based on current *"System Models"* (business models) in the utilisation of *"Products"* (business and productivity tools) and, therefore, leads to inaccurate, unscalable and inconsistent *"Data"* (raw, machine-readable and machine-interpretable data) generated across all phases of the project lifecycle in a fragmented manner (Figure 5).

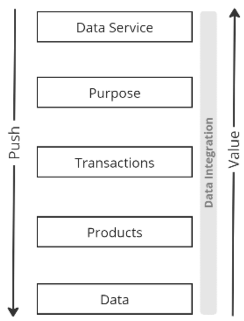

Figure 5: Current status of data integration

The push strategy means that data service providers develop their offerings by focusing on their technological developments and depending on assumed market segments and by some interactions with parts of the fragmented market, which results in simplified deductions of user data needs. In this regard, data service providers may engage with only one actor in the market with the assumption that they are solving the pain point of one market segment. However, in reality, the data that one stakeholder utilises is interdependent in a complex supply chain. For example, an architect typically finds product data online and integrates it into an information model before meeting a manufacturer, whereas, in autonomous driving, because there is a high degree of technological complexity and the supply chain is more straightforward, this makes it easier to make scalable developments. As such, the push strategy works in simpler supplier chains where the value that data brings to all stakeholders is more transparent.

4.3 Conceptual framework for data integration

Following on from the previous section, one could question why the push-based strategy remains dominant. The fundamental reason could be attributed to the prevalent mental models that employ a simplistic approach to managing complexity, which may seem effective, but only in the short term, and stakeholders interact based on their position in the supply chain. These have been proven in manufacturing literature by adopting the flow model from the transformation model, which is reductionist and focuses on breaking down an activity and analysing its parts. This logic is applied to Design for Manufacture and Assembly (DFMA), where a lean production approach is used for construction. In addition, the predominance of the push-based strategy might also be linked to the fact that private market forces primarily drive data service providers and lack the incentive to assess value from a holistic perspective that encompasses societal benefits.

In the AECO industry, there are still many opportunities to exploit data that can generate value for stakeholders that are not practically possible to answer. For example, if a new MEP maintenance provider is established in a new city, knowing which pump configurations are the most common in the city would benefit their hiring strategy and ability to order parts in bulk and, therefore, apply economies of scale savings. Similarly, in terms of fire safety, if a faulty product is recognised, it would be valuable to be able to identify which buildings are installed in the city where they are installed. The above underscores the necessity for stakeholders to communicate their needs effectively across their value streams. Based on the analysed data, it can be deduced that successful cases often involved projects that emphasised asset owner-driven collaboration (finding new value), clear communication, open stakeholder engagement, and incremental adoption strategies beyond single projects. This enabled the development and rearrangement of themes into a proposed conceptual framework for integrating data, products and services in the AECO industry based on a pull strategy (Figure 6). This approach suggests that the *"Purpose"* drives the *"System Models"* (business models) to define their organisational information requirements to guide the *"Transactions"* (business processes) to deliver the exchange information requirements, which determine the *"Products"* (business and productivity tools), *"Data Service"* (project infrastructure) and, therefore, *"Data"* (raw, machine-readable and machine-interpretable data) to be generated across all phases of project delivery.

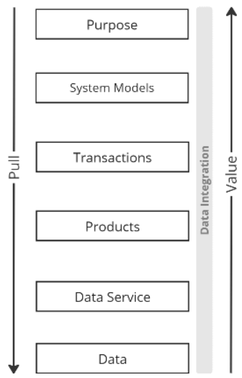

Figure 6: A Holistic Framework for Enabling in the AECO industry

5 Conclusion

The study aimed to propose a holistic framework for enabling the integration and implementation of digital transformation strategies, products, and services in the built environment. This was achieved through exploratory research around the perceptions of stakeholders, suggesting the need to define a roadmap that provides the rationale for the adoption of digitally enabled data, products, and services in the built environment. The proposed conceptual framework provided both theoretical insights and practical challenges, offering propositions for a comprehensive approach to enhancing digital adoption and implementation in the AECO industry. It highlights the prevalence of push-based systems and the need to transform to pull and demand-based systems that focus on value creation. The resources invested in development and implementation need a better balance, and the example of the *"Michelin Guide"* demonstrates the importance of a stakeholder-centric approach by considering the social and practical needs to create a valuable resource-based platform that enhances trust and reliability between stakeholders. However, stakeholders are required to communicate their needs across their value streams, not only within the market segments from which they derive direct value, as there are currently not enough incentives to discuss value openly beyond a single market segment. Furthermore, strategic alignment with stakeholder needs, societal needs and market trends is essential for successful technology diffusion and organisational business-process sustainability, which is effectively linked to its purpose. This alignment would ensure that adopted technologies are cutting-edge to meet the practical needs of the broader market and facilitate wider adoption and integration in the AECO industry. Furthermore, emphasising practical needs over purely innovative solutions increases motivation among the early majority to adopt new technologies and processes, driving widespread digital transformation and business value delivery. Lastly, as Michelin achieved systemic drivers, the AEC needs to mirror this at a larger scale between actors across the asset and project lifecycle by identifying common goals.

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