

Exploring Business-IT Strategic Alignment Models in the Big Data Era: A Postprint

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Abstract

[Purpose/Significance] Big data has recently become a focal point in both industry and academia, with increasing numbers of enterprises seeking competitive advantage through investments in big data analytics. This study aims to explore the strategic integration of big data with business to realize the strategic value of big data applications. [Method/Process] First, it reviews the impact of big data on enterprises at the strategic level. Based on comparative analysis of different business-information technology strategic alignment models, it proposes a business-information technology strategic alignment model under big data application environments. Finally, through three case analyses, it elaborates in detail on different patterns of alignment between big data technology and business strategy under various circumstances, as well as the corresponding different processes for realizing the strategic value of big data applications. [Results/Conclusion] This paper analyzes and proposes a business-information technology strategic alignment model in the big data environment. The model illuminates different alignment approaches between big data and business, and further reflects the corresponding different realization processes of strategic value from big data applications, emphasizing the dynamic connotation of strategic alignment. The proposed business-information technology strategic alignment model in the big data environment not only theoretically updates existing business-information technology alignment models to make them more conducive to analyzing big data applications, but also plays a role in promoting enterprises to realize the strategic value of big data applications in practice.

Full Text

Preamble

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Abstract

[Purpose/Significance] Big data has recently become a focal point for both industry and academia, with an increasing number of enterprises seeking to gain competitive advantages through investments in big data analytics. This study aims to explore the strategic integration of big data with business operations to realize the strategic value of big data applications. **[Method/Process]** We first review the strategic-level impacts of big data on enterprises. Based on a comparative analysis of different business-IT strategic alignment models, we propose a strategic alignment model for business and information technology in the big data application environment. Finally, through three case studies, we elaborate on the different patterns of alignment between big data technology and business strategy under various circumstances, and the corresponding processes for achieving the strategic value of big data applications. **[Result/Conclusion]** We analyze and propose a business-IT strategic alignment model in the big data environment. This model explains different alignment patterns between big data and business, and further demonstrates the different implementation processes for achieving corresponding strategic value from big data applications, emphasizing the dynamic nature of strategic alignment. The proposed model not only theoretically updates existing business-IT alignment models to better facilitate big data application analysis, but also provides practical guidance for enterprises seeking to achieve strategic value from big data applications.

Keywords: business strategy, information technology strategy, strategic alignment, big data

2. Transformation of Enterprise Business Strategy and IT Strategy in the Big Data Context

Current scholarly attention regarding big data's impact on enterprise strategy primarily focuses on how big data changes the context of strategy formulation, increases the information utilized in strategic decision-making, and consequently transforms strategic planning tools and methods [11-12]. Specifically, big data not only facilitates existing strategy implementation but also expands the information resources available to enterprises in the business environment, enabling them to respond to market changes in a timely, rapid, and continuous manner [11,13]. Moreover, big data has altered how enterprises acquire data when formulating business strategies [11]. When using big data to support strategic decisions, some traditional business strategy formulation methods and tools require replacement or modification [11]. For instance, in rapidly changing market environments, more sophisticated algorithms are needed to process dynamic datasets to support continuously updated big data analytics, which are further

complemented by new metrics, visualizations, and visualization methods to enable rapid and effective organizational responses to environmental changes [11]. Additionally, because of big data usage, strategy formulation must consider broader social data, which drives the trend of redefining organizational membership and boundaries, and further transforms data generation patterns and data-based service models [11,14].

However, big data's impact on enterprise strategy extends beyond merely expanding accessible information resources in the business environment and changing strategy formulation methods and tools. Big data applications actually affect enterprises from three levels—operational, structural, and strategic—either top-down or bottom-up, with each dimension influencing both business and IT strategy. At the operational level, innovation in business models and enterprise products and services driven by big data has received considerable attention [14-17]. P. M. Hartmann et al. [18] proposed data-oriented new business processes, while A. McAfee and E. Brynjolfsson [19], H. Choi and H. Varian [20], and H. R. Varian [21] discussed how big data improves specific internal organizational activities, such as enhancing customer relationship management and economic transactions like contracts.

At the structural level, big data also requires corresponding organizational structural alignment to facilitate its successful application [5,13,22-23]. R. Schmidt and M. Mohring [24] emphasized that big data applications at the structural level further support the alignment between big data and business at the strategic level. Current research on big data's strategic-level impact primarily focuses on three aspects: (1) formulating corresponding big data strategies for changes in business strategy, such as D. Opresnik and M. Taisch's [25] proposal for servitization-oriented big data strategies in manufacturing; (2) employing big data technology to replace or support managers' strategic decision-making processes with intelligent algorithms [26-27]; and (3) examining big data applications' impact on enterprise performance and strategic competitive advantage, exploring the strategic value of big data from the perspective of information resource utilization [28-29].

In summary, big data applications have induced corresponding changes in enterprises' strategic business environment, operational level, structural level, and strategic level, while also presenting new challenges. In this new environment, big data transforms the environment, information sources, and context for business strategy formulation. The application of big data necessitates adjustments at the strategic, structural, and information levels, which may catalyze or intensify conflicts between business and IT. From a big data application perspective, big data projects do not operate in isolation from other IT projects, making their alignment with other projects a key consideration for managers [6]. To achieve the strategic value of big data applications, horizontal alignment with existing IT and information systems is required, while vertically, big data applications combined with existing IT must align with business operations at the strategic, structural, and operational levels.

3. Discussion and Exploration of Strategic Alignment

The concept of business-IT strategic alignment emerged in the 1990s, marking the beginning of the strategic alignment era [30]. During this period, IT transitioned from a traditional support role to a strategic role, prompting scholars to explore how enterprises could capture IT's strategic value through business-IT strategic alignment. Business-IT strategic alignment is defined as a state or process where business and IT missions, objectives, and plans mutually support each other [31-34]. The strategic alignment model proposed by J. C. Henderson and N. Venkatraman in 1993 is considered the most influential framework for explaining business-IT strategic alignment and remains the most widely used model in theoretical and empirical research [36-37]. Their model identifies four components—business strategy, IT strategy, organizational structure and processes, and IT architecture and processes—that form three types of alignment relationships to interpret the concept of business-IT strategic alignment. External alignment refers to the mutual influence and support between business strategy and IT strategy, while internal alignment reflects the match between organizational structure/processes and IT architecture/processes [38-39]. Cross-domain alignment demonstrates the matching between strategy and architecture/processes, encompassing four cross-domain combinations: strategy implementation, technology exploitation, technology leverage, and technology implementation [35,38-39]. Enterprises can select an appropriate path from these four combinations to achieve business-IT strategic alignment based on their circumstances [35,40].

Subsequently, R. E. Maes et al. [32] identified two main limitations in Henderson and Venkatraman's model. First, the model assumes direct mutual influence between business and IT, whereas Maes et al. argued that this interaction is actually more complex. Second, strategic-level alignment dominates and leads the overall relationship in their model. Maes et al. emphasized the role of internal and external information sharing, proposing a revised business-IT strategic alignment model where IT and business are connected through information communication. IT must be utilized by business through processes of interpretation, communication, and knowledge sharing. Additionally, instead of analyzing the relationship between strategy and architecture/processes at two levels, Maes et al. proposed that business-IT strategic alignment should be considered across three layers: strategic, structural, and operational. Regarding the alignment process, Maes et al. identified environment and resources as two influencing factors, where environment affects strategic decisions and choices, while resources facilitate operational-level business activities.

In subsequent research, scholars continuously refined the concept of business-IT strategic alignment to deepen understanding. F. Bergeron et al. [43] explored the four strategic alignment domains defined in Henderson and Venkatraman's model and proposed a holistic alignment concept. In their framework, any two of the four domains combine to form six alignment types, with holistic alignment referring to the simultaneous examination of all six types to determine

the organization's overall strategic alignment status. J. E. Gerow et al. [44] also defined six alignment types based on the classic model but emphasized that strategic alignment is a continuous and dynamic process requiring adaptation to environmental changes. These six different alignment processes have varying impacts on economic performance. Table 1 summarizes and analyzes the characteristics, advantages, and disadvantages of different business-IT strategic alignment conceptual models or frameworks.

In the big data application context, using these models to discuss how enterprises can better leverage big data information resources through business-IT strategic alignment has corresponding limitations. Although researchers have conducted multi-level explorations of the alignment concept, they have not reached a consensus. Moreover, these models do not specifically focus on new IT applications and lack detailed explanations of how to achieve business-IT alignment during new technology implementation. Therefore, analyzing how big data applications can provide strategic-level competitive advantages through business-IT alignment requires constructing a new alignment model.

4. Business-IT Strategic Alignment Model in the Big Data Environment

Although scholars have continuously developed and improved traditional business-IT strategic alignment models, applying current mainstream models to analyze the realization of big data's strategic value in organizations has certain drawbacks. First, these models do not elaborate sufficiently on the structural and implementation layers, which hinders analysis of how big data applications at the implementation level affect business value realization. Second, existing models do not specifically focus on new IT applications or clearly demonstrate the alignment process in such contexts. Therefore, to address these limitations in analyzing how to achieve big data's strategic value through business-IT alignment, we propose a strategic alignment model for big data applications.

In the big data application strategic alignment model (see Figure 2 [Figure 2: see original paper]), business-IT strategic alignment is a multi-dimensional concept encompassing strategic, structural, and implementation layers. Strategic-level alignment primarily involves matching business and information systems in terms of mission, scope, governance, and core capabilities. Specifically, information system priorities, functionalities, and decision-making should mutually support overall business activities at the strategic level. Structural-level alignment mainly concerns the alignment between business architecture and information systems architecture. At this level, information system application structure and communication should match organizational structure and management structure, and should further support organizational objectives. At the implementation layer, alignment includes matching business activities, processes, value-added services, and employee skills with information system functionalities and usage, with IT serving as either a driver or technical service

factor supporting business operations across all three layers.

Compared with previous strategic alignment models, this new business-IT strategic alignment model advances the concept in four aspects:

First, information systems have not traditionally been considered a primary component of alignment models. The business-IT strategic alignment concept has focused on IT's support for business strategy and activities, with information systems viewed as merely one form of IT service. However, as technological evolution has enabled IT strategy implementation to support information systems application in organizations [45], IT supports business primarily through information systems. Therefore, business-IT strategic alignment should emphasize business-information systems alignment. In the new model, IT-related factors are linked to information systems application. Strategic alignment primarily considers the relationships between business and information systems across strategic, structural, and operational layers. Distinguishing between business-IT alignment and business-information systems alignment is crucial. In past research, the business-IT strategic alignment concept has been expressed in various forms, with the terms "information technology" and "information systems" often used interchangeably [37]. As discussed earlier, IT's strategic value began to be recognized in the 1980s, and the business-IT strategic alignment concept developed during the 1980s-1990s [30]. However, IT usage is closely related to enterprise management through information systems application. IT's strategic value is realized through applying information systems to improve enterprise management. Therefore, this new model uses information systems strategic alignment to strengthen the focus on how information systems support enterprise management and development, emphasizing the complex relationship between business and information systems while positioning IT as the technical enabler for information systems strategic alignment.

Second, the new model emphasizes implementation-layer alignment. In Henderson and Venkatraman's model, structural and implementation layers were not separated but combined within the architecture and processes component. In Maes et al.'s model, although the implementation and structural layers were separated, no further details on the implementation layer were provided. Additionally, the new model highlights that the relationship between information systems architecture and business operations is also a crucial aspect of strategic alignment. Information systems architecture not only supports business architecture at the structural level but also affects specific business activities at the operational level.

Third, IT and environmental factors are explicitly incorporated in the new model. Both internal and external organizational environments influence business-IT strategic alignment. Notably, IT can be considered both an internal and external environmental factor. Industry IT innovation constitutes the external environment, while internal IT usage levels represent the internal environment. External environmental changes affect organizational strategy, while internal environments impact strategy implementation.

Finally, the new model considers the dynamic balancing process of strategic alignment implementation. Strategic alignment can achieve dynamic balance within a strategy implementation cycle. When organizational strategy changes, or when structural and implementation-level factors affect strategy, alignment must reach a new dynamic balance during strategy formulation and implementation.

In summary, the new business-IT strategic alignment model re-examines IT's impact on enterprises. Industry IT serves as an external environmental factor affecting strategy formulation for specific enterprises, while internal IT application supports organizational information systems. Business-information systems strategic alignment focuses on mutual support across strategic, structural, and implementation layers, with information systems architecture also supporting specific business activities at the implementation level. In the new big data context, this alignment model can be better applied. Big data as an IT transformation has significantly impacted business-information systems alignment across all three layers. Big data changes how enterprises acquire information from their environment and the volume of information, thereby affecting strategy formulation methods and content [25]. At the structural and operational levels, big data transforms information systems architecture [24] and adjusts and promotes business activities [19], all of which interact with higher-level strategic adjustments. This big data-enabled business-IT strategic alignment model effectively explains how big data technology can achieve strategic value in enterprises.

5. Business-IT Strategic Alignment in the Big Data Application Context

5.1 Information Systems Strategy-Driven Business-IT Strategic Alignment

Big data applications change the competitive environment of industries, with the most direct driver of broken alignment balance being the need for enterprises to formulate corresponding information systems strategies to maintain competitiveness, as shown in Figure 3 [Figure 3: see original paper]. In this scenario, information systems architecture must be designed to support the new strategy, while business structure, organizational architecture, and management architecture must align with information systems architecture to ensure successful strategy implementation. This alignment approach primarily supports effective utilization of new IT. Through information systems strategy adjustment, effective information resource utilization is achieved, thereby enabling enterprises to respond quickly to business changes and technological demands.

S. F. Wamba et al. [29] discussed the case of NSW SES, an emergency services company that exemplifies information systems strategy-driven alignment. NSW SES provides emergency response to crises and disasters such as floods, hurricanes, storms, and tsunamis, and supports communities facing flood dis-

asters. With the emergence of big data technology, the company implemented the following changes to achieve strategic value from big data applications:

Phase 1: Information Systems Strategy Change

Effective emergency response management requires integrating data from different sources across various agencies and combining it with historical information to provide better emergency services. NSW SES incorporated big data utilization to enhance emergency response management into its information systems strategy.

Phase 2: Information Systems Architecture Change to Support Strategy Implementation

NSW SES established a direct two-way platform linking its website with the official meteorological bureau's website and upgraded its IT architecture by adopting a new collaborative platform. This platform enabled the agency to utilize emergency services provided by an ERP system shared with emergency agencies in other states.

Phase 3: Information Systems Process Changes Following Architecture Changes

Approximately 95,000 staff and volunteers across NSW could use the shared ERP system to support their daily work. Simultaneously, social media tools expanded their service community during emergencies and helped the organization and its members build positive profiles.

Phase 4: Information Systems Architecture Impact on Business Architecture and Processes

The shared ERP platform enabled collection, organization, and sharing of critical internal and external data, supporting core internal and external processes and thereby improving business processes. Additionally, the shared platform connected different internal departments with external agencies, promoting changes in business architecture.

Through this alignment process, the enterprise's big data information systems strategy was successfully implemented. From another perspective, the interaction between business processes and information resources further promoted connections between different data sources and existing structured, unstructured, and historical data within systems. Integration of all data resources improved emergency response service capabilities, thereby enhancing competitive advantage.

5.2 Business Strategy-Driven Business-IT Strategic Alignment

Big data applications not only change the competitive environment of specific industries but also transform the entire market's external environment, creating more possibilities for enterprises. In this situation, enterprises adjust business strategies to gain more strategic advantages, requiring corresponding business architecture and big data-enabled information systems architecture to align with

the new strategy, as shown in Figure 4 [Figure 4: see original paper]. Changes in information systems strategy require information systems design to support implementation, while new information systems structures and functionalities also transform enterprise structure and supply chain structure.

The case summarized by D. Opresnik and M. Taisch [25] exemplifies business strategy-driven alignment triggered by big data utilization. This alignment process underwent the following stages:

Phase 1: Business Strategy Transformation

In the context of big data utilization, manufacturing is undergoing a service-oriented strategic transformation. Due to big data usage, enterprises can begin offering customized products and proprietary services to customers. Opresnik and Taisch [25] refer to this as the servitization of manufacturing.

Phase 2: Business Architecture Changes to Support Strategy Implementation

Under the guidance of servitization strategy, many enterprises lack the appropriate organizational structures and production processes to achieve product servitization. Therefore, business processes must be restructured to implement a servitized supply chain that extends to upstream and downstream enterprises, creating broader connections with partners.

Phase 3: Information Systems Architecture Changes to Support Business Architecture and Processes

Given that servitization is a data-intensive process, enterprises need a product-service system to provide corresponding data. Through business intelligence analytics, information from the product-service system can also serve as input for producing servitized products.

In this business strategy-driven alignment process, big data's impact on the competitive environment and industry transformation drives enterprises to formulate new business strategies to enhance competitiveness. Through the alignment process, innovations in business architecture and information systems architecture enable production processes, supply chains, and corresponding information layers to support new business strategy implementation, thereby improving enterprise competitiveness in the big data environment.

5.3 Information Systems Architecture-Driven Business-IT Strategic Alignment

In this mode, big data changes the competitive environment, and enterprises adopt bottom-up transformation using big data technology, as shown in Figure 5 [Figure 5: see original paper]. Due to big data usage, enterprise information systems architecture requires corresponding changes. In this scenario, more effective information systems alter enterprise management models and supply chain production models, thereby providing new competitive advantages. Based on industry characteristics and comparative advantages, enterprises can achieve

more precise positioning and sustained competitiveness. Changes in information systems architecture lead to corresponding adjustments in information systems processes and business processes. Improvements in business architecture driven by information systems architecture also interact with business processes.

The case of Nielsen Company presented by M. E. Prescott [46] exemplifies information systems architecture-driven alignment. Nielsen primarily collects and provides information about audience viewing and purchasing behavior for television programs. As IT evolved, competitors began using big data technology to collect and analyze broader information, transforming the industry. The company implemented the following changes to achieve strategic value from information resources in the big data context:

Phase 1: Information Systems Architecture Change

The company consolidated all IT platforms to enable more effective and timely data sharing across the entire company, thereby improving big data technology application capabilities.

Phase 2: Business Architecture Change to Align with Information Systems Architecture

The company ensured that IT management teams and business management teams at different management levels could understand and cooperate with each other effectively, jointly addressing IT and business decision-related issues and promoting business plan implementation.

Phase 3: Business Strategy Transformation

The company conducted a series of acquisitions and strategic alliances to obtain necessary data collection technologies. This coordinated IT-business planning process enabled Nielsen to acquire advanced technologies and competitive advantages more quickly.

In the information systems architecture-driven alignment process, enterprises begin with the goal of using big data in information systems to enhance competitiveness. Through bottom-up alignment and interaction between business and information systems—including cooperation between business management teams and IT management teams—these efforts ultimately drive business strategy transformation. Under technology-driven conditions, enterprises adopt acquisition and merger strategies to obtain advanced technologies and seek more data sources to provide customers with more comprehensive, high-quality information to surpass competitors.

In all three scenarios, changes at the business and information implementation levels cannot independently drive strategic adjustments. All strategic or structural-level adjustments require support from implementation-level business activities and human resources. In bottom-up structures, big data applications affect business models and specific business activities at the operational level, further prompting organizational structure changes at the structural level to support big data applications. These operational and structural changes—through optimizing business processes, creating new customer value, discovering strate-

gic advantages, and reducing risks—all influence enterprise strategy formulation. In top-down processes, transformations in strategic decision-making processes, new business strategies, new big data strategies that support their formulation and implementation, and improved enterprise performance and competitive advantages resulting from big data strategy implementation all prompt senior and middle managers to make adjustments at structural and operational levels to promote big data strategy implementation. As a new IT, big data brings new development opportunities to enterprises, but leveraging it to gain new strategic-level competitive advantages requires adjustments and mutual alignment across strategic, structural, and implementation layers.

Conclusion

We have analyzed the changes that big data applications bring to enterprises and proposed a strategic alignment model for business and IT in the big data context, suggesting that the application and strategic impact of big data in enterprises should be considered across three layers: strategic, structural, and implementation. We further analyzed how different alignment types in this model reflect different processes for achieving strategic value from big data applications. Future research will focus on the enabling and inhibiting factors of big data applications at different enterprise levels and their impacts, providing deeper exploration into the successful application of big data in enterprises.

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Author Contributions

Chen Si: Literature review, proposed research ideas, wrote and revised the manuscript.

Zhao Yuxiang: Proposed research framework, designed paper structure, revised the manuscript.

Zhu Qinghua: Provided revision suggestions, finalized the manuscript.

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