

Digital Transformation in Product Innovation: A Multidimensional Framework and Case Study Analysis of Automated Beverage Equipment

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Abstract:

Innovation and Transformation have been an integral part of successful organizations for the last several decades, as digitization has conquered every aspect of business, from operations and customer support to engineering. The digitization of existing tools, while introducing new tools, has led to much more significant change management needs in innovation than in previous years. The integration of multidimensional models and digital tools to enhance product innovation and transformation in large corporations has become extremely important. This paper leverages a multidimensional product-concept model, examining the impact of technology, end-user experience, brand, and business strategy on cross-functional knowledge creation. The application of this model is illustrated through a case study of Foodservice equipment from the quick-serve restaurant industry, highlighting the significant role of end-user experience in driving innovation transformation. Additionally, the paper investigates the role of Product Innovation Strategy (PISs) in setting organizational goals, strategic direction, and resource allocation for new product portfolios. The findings suggest that highly innovative firms benefit from specific PIS content and a well-formulated PIS process, which positively influences new product performance. Furthermore, the study underscores the transformative impact of digital collaboration tools, such as collaborative information technology (CIT), and Artificial intelligence (AI), on the innovation process in new product development (NPD). These tools facilitate knowledge creation, accelerate problem-solving, and enable new configurations of people, teams, and firms. The research also addresses the challenges and opportunities presented by these tools, including the need for new skills and the potential for tool switching costs. This paper provides valuable insights for organizations aiming to enhance their product innovation capabilities through the strategic use of multidimensional models and digital tools.

Keywords: Product Innovation, Digital Tools, Multidimensional Models, Cross-Functional Knowledge Creation, Product Innovation Strategy (PISs), New Product Development (NPD), Human-Centered Design, Business Architecture, End-User Experience, Technology Integration, Brand Strategy, Business Logic, Collaborative Information Technology (CIT), Process Optimization, Capability Transformation, Strategic Resource Allocation, Innovation Process, Organizational Transformation

INTRODUCTION

In rapidly evolving business landscape, product innovation and transformation have become critical drivers of competitive advantage for large corporations. The ability to innovate and transform products not only determines a company's market position but also its long-term sustainability. This paper aims to explore the integration of multidimensional models and digital tools to enhance product innovation and transformation in large corporations based on the concepts discussed in [1], [2], [3]. By leveraging a multidimensional product-

concept model, the study examines the impact of technology, end-user experience, brand, and business strategy on cross-functional knowledge creation.

The multidimensional product-concept model provides a comprehensive framework for understanding the various dimensions that influence product innovation [4][5]. Technology, as a dimension, encompasses the technical capabilities and advancements that drive product development. End-user experience focuses on the needs, preferences, and behaviors of the target audience, ensuring that the product meets their expectations. Brand represents the identity and perception of the product in the market, while business logic involves the strategic and financial considerations that guide product innovation.

The application of this model is illustrated through a case study of the Automated Beverage Sealer [6]. This case study highlights the significant role of end-user experience in driving innovation. By considering the end-user's experience, the team was able to create a product that not only met the technical requirements but also provided a superior user experience. This case study underscores the importance of integrating various knowledge bases and the role of cross-functional collaboration in enhancing product innovation.

In addition to the multidimensional product-concept model, the paper examines the role of Product Innovation Strategy (PISs) Product Innovation Chapters (PICs) [7] in setting organizational goals, strategic direction, and resource allocation for new product portfolios. PISs serve as a blueprint for product innovation [8], [9], outlining the objectives, strategies, and resources required for successful product development. The findings suggest that highly innovative firms benefit from specific PIS content and a well-formulated PIS process, which positively influences new product performance. The specificity of PIS content ensures that the product innovation efforts are aligned with the organization's strategic goals, while the formulation process fosters collaboration and satisfaction among team members.

Furthermore, the study underscores the transformative impact of digital design and collaboration tools [10],[11] on the innovation process in new product development (NPD). Digital tools, such as CAD and collaborative information technology (CIT), have revolutionized the way products are designed, developed, and brought to market. These tools facilitate knowledge creation, accelerate problem-solving, and enable new configurations of people, teams, and firms. The use of digital tools enhances the efficiency and effectiveness of the innovation process, allowing organizations to respond quickly to market changes and customer demands.

However, the adoption of digital tools also presents challenges and opportunities. The need for new skills and competencies to effectively use these tools is a significant challenge for organizations. Additionally, the potential for tool switching costs, where the transition from one digital tool to another incurs costs and disruptions, must be carefully managed. Despite these challenges, the benefits of digital tools in enhancing product innovation and transformation far outweigh the drawbacks.

This research paper provides valuable insights for organizations aiming to enhance their product innovation capabilities through the strategic use of multidimensional models and digital tools. By integrating technology, end-user experience, brand, and business logic, and leveraging digital design and collaboration tools, organizations can drive product innovation and transformation, ensuring long-term success in a competitive market.

EXISTING KNOWLEDGE AND NEW THEORY DEVELOPMENT

The product innovation and transformation underscores the critical role of cross-functional knowledge gathering and the transformative impact of digital tools in enhancing the innovation process [7] [12]. Recent studies have shown that the integration of digital tools has fundamentally changed how teams collaborate and innovate [12]. This section delves into various dimensions of product innovation, including technology, end-user experience, brand, and business logic, and examines the role of Product Innovation Strategy (PISs) and digital tools in driving successful product development.

A. Multidimensional Product-Concept Model [1]

The multidimensional product-concept model provides a comprehensive framework for understanding the various dimensions that influence product innovation. This model encompasses four key dimensions: technology, end-user experience, brand, and business logic. Each dimension plays a crucial role in shaping the innovation process and determining the success of new products.

PRODUCT	Name, type number, nickname
TECHNOLOGY	– Underlying technologies
-Technical solution	– What solutions do the technologies offer?
-Features-main functions	– What critical features do the technologies offer?
-Unique selling proposal	– What are the added value functions?
	– Is there a single unique benefit?
END-USER	– Personality, profession, hobbies, consumerism
-Ethnology	– Real-world behavioural patterns in brief
-Usage context	– How is the product really used?
-Needed value	– Which customer needs does the product satisfy?
-Customer's experience about the product, in their own words	– "What is my experience of using the product?"
BRAND	
-Promise of value	-Nature of expectations, e.g. from the brand slogan
-Values	-Brand's main values
-Brand characters	-Concretely verifiable characters
-Design hardware	-Brand indicators of form of the product
-Design software	-Software's brand characters
-Surprise	-Something unexpected
BUSINESS LOGIC	
	-Key drivers of profit flow
	-Solutions to the barriers of profit flow

Figure 1: The Four-Dimensional Product-Concept Model [1]

- **Technology [1]**

Technology is a fundamental driver of product innovation [4]. It encompasses the technical capabilities and advancements that enable the development of new products and the enhancement of existing ones. Technological innovation can take various forms, including the introduction of new materials, the development of advanced manufacturing processes, and the integration of cutting-edge software and hardware components. The literature highlights the importance of leveraging technological advancements to create products that offer superior performance, functionality, and user experience.

- **End-User Experience**

End-user experience is a critical dimension [5], [2] of the multidimensional product-concept model. It focuses on understanding the needs, preferences, and behaviors of the target audience to ensure that the product meets their expectations. The literature emphasizes the importance of adopting a user-centered design approach, which involves engaging end-users throughout the product development process to gather feedback and insights. This approach helps to create products that are not only technically advanced but also user-friendly and intuitive.

- **Brand [1]**

Brand represents the identity and perception of the product in the market. It encompasses various elements, including the product's name, logo, packaging, and marketing messages. A strong brand can differentiate a product from its competitors and create a lasting impression in the minds of consumers. The literature highlights the importance of building a strong brand that resonates with the target audience and aligns with the company's overall brand strategy.

- **Business Logic [1]**

Business logic involves the strategic and financial considerations that guide product innovation. It includes factors such as market analysis, competitive positioning, pricing strategy, and revenue models. The literature underscores the importance of aligning product innovation efforts with the company's strategic goals and

ensuring that the product is financially viable. This dimension also involves identifying and mitigating potential risks associated with product development and market entry.

B. Product Innovation Strategy (PISs)

Product Innovation Strategy (PISs) serve as a blueprint for product innovation [8], outlining the objectives, strategies, and resources required for successful product development. The literature on PISs highlights their role in setting organizational goals, strategic direction, and resource allocation for new product portfolios. Highly innovative firms benefit from specific PIS content and a well-formulated PIS process, which positively influences new product performance. Study has shown that the content and process of product innovation charters significantly impact performance outcomes [7], [13]. Studies indicate that organizations with well-defined product innovation strategies and portfolio management processes consistently outperform their peers [13], [14].

• Specificity of PIS Content

The specificity of PIS content is crucial for aligning product innovation efforts with the organization's strategic goals [7], [15]. Detailed PISs provide clear guidance on the product's objectives, target market, key features, and performance metrics [15]. The literature suggests that highly innovative firms develop PISs with specific content that addresses the unique needs and challenges of the product development process [16]. This specificity helps to ensure that all stakeholders are on the same page and working towards a common goal.

• PIS Formulation Process

The formulation process of PISs plays a significant role [9] in fostering collaboration and satisfaction among team members. The literature emphasizes the importance of involving cross-functional teams in the PIS formulation process to gather diverse perspectives and insights. This collaborative approach helps to identify potential risks and opportunities early in the development process and ensures that the PIS is comprehensive and well-rounded. The findings suggest that a well-formulated PIS process positively influences new product performance by fostering a sense of ownership and commitment among team members.

C. Digital Tools in New Product Development (NPD)

Digital tools have revolutionized the innovation process in new product development (NPD) [10], [11]. This digital transformation of product development has fundamentally changed how teams work and collaborate [12]. These tools facilitate knowledge creation, accelerate problem-solving, and enable new configurations of people, teams, and firms. The literature highlights the transformative impact of digital design and collaboration tools, such as project management Software (PMS), Computer added Tools (CAD), and collaborative information technology (CIT), on the innovation process.

• Computer-Aided Design (CAD)

Computer-Aided Design (CAD) tools have become indispensable in the product development process. CAD tools enable designers and engineers to create detailed 3D models of products, simulate their performance, and make iterative improvements. The literature highlights the benefits of CAD tools in enhancing the accuracy and efficiency of the design process, reducing the time and cost associated with physical prototyping, and enabling rapid iteration and refinement of product concepts.

• Project Management Software (PMS)

Studies have shown that the adoption of digital project management tools has led to significant improvements in project outcomes and team coordination [12]. These improvements are particularly evident in cross-functional teams where traditional coordination mechanisms were less effective [7], [14]. These tools enable teams to plan, execute, and monitor projects efficiently. Project management software provides features such as task assignment, timeline tracking, resource allocation, and progress reporting. benefits of project management software in enhancing the coordination and efficiency of the development process, reducing the time and cost associated with project management, and enabling rapid iteration and refinement of project plans.

- **Collaborative Information Technology (CIT)**

Collaborative Information Technology (CIT) tools facilitate communication and collaboration among cross-functional teams. These tools enable team members to share information, collaborate on design and development tasks, and track project progress in real-time. The literature underscores the importance of CIT tools in enhancing cross-functional knowledge creation, improving decision-making, and fostering a culture of collaboration and innovation. CIT tools also enable organizations to leverage the expertise of geographically dispersed teams, leading to more diverse and innovative solutions.

D. Challenges and Opportunities

The adoption of digital tools presents both challenges and opportunities for organizations. The literature highlights the need for new skills and competencies to effectively use these tools. Organizations must invest in training and development programs to equip their employees with the necessary skills to leverage digital tools effectively. Additionally, the potential for tool switching costs, where the transition from one digital tool to another incurs costs and disruptions, must be carefully managed. Despite these challenges, the benefits of digital tools in enhancing product innovation and transformation far outweigh the drawbacks.

METHODOLOGY

The research methodology for this study involves a comprehensive case study approach, focusing on the Foodservice Automated Beverage Sealing Machine initiative at a large food service company. This approach allows for an in-depth examination of the application of the multidimensional product-concept model and the role of digital tools in enhancing product innovation and business transformation. The case study is particularly aimed to provide a detailed understanding of the processes, challenges, and outcomes associated with the initiative.

The research method involves only Qualitative analysis based on the interactions, observation, documents and the process followed during the initiative execution. The information is then systematically evaluated and understood to cross reference with the multidimensional factors. Then an internal validation on the acceptance and reliability on the information and conclusion is conducted. The complete information on the internal validation and not shared due to confidentiality.

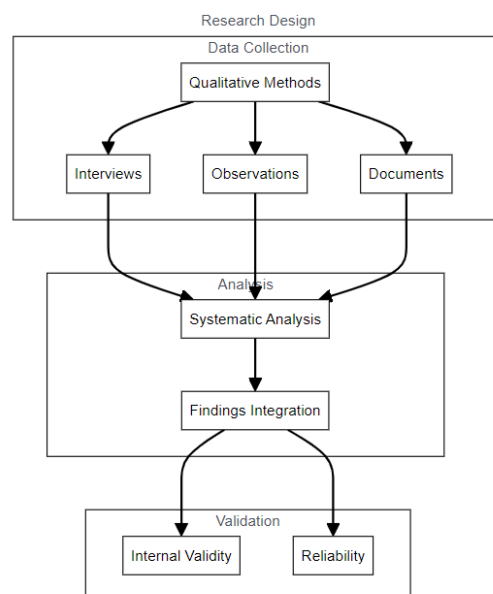


Figure 2: Research Method

Data collection for the case study included first-hand experience leading the initiative and interactions with the

key stakeholders, analysis of project documents, and observation of project activities []. The experience and interactions provide insights into the experiences and perspectives of the stakeholders involved in the transformation initiative. These stakeholders include senior leadership, engineers, industrial designers, manufacturing, supply chain, sales, finance and end-users who have been directly involved in the development and implementation of the Foodservice Automated Beverage Sealing Machine. Based on the execution for over 2 years on the complete platform development, interactions allowed for flexibility in exploring various aspects of the initiative while ensuring that key topics are covered.

The analysis of project documents helps to understand the objectives, strategies, and outcomes of the initiative. These documents include project plans, design specifications, meeting minutes, progress reports, and performance metrics. By examining these documents, the research can identify the key milestones, decision points, and challenges encountered during the project. This analysis also provides a comprehensive overview of the project's scope, timeline, and resource allocation.

Observing and leading the project activities allowed for a firsthand understanding of the processes and practices involved in the transformation initiative. This includes leading and observing design and development meetings, testing and validation sessions, and user feedback sessions. By leading the team it provided the research on the experimentation of different collaborative dynamics, problem-solving approaches, and iterative processes that characterize the project and gain relative insights. This observational data complements the information obtained from interactions, personal experience and document analysis, providing a holistic view of the initiative.

CASE STUDY: FOODSERVICE AUTOMATED BEVERAGE SEALING MACHINE INITIATIVE

The Foodservice Automated Beverage Sealing Machine initiative at a large Foodservice company represents a significant effort to enhance product innovation and business transformation through the application of multidimensional models and digital tools. This case study provides a detailed examination of the processes, challenges, and outcomes associated with the initiative, highlighting the role of human-centered design, business architecture, and digital tools in driving successful product development.

A. Background and Objectives

The Foodservice Automated Beverage Sealing Machine initiative was launched with the objective of developing a state-of-the-art sealing machine that could improve efficiency, reduce order errors, and enhance the overall user experience in the Quick Service Restaurants (QSR). The main aim of the product is to reduce the use of plastic and support the organizational sustainability journey while increasing operational efficiency and optimizing storage. The project also aimed to address several other challenges, including the need for faster and more accurate sealing processes, the reduction of manual labor, and the minimization of order errors. By leveraging advanced technologies and innovative design approaches, the initiative sought to create a product that could meet the evolving needs of the market and provide a competitive advantage for the company. It also aimed at providing IoT based insights and remote diagnostics and firmware updates.

B. Multidimensional Product Concept [1]

The Product design met all the four dimensions of the model expect the business logic. While the product utilized the all the aspects of technological evolution and meeting the end user needs and behavior creating a customer delight and value. The established brand value of the existing company and customer loyalty made it easy for the customers to connect with the product and believe in the success, however there is also a segment of customers that treat the existing brand as a non-technical brand and lost the confidence on the innovation. Marketing team and sales team ran relatively higher campaigns to sets this brand view to align with the disruptive innovation. The biggest failure is alignment with the long-term strategy of the business, the product had a better business case to be successful as a individual product generating huge revenue meeting the short-term goals but failing with its alignment with the long-term strategy and direction of the or-

ganization.

C. Human-Centered Design and Business Architecture

The initiative adopted a human-centered design approach to ensure that the product met the needs and preferences of end-users. This approach involved engaging end-users throughout the product development process to gather feedback and insights. User research activities, such as interviews, surveys, and usability testing, were conducted to understand the pain points, requirements, and expectations of the target audience. The insights gained from these activities informed the design and development of the Foodservice Automated Beverage Sealing Machine, ensuring that it provided a superior user experience.

In addition to human-centered design, the initiative also applied business architecture principles to define product and service portfolios, identify capability gaps, plan future developments, and prioritize initiatives. Business architecture provided a structured framework for aligning the product development efforts with the strategic goals of the organization. It helped to ensure that the product was not only technically advanced but also aligned with the business objectives and future industrial opportunities.

D. Collaboration and Cross-Functional Teams

The success or failure of the Foodservice Automated Beverage Sealing Machine initiative was largely attributed to the collaboration and cross-functional teamwork that characterized the project. The initiative involved collaboration across various capabilities from supply chain to customer service and engineering to marketing and sales. Cross-functional teams, comprising engineers, designers, project managers, Category managers, senior leaders and end-users, worked together to address the challenges and achieve the project objectives.

Regular meetings, workshops, and brainstorming sessions were conducted to facilitate communication and collaboration among team members. These activities helped to foster a culture of innovation and continuous improvement, enabling the team to identify and address issues promptly. The team was divided based on the comparative advantage to streamline communication and increase efficiency in information sharing. The use of collaborative information technology (CIT) tools such as team's structure with specific communication channels that support file sharing further enhanced the communication and coordination among team members, allowing them to share information, collaborate on design and development tasks, and track project progress in real-time.

E. Tools and Technologies

Digital tools and technologies played a crucial role in the development and implementation of the Foodservice Automated Beverage Sealing Machine. The initiative leveraged various digital design and collaboration tools to enhance the efficiency and effectiveness of the product development process. These tools included project management software (PMS) and collaborative information technology (CIT) tools. Additionally the digital emerging technologies likes IoT helped to advance the functionality of the product.

Project management software(PMS) enabled the team to plan, execute, and monitor the project efficiently. These tools provided features such as task assignment, timeline tracking, resource allocation, and progress reporting, enabling the team to manage the project effectively. This system also helped the team members to understand the expectations from them and request any support needed to overcome the challenges. CIT tools facilitated communication and collaboration among cross-functional teams, enhancing cross-functional knowledge creation, improving decision-making, and fostering a culture of collaboration and innovation.

TABLE DIGITAL TOOLS AND SOFTWARE EXAMPLES

Purpose	Tool / Software
Communication Tools	Microsoft Outlook, Teams
Product Design And Analysis	ANSYS, SolidWorks, Altium
Project Management	Microsoft Project, Teams, Planner, OneNote

Purpose	Tool / Software
Product Data And Knowledge Management	Internal SharePoint site and drive

F. Achievements and Impact

The Foodservice Automated Beverage Sealing Machine initiative achieved several key milestones and delivered significant benefits for the company. One of the key achievements of the initiative was the change in its traditional business model and opening to see the new digital business strategies. The change in this mindset challenged the leadership team to strategically align with the changing expectations in the market. The initiative also optimized processes to reduce friction involved in developing the disrupting product that not only changes the organization reputation but also changes the way it operates with its customers.

The initiative's emphasis on human-centered design and business architecture ensured that the product met the needs and preferences of end-users, providing a superior user experience. The use of digital tools and technologies enhanced the efficiency and effectiveness of the product development process, enabling the team to respond quickly to market changes and customer demands. The collaboration and cross-functional teamwork that characterized the project fostered a culture of innovation and continuous improvement, contributing to the overall success of the initiative.

G. Challenges and Lessons Learned

The Foodservice Automated Beverage Sealing Machine initiative also encountered several challenges that provided valuable lessons for future projects. One of the key challenges was the need for new skills and competencies to effectively use digital tools and technologies. The initiative highlighted the importance of investing in training and development programs to equip team members with the necessary skills to leverage digital tools effectively.

Another challenge was the change management needed to influence and align senior leaders to understand the new changing market expectations and pivoting organization strategy to meet it. This came with the heavy lift of understanding the organizational core competencies and its capabilities and challenging them to change their operations to support the new and technologically advanced products. For instance, the Customer service process supporting the traditional business was completely reinvented to support the new disruptive methods. Additionally, the potential for tool switching costs, where the transition from one digital tool to another incurred costs and disruptions. The initiative underscored the need for careful planning and management of tool transitions to minimize disruptions and ensure a smooth transition.

The Automated Beverage sealing machine failed to incorporate the business strategy at higher level and consider the opportunity cost it was losing in pivoting the organization to a niche segment. This led to the misalignment of leadership and the aligned business strategy that the organization considered its future state. This may lead to the downfall of the equipment for the larger organization as the smaller organizations have less to worry about the opportunity cost. The need for fostering the innovation and entrepreneurial mindset in the organizations is challenging and needs different strategies like cross-capability mentorship, talent network teams, etc.

Despite these challenges, the benefits of digital tools in enhancing product innovation and transformation far outweighed the drawbacks. The initiative demonstrated the importance of adopting a multidimensional approach to product innovation, considering various dimensions such as technology, end-user experience, brand, and business logic. It also highlighted the transformative impact of digital tools and the importance of collaboration and cross-functional teamwork in driving successful product development.

DISCUSSION

The findings from the case study of the Foodservice Automated Beverage Sealing Machine initiative provide valuable insights into the integration of multidimensional models and digital tools in enhancing product innovation and business strategy transformation. This section discusses the key themes and implications of the

case study, highlighting the importance of considering various dimensions in the product innovation process and the transformative impact of digital tools.

The case study highlights the importance of adopting a multidimensional approach to product innovation. By considering various dimensions such as technology, end-user experience, brand, and business strategy, the initiative was able to create a product that not only met the technical requirements but also provided a superior user experience. This approach ensured that the product was aligned with the strategic goals of the organization and addressed the needs and preferences of the target audience. However the misalignment with the higher business strategy and future goals of the organizations are challenging to understand as they continue to change with market conditions.

The integration of human-centered design and business architecture principles played a crucial role in the success of the initiative. Human-centered design ensured that the product development process was guided by the needs and preferences of end-users, while business architecture provided a structured framework for aligning the product development efforts with the strategic goals of the organization. This combination of approaches helped to create a product that was both technically advanced and aligned with the business objectives and market opportunities.

The case study highlights the transformative impact of digital tools in enhancing the product innovation process. The use of project management software and collaborative information technology (CIT) tools facilitated communication and collaboration among cross-functional teams, enhancing cross-functional knowledge creation, improving decision-making, and fostering a culture of collaboration and innovation. Project management software enabled the team to plan, execute, and monitor the project efficiently, providing features such as task assignment, timeline tracking, resource allocation, and progress reporting. CIT tools facilitated communication and collaboration among team members, allowing them to share information, collaborate on design and development tasks, and track project progress in real-time. These tools enabled the team to leverage the expertise of geographically dispersed teams, leading to more diverse and innovative solutions.

The success of the Foodservice Automated Beverage Sealing Machine initiative was largely attributed to the collaboration and cross-functional teamwork that characterized the project. The initiative also encountered several challenges that provided valuable lessons for future projects. One of the key challenges was the need for new skills and competencies to effectively use digital tools and technologies. The initiative highlighted the importance of investing in training and development programs to equip team members with the necessary skills to leverage digital tools effectively. Another challenge was the potential for tool switching costs, where the transition from one digital tool to another incurred costs and disruptions. The initiative underscored the need for careful planning and management of tool transitions to minimize disruptions and ensure a smooth transition. Despite these challenges, the benefits of digital tools in enhancing product innovation and transformation far outweighed the drawbacks.

CONCLUSION

the case study of the Foodservice Automated Beverage Sealing Machine initiative provides valuable insights into the integration of multidimensional models and digital tools in enhancing product innovation and transformation. The initiative's emphasis on human-centered design, business architecture, and digital tools ensured that the product met the needs and preferences of end-users, provided a superior user experience, and delivered significant benefits for the organization. The collaboration and cross-functional teamwork that characterized the project fostered a culture of innovation and continuous improvement, contributing to the overall success of the initiative. This case study highlights the importance of adopting a multidimensional approach to product innovation and leveraging digital tools to enhance the efficiency and effectiveness of the product innovation process while justifying the need to manage the business strategy transformation to support

the disruptive product innovation. It also highlights the need to align leadership and transform capabilities to support the disruptive innovation.

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