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Technological and Managerial Aspects in Context of Business-Process Management and Optimization

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Abstract. This article presents an original business-process-management (BPM) approach that integrates modern information technologies with managerial methods to enhance operational agility and organizational adaptability in a dynamic environment. The findings indicated that a harmonious integration of diverse information technologies with managerial methods significantly improved the execution of processes and enhanced organizational efficiency in achieving strategic objectives. A two-stage analysis was conducted, including a detailed review of key tools and strategies that supported essential business processes such as production, distribution, customer service, and order processing. Subsequently, the interdependencies among these processes were assessed, thus analyzing their impacts on operational flexibility and fluidity. The results suggested that an integrated approach that combines modern information technologies with managerial methods leads to significant improvements in performance, shorter lead times, optimized resource utilization, and faster responses to changing market demands. This study provides practical insights for those organizations that seek to maximize the benefits of digitalization and implement proven managerial methods to improve operational outcomes and achieve sustainable competitive advantages amid increasing competition and dynamic market changes.

Keywords: business-process management (BPM), process optimization, technology integration, operational efficiency

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1. INTRODUCTION

This study aims to present the results of analyses that assessed how an integrated approach that combined modern information (digital) technologies with managerial and business-process-optimization methods supported the growth of organizational efficiency and adaptability. Companies must effectively integrate information technologies with process-management methods in today's dynamic business environment; such an approach allows them to meet the increasing demands for quality, flexibility, and speed in their business processes. Previous studies have typically focused on examining these elements separately, highlighting the need for a more comprehensive perspective (Fischer, 2010; Rosemann & vom Brocke, 2015).

The analysis centered on key organizational business processes, including production, distribution, customer service, and order processing; it focused on integrating technology and managerial methods within BPM. The objective was to determine which combination of information technologies and organizational practices brought the most substantial process-optimization benefits. Particular attention was paid to how these solutions could be effectively implemented in enterprises in order to maximize their operational efficiency and enhance their organizational flexibility in adapting to dynamic market demands and customer expectations (Hammer, 2015).

The findings provided practical insights into effectively combining advanced technologies with managerial methods in order to optimize key processes and gain competitive advantages. These strategies can be applied across various sectors for enhancing operational efficiency, reducing process lead times, and improving resource allocation. Furthermore, integrating technology with management facilitates smoother innovation implementation, significantly strengthening an organization's ability to maintain competitiveness and respond swiftly to emerging market challenges and opportunities (vom Brocke & Mendling, 2018; Mendling et al., 2010).

2. LITERATURE REVIEW

Previous studies on business-process management (BPM) have often focused on information technologies and managerial methods separately, thus limiting a complete understanding of the benefits of their combined application. Literature reviews indicated that information technologies can significantly enhance monitoring, control, and data analysis, which are essential for making sound operational decisions. Concurrently, research on process-improvement methodologies highlighted their role in waste elimination, process stabilization, and the implementation of the continuous improvement strategies that form the foundation of operational efficiency (Attaran, 2003).

Further studies are needed to highlight the impact of integrating digital solutions and managerial methods on optimizing production, logistics, customer service, and order processing – especially amid evolving market conditions. Most research has focused on either a technological or managerial aspect rather than their interplay, which could drive broader operational transformation (Maull et al., 2003; Röglinger et al., 2012).

Analyses related to change and risk management within the BPM framework also suggested a more integrated approach to process optimization. However, there remains a shortage of detailed studies that have illustrated how modern information technologies and managerial methods can jointly support an organization's adaptability under rapidly changing market conditions. This study addresses this gap by providing evidence that integrating digital tools with managerial practices significantly enhances an organization's process adaptability and flexibility, minimizes its operational risk, and strengthens its ability to respond dynamically to environmental changes (Dumas et al., 2018; Fettke & Loos, 2007; Maull et al., 2003).

3. RESEARCH METHODOLOGY

This study employed a two-stage analytical approach to evaluate how integrating modern information technologies and managerial methods impacted the operational efficiency of enterprises. The methodology included a literature review, empirical observations in an automotive company, and a theoretical assessment of the interactions between these two elements.

The research aimed to understand how combining information technologies (e.g., ERP, MES, IoT systems) with managerial methods such as lean, Six Sigma, and the Theory of Constraints contributed to optimizing key business processes (including production, logistics, customer service, and order management). Previous studies have often focused on these elements separately, leaving a gap in exploring their combined effects. This led to the central question: **"How can integrating information technologies and managerial methods optimize business processes and enhance flexibility under dynamic market conditions?"**

Optimization is defined through the following three criteria:

1) **efficiency** – reducing process-execution time and maximizing resource utilization;
2) **quality** – improving process accuracy, consistency, and compliance with customer requirements;
3) **flexibility** – enabling rapid adaptation to market changes and specific customer needs.

Stage 1: Literature Review

The first stage involved reviewing the existing research in order to identify the widely used information technologies (e.g., ERP, MES, IoT) and managerial methods (e.g., lean, Six Sigma). The review also revealed gaps in the understanding of their combined use for process optimization.

Stage 2: Observations and Analysis

The second stage included observations in an automotive company that focused on processes like production, logistics, and order management. These observations analyzed the following areas:

- implementations of information technologies (such as MES and IoT systems);
- applications of managerial methods (such as lean and Six Sigma) in operational environments;
- interactions between these tools and methods in achieving process optimization.

A theoretical analysis further supported these observations to evaluate how integrating information technologies with managerial methods enhanced process stability, flexibility, and overall efficiency (Gadatsch, 2023; Harmon, 2019; Škrinjar et al., 2008; Zebec & Indihar Štemberger, 2024).

4. RESULTS

This section analyzes the key interdependencies between technological solutions and managerial methods in production, distribution, customer service, and order processing. The study identifies how advanced digital tools and process-management strategies support optimization and operational efficiency. The findings illustrate how combining information technologies (such as comprehensive resource-management systems, process monitoring, and customer relationship management) with optimization methods (including continuous improvement and agile approaches) can enhance operational efficiency and increase organizational flexibility. The following sections describe the nature of these interdependencies and their impacts on the efficiency of specific processes within the studied context (van der Aalst, 2013; Niederman, 2021; Rudolf & Roszak, 2024).

4.1. Process: order intake

In the order-intake process (Table 1), integrating information technologies and managerial methods facilitates smooth, fast, and compliant order fulfillment, thus enhancing customer satisfaction and operational stability. E-commerce systems that consolidate orders from various sales channels support the optimization of the intake process by centralizing transaction data; this enables quick access to critical information and efficient order management, thus eliminating delays and minimizing the risk of discrepancies in fulfillment. Managing this process in alignment with customer expectations strengthens an organization's competitiveness.

Simultaneously, return-merchandise-authorization (RMA) systems streamline the return process, thus helping to manage customer expectations. The quick and efficient handling of returns eliminates potential disputes between an organization and its customers, thus fostering long-term relationships and trust. Integrating e-signature technology accelerates document verification and approval, supports compliance management, and removes the need for manual signatures. This reduces order-processing times and prevents delays at every stage of order fulfillment; this is crucial in a rapidly changing business environment where customers expect flawless and timely service.

Used for demand forecasting, predictive analytics is a key tool in order management; it enables anticipations of market changes and adjustments of operational plans to one's current needs. This allows companies to plan their resources better and respond to their customer demands, thus minimizing the risk of stockouts or excess inventory (thereby, reducing operational costs). Such precision in resource planning enhances order handling and increases customer service flexibility.

Table 1. *Technological and managerial aspects for order-intake process*

Technological aspects	Managerial aspects
E-commerce System Order Integration Centralized order-management across multiple sales channels for improved order-cycle efficiency	**Order-Cycle Optimization** Streamlining order-fulfillment process to reduce delays and minimize errors
RMA Systems Return-Merchandise Authorization Automated handling of returns for efficient resolutions and tracking of customer requests	**Customer-Expectation Management** Meeting customer service expectations through transparent, reliable return processes
E-signature Document Verification and Approval Fast and secure digital document signing to reduce processing time and ensure compliance	**Order-Process Management** Adapting order handling based on demand forecasts to optimize resource allocation and scheduling
Predictive Analytics – Demand Forecasting Data-driven forecasting to adjust resources and reduce stockouts or overstock situations	**Total Productive Maintenance (TPM)** Maximizing uptime and asset reliability
Electronic Document Workflow System Automated document flow and centralization for streamlined processing and risk control	**Risk-Management Strategy** Reducing operational risks through accurate documentation and tracking of order-related activities

Source: own elaboration based on Fettke & Loos (2007)

An electronic document-management system centralizes documentation processing, thus supporting an organization's risk-management strategy; this provides a comprehensive oversight of its documentation, allowing for the swift identifications and resolutions of potential compliance issues. This holistic approach to document management is critical in risk management, as it helps to prevent errors due to outdated or incomplete information. Consequently, effectively linking information technologies with managerial processes in the order-intake cycle enhances control over the order cycle, boosts operational efficiency, and fosters positive customer relationships.

4.2. Process: production

In the production process (Table 2), integrating information technologies and managerial methods plays a crucial role; they mutually complement each other to form a foundation for enhancing operational efficiency and flexibility. Particularly, manufacturing-execution systems (MES) align with lean-manufacturing principles, thus enabling waste elimination through the real-time monitoring of key performance indicators such as production-cycle times, machine utilization, and product quality. MES provides detailed data on current operations, thus allowing for the rapid detections and immediate rectifications of inefficiencies. This aligns with lean principles, thus prioritizing a minimization of waste and a maximization of value-added activities.

Table 2. *Technological and managerial aspects for production process*

Technological aspects	Managerial aspects
MES – Manufacturing Execution Systems Real-time control and quality monitoring	**Lean Manufacturing** Eliminating waste to improve efficiency
ERP – Enterprise Resource Planning Comprehensive resource and process integration	**Six Sigma** Reducing defects and process variability
IoT – Internet of Things Continuous machine-condition and -process monitoring	**Theory of Constraints** Identifying and managing bottlenecks
RPA – Robotic-Process Automation Automating high-frequency manual tasks	**Total Productive Maintenance (TPM)** Maximizing uptime and asset reliability
CAD/CAM Computer-aided design/manufacturing efficient prototyping and design	**Agile Manufacturing** Rapid, flexible production adaptations

Source: own elaboration based on Attaran (2003) and Dumas et al. (2018)

An example of this integration is the collaboration between enterprise-resource-planning (ERP) systems and Six Sigma methodologies. ERP systems streamline resource management and improve information flow, which Six Sigma requires for process stability. The quick access to resource- and process-status data facilitates effective control of variability and continuous quality improvement, supporting Six Sigma's goal of reducing defects and deviations in production.

The Internet of Things (IoT) and the theory of constraints (TOC) form a powerful combination for effectively identifying and managing bottlenecks in production. Through the real-time monitoring of machine and process conditions, IoT provides critical insights into potential downtimes or performance issues. When combined with TOC (which optimizes throughput by managing constraints), this enables prompt responses to identified problems, maximizing productivity and minimizing downtimes.

Robotic process automation (RPA) and total productive maintenance (TPM) work together to enhance operational stability and reduce downtimes. RPA automates repetitive labor-intensive tasks, thus freeing up human resources and speeding up routine activities; this supports TPM by making maintenance more systematic. TPM engages one's personnel in autonomous maintenance activities, thus reducing machine downtime. Together, RPA and TPM improve machine availability and reliability.

CAD/CAM (computer-aided design/manufacturing) systems support agile manufacturing by enabling the rapid design and production of prototypes, which is crucial for agile-production methods. These systems allow designers and engineers to quickly test and implement changes without delays, thus aligning with agile principles and emphasizing swift adaptations to market needs. CAD/CAM systems and agile manufacturing shorten production cycles, provide flexibility in responding to changes, and enhance competitiveness and customer satisfaction.

4.3. Process: distribution

In the distribution process (Table 3), the synergistic integration of information technologies and managerial methods is crucial for achieving operational efficiency and ensuring one's continuity of supplies. Radio-frequency-identification (RFID) technology enables real-time product tracking, which enhances supply-chain management (SCM) by increasing inventory visibility. This improved visibility allows for the better coordination of deliveries and prevents potential disruptions that are caused by stock shortages. When supported by RFID, SCM facilitates a smoother flow of goods and helps maintain optimal inventory levels that adapt to changing demands.

Predictive analytics systems forecast changes in demand, thus enabling dynamic inventory management. By leveraging data-driven predictions, companies can adjust their stock levels to anticipated needs, thus reducing the risk of overstocking and stockouts. Inventory management based on predictive analytics allows for better planning and flexibility in warehouse operations.

Automated guided vehicles (AGVs) support internal logistics by automating the movements of goods between warehouse sections and production facilities, thus facilitating process modeling and execution. This automation optimizes resource allocations and streamlines material flow, thus eliminating unnecessary downtime. Integrating AGVs with material-flow processes enhances an organization and the efficiency of its internal logistics, thus leading to the better utilization of production resources.

Table 3. *Technological and managerial aspects for order-distribution process*

Technological aspects	Managerial aspects
RFID – Product Identification and Tracking Real-time tracking to enhance stock control	**Supply-Chain Management (SCM)** Streamlining flow and reducing inventory gaps
Predictive Analytics Systems Forecasting demand to optimize inventory levels	**Inventory Management** Adjusting stock based on demand predictions
AGVs Automated Guided Vehicles Internal Logistics Automated transport for efficient resource flow	**Process Modeling** Optimizing resource flow for better efficiency
TMS Transportation-Management Systems Coordinating transport for timely cost-effective delivery	**Logistics Strategy** Aligning transport with organizational goals
Blockchain Data Security and Batch Tracking Secure tracking across supply-chain stages	**Supplier-Relationship Management** Ensuring transparency and trust in transactions

Source: own elaboration based on Zebec & Indihar Štemberger (2024)

Transportation-management systems (TMSs) are crucial for managing transportation and delivery schedules and supporting an organization's logistics strategy. By coordinating routes and delivery timings, TMS ensures efficient and timely distribution that is aligned with one's organizational goals. This strategic approach optimizes transportation costs and ensures predictable deliveries, thus enhancing customer satisfaction.

Blockchain technology enables the secure tracking of product batches throughout a supply chain, thus supporting supplier-relationship management. It ensures transaction transparency and information clarity, which are key to building trust and sustainable relationships with one's business partners. Integrating blockchain technology with supplier management minimizes the risk of fraudulent practices and increases the overall stability of the supply chain.

4.4. Process: customer service

In customer service (Table 4), integrating information technologies and managerial methods enables the creation of consistent and personalized interactions, thus leading to positive customer experiences and loyalty. Unified communications (UC) systems integrate various communication channels – phone, email, and social media – thus supporting customer-experience management (CXM). CXM facilitates seamless and consistent interactions at every contact stage, thus ensuring that one's customers have easy access to the necessary information and responses regardless of the channel that is used.

Table 4. *Technological and managerial aspects for customer service process*

Technological aspects	Managerial aspects
UC Systems (Unified Communications) Integrates communication channels for cohesive client experience	**Customer-Experience Management (CXM)** Provides seamless interactions across multiple touchpoints
BI – Business Intelligence Data analysis for customer-behavior insights	**Personalization Strategy** Adapting services to individual customer needs
AI Chatbots 24/7 automated customer support	**Service-Quality Monitoring** Ensures timely and consistent responses
CMS – Content-Management Systems Efficient management of digital resources and client content	**Customer-Lifecycle Management** Consistent service across customer's journey
Emotion Recognition in Voice Analysis Detects customer sentiment for tailored service	**Customer-Satisfaction Management** Improves satisfaction by responding to emotional cues

Source: own elaboration based on van der Aalst (2013)

Business intelligence (BI) provides advanced analytics on customer behaviors and preferences, thus supporting personalization strategies. With BI insights, or-

ganizations can tailor their services to individual customer needs and expectations, thus enhancing engagement and offering well-suited solutions. When driven by BI, personalization increases service value and positively impacts customer satisfaction.

As a tool for automated customer service, AI chatbots enable prompt responses to customer inquiries anytime, thus enhancing service-quality monitoring. They provide consistent and quick answers to frequently asked questions, thus reducing wait times and improving user convenience. Simultaneously, monitoring one's service quality allows for the real-time evaluation of interaction effectiveness and the implementation of corrective actions should any issues arise.

Content-management systems (CMSs) ensure efficient digital content and resource management, thus supporting a customer's lifecycle and creating a cohesive experience throughout the customer's journey. CMS allows organizations to plan and execute communication strategies more effectively, thus fostering increased trust and lasting customer relationships.

Emotion-recognition systems in voice analysis represent an innovative tool for enhancing customer-satisfaction management. Organizations can tailor responses to better align with customer needs and moods by detecting any emotions that are expressed during interactions. When supported by emotion analysis, customer-satisfaction management enables quicker responses to potential dissatisfactions and helps take proactive steps to improve customer relationships.

5. DISCUSSION

The study found that the synergy between information technologies and managerial methods can potentially enhance operational efficiency and organizational flexibility. These conclusions were based on theoretical analyses and observations that were conducted in an automotive industry enterprise. Observations in the enterprise provided additional context, thus enabling the identification of the practical challenges that are associated with implementing technologies that support decision-making and management. However, further explorations of these findings require the collection of detailed empirical data in order to validate the effectiveness of the proposed solutions across various business environments (Martín-Navarro et al., 2023).

Future research can explore additional factors influencing the effectiveness of the proposed methods and refine the approach to enhance its applicability across different contexts:

- **Collecting Empirical Data** – one essential step for advancing research is gathering specific quantitative and qualitative data, including the following:
  - evaluating performance of business processes before and after implementing integrated technological and managerial solutions;
  - measuring impact of emerging technologies (such as MES or IoT systems) on key performance indicators (e.g., order-fulfilment time, forecast accuracy, and customer satisfaction);
  - conducting surveys and interviews with employees and managers to assess their perceptions of synergy between technology and management.

- **Industry-Specific Adaptations** – future research could examine integration of technologies and managerial methods in different sectors (such as pharmaceutical industry, energy, or e-commerce) to identify variations in their applications and effectiveness.
- **Long-Term Effects** – investigating impact of integrating technologies and managerial methods on operational stability, cost efficiency, and organization's ability to innovate over longer time horizon.
- **Exploring Emerging Technologies** – examining potential of artificial intelligence, blockchain, and predictive analytics in further enhancements of business-process-management practices.

6. SUMMARY

This study emphasizes the need for a balanced integration of information technologies and managerial methods for achieving sustainable improvements in business-process performance. Through a theoretical framework and real-world observations, the research highlights the opportunities that are created by this alignment. It sheds light on practical challenges such as adapting solutions to industry-specific requirements and ensuring organizational readiness for change.

The findings emphasize that organizations must adopt a multi-dimensional approach that combines technological advancements with well-established management strategies in a dynamic business environment. Only then can they effectively address evolving market needs while minimizing operational risks.

A significant contribution of this study lies in identifying the benefits of such an integration and in highlighting the challenges that are associated with its implementation, such as adapting technologies to specific industry needs or addressing the necessity for organizational culture changes.

The analyses that were presented in this work open up new perspectives for research in business-process management. Future efforts should focus on developing metrics that measure the effectiveness of integrating technologies and management methods across various sectors. Equally important is examining the long-term effects of this integration – particularly in the context of innovation, organizational resilience, and the management of complex operational environments.

In conclusion, this study provides theoretical foundations and practical insights for organizations that seek integrated approaches to business-process management. At the same time, it opens up new avenues for research, which can further enhance the understanding and utilization of contemporary technological tools and management methods.

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