SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 185

PAVING THE WAY FOR TOMORROW: THE EVOLUTION OF ERP AND BPMS SYSTEMS

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Purpose: This paper aims to assess the contemporary relevance of Enterprise Resource Planning (ERP) systems and Business Process Management Systems (BPMS) in the context of Industry 4.0 and Industry 5.0. The purpose is to investigate whether BPMS remains pertinent in the face of increasingly complex and diverse business processes, considering the overlapping functionalities with ERP systems.
Design/methodology/approach: This discussion paper employs a systematic theoretical literature review approach. The methodology integrates insights from existing research, conducting comprehensive searches across reputable academic databases, including Web of Science, Scopus, IEEE Xplore, ScienceDirect, and Google Scholar. Keyword searches yielded over 500 results, which were refined to 203 relevant articles through prioritizing peer-reviewed sources. The synthesis of literature includes an analysis of historical evolution and a comparative study of critical success factors, forming the basis for deriving potential future trajectories for these interconnected system classes, and emphasizing their strategic alignment.
Findings: This discussion paper presents an overview of the current state and future development trajectory of the two critical information systems (IS) classes for modern organizational management—ERP and BPMS—and compares the critical success factors (CSFs) associated with each system class. Based on this comparison, the paper determines the development direction of both system classes concerning business requirements.
Originality/value: Unlike prior literature which has examined ERP and BPMS systems individually, this study provides original perspectives by conducting a direct comparative analysis of the critical success factors for each system class. The comparative CSF analysis approach enables this study to contribute unique insights into the status and future trajectory of ERP and BPMS systems.

Keywords: Enterprise Resource Planning System (ERP), Business Process Management System (BPMS), Business Process Management Suite, Industry 4.0, Industry 5.0.

Category of the paper: Literature Review.

1. Introduction

Enterprise Resource Planning (ERP) and Business Process Management Systems (BPMS) enable organizations to operate efficiently (Davenport, 2018; Klaus et al., 2000). However, as these systems evolve, critical decisions arise regarding the implementation approach, integration architecture, and future trajectory (Esteves, Pastor, 2006; Shang, Seddon, 2002; Teltumbde, 2000).

ERP vendors must choose between building process capabilities natively or integrating with separate BPMS tools (Gartner, 2021a; Gartner, 2021b; Haddara, Elragal, 2015). Adopters must decide between process-centric ERP or flexible ERP-BPMS integration (Soh et al., 2000; Weske, 2012). These strategic decisions have long-term implications, necessitating substantial investments (Gable et al., 2003).

While frameworks like Enterprise Architecture (EA) and Digital Twin (DT) model technical integration, this paper uniquely analyzes ERP and BPMS systems from a business strategy lens. It asks, "Is the future better served by unified process-ERP systems or flexible ERP-BPMS integration?" (Dubey et al., 2019; Perboli et al., 2018; van der Aalst et al., 2016).

Rather than a technical focus, this study examines the alignment of ERP and BPMS's business objectives and critical success factors (CSFs) for implementation. By identifying CSFs from literature and comparative analysis, novel perspectives emerge on ERP and BPMS trajectories grounded in strategic requirements versus purely technical considerations (Asante et al., 2021; Szelągowski et al., 2022).

Critical Success Factors (CSFs) represent the key areas and activities that must be focused on to ensure the successful implementation and adoption of a technology or system. In the context of ERP and BPMS, CSFs reflect the vital organizational, managerial, strategic, and technological factors that determine the effective deployment of these systems. Clearly defining and understanding the CSFs enables organizations to allocate resources proactively and plan toward high-priority domains essential for successful implementation. Common CSFs include top management commitment, effective project management, user training and engagement, business-IT strategic alignment, and organizational cultural readiness. Operationalizing the CSFs with metrics and key performance indicators (KPIs) can further help organizations track progress on these fronts tangibly. For instance, KPIs like employee adoption rates, user satisfaction scores, process cycle time reduction, and system uptime and performance can quantify outcomes related to user engagement, change management, and technical robustness CSFs. The following sections will delve deeper into analyzing and comparing the specific CSFs for ERP and BPMS systems highlighted in scholarly literature.

ERP systems: The paper outlines the research methodology, reviews ERP and BPMS system evolution, compares CSFs, and concludes with recommendations based on the business-focused analysis. While technical integration frameworks exist, this strategic CSF approach provides unique insights into the current status and future direction of ERP and BPMS.

2. Methods

This discussion paper employs a systematic theoretical literature review approach to examine the evolution, current status, and future directions of ERP and BPMS systems. This methodology synthesizes findings from existing research to identify concepts, relationships, and patterns that can inform theoretical development (Pare et al., 2015; Webster, Watson, 2002).

The literature search utilized the following academic databases: Web of Science, Scopus, IEEE Xplore, ScienceDirect, and Google Scholar. Initial keyword searches were conducted using the terms "ERP system", "BPMS system", "BPM system", "workflow system", "critical success factors," and "system evolution". These searches yielded over 500 results published over the past 20 years.

The results were further refined by limiting to peer-reviewed conference proceedings and journal articles published in relevant disciplines, including information systems, business process management, operations management, and supply chain management. Priority was given to studies published in highly cited journals. In total, 203 relevant articles were identified for inclusion in the analysis.

Literature was synthesized to develop an understanding of the evolution of ERP and BPMS systems over time. Additionally, scholarly research on critical success factors (CSFs) for ERP and BPMS implementation was compiled and systematically compared. This comparison provides the basis for deducing the potential future trajectories of these interconnected system classes based on their strategic alignment.

The following sections outline the historical development progression of ERP and BPMS, followed by a comparative CSF analysis. Finally, conclusions are presented on the likely future direction and integration possibilities for ERP and BPMS centered on meeting business objectives. The CSF analysis provides a unique perspective grounded in strategic business factors rather than technical considerations alone.

While contemporary technical paradigms like Enterprise Architecture (EA) and Digital Twin (DT) model the integration of ERP and BPMS from an architectural perspective, this research maintains a focus on comparative analysis of the critical success factors (CSFs). The study acknowledges that frameworks like EA and DT provide valuable insights into the technical dynamics and integration considerations for ERP and BPMS systems. However, a strategic evaluation of the alignment in ERP and BPMS's business objectives, as represented through their shared CSFs, can offer complementary perspectives to guide integration decisions. The CSF lens illuminates core areas organizations must focus on for implementation success, irrespective of technical approach. Thus, this research puts forth the CSF analysis as a novel, business-strategy-oriented perspective, while acknowledging the technical insights offered by integration frameworks like EA and DT.

3. Enterprise Resources Planning Systems

The evolution of ERP systems started in the 1960s and 1970s and can be presented in five stages (Figure 1).

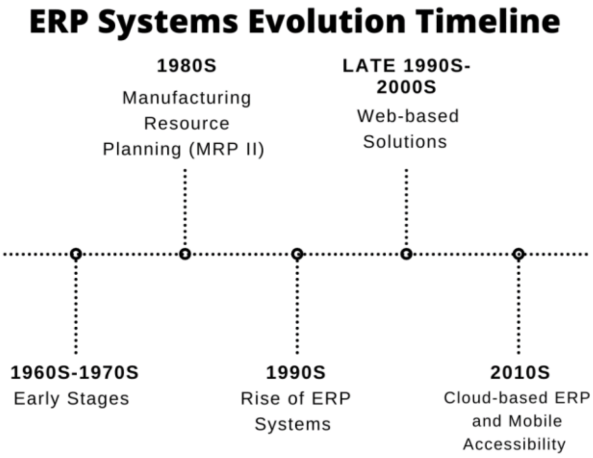

Figure 1. The evolution of ERP systems.

The evolution diagrams drawn in Figures 1 and 2 aim to provide a high-level historical overview of the development progression of ERP and BPMS systems over time. However, it is acknowledged that these simple linear diagrams have limitations in capturing the nuances and architectural details underpinning each phase. The diagrams serve as a starting point to orient the reader on the eras and driving forces that shaped the advancement of ERP and BPMS systems. However, they do not delineate the specific technological shifts or integration architectures that characterized each era. As such, while providing a historical context, the diagrams necessarily simplify the technical complexities and modular capabilities added during each period of evolution. The narrative in the following sections will dive deeper into the technical factors and integration possibilities shaping ERP and BPMS systems' ongoing advancement.

- 1960s-1970s: Early Stages - The foundations of ERP systems were laid during this period with the emergence of inventory management and control systems. These early systems focused on tracking inventory and managing material requirements.
- 1980s: Manufacturing Resource Planning (MRP II) - MRP systems advanced into MRP II, expanding their functionalities to include shop floor control, capacity planning, and master production scheduling. This allowed for more comprehensive manufacturing resource planning.
- The 1990s: Rise of ERP systems - ERP systems gained prominence during the 1990s by integrating multiple business functions, such as finance, human resources, and manufacturing, into a unified system. Notable ERP systems like SAP R/3 and Oracle Applications emerged and became widely adopted.

- The late 1990s-2000s: Web-based Solutions - With the advent of the internet, ERP systems embraced web-based interfaces and began integrating with e-commerce platforms. This enabled organizations to conduct online transactions and streamline their operations.
- The 2010s: Cloud-based ERP and Mobile Accessibility - The 2010s witnessed the rise of cloud-based ERP systems, offering benefits such as lower costs, more straightforward implementation, and improved scalability. Additionally, mobile accessibility became a key feature, allowing users to access and interact with ERP systems through smartphones and tablets, enhancing flexibility and productivity.
- Late 2010s-Present: Integration of Big Data, IoT, and AI - In recent years, ERP systems have been integrating emerging technologies such as Big Data analytics, the Internet of Things (IoT), and Artificial Intelligence (AI). These integrations enable organizations to harness the power of data analytics, optimize processes, and make more informed decisions.

The use of IS in business initially involved simple programs primarily focused on maintaining databases for record-keeping purposes. However, it quickly became evident that these systems could effectively handle material records and other types of resources. Subsequently, efforts were made to expand these systems by incorporating modules capable of recording operations specific to different resources. These operations encompassed receipts, issues, purchases, sales, employment, and dismissals. This expansion enabled IS to support and monitor various functional areas within an enterprise, employing independent programs tailored to each respective area, such as warehouse management, human resources, payroll, or financial accounting.

As the IS progressed, the logical next step was to enhance its functionality to encompass material requirements planning (MRP) and, subsequently, material resources planning (MRP II) (Katuu, 2020). During this phase, the need for internal integration of the diverse areas of IS operation emerged as a fundamental characteristic of the subsequent generation of IS – Enterprise Resource Planning (ERP) systems. ERP systems facilitated the comprehensive management not only of production resources but also the resources spanning the entire organization, representing a significant advancement in IS capabilities.

Initially, ERP systems were similar to their predecessors, functioning as monolithic systems with tightly integrated mechanisms for different areas within the system's architecture and IS database (Katuu, 2020). During the 1990s and early 2000s, ERP software became the standard and formed the foundation of organizational systems architecture. However, by the mid-2000s, the limitations of this approach became increasingly evident, including lack of flexibility, dependency on a single supplier, high costs of acquisition and usage, and challenges in adapting to the user's specific business processes (Haddara, Elragal, 2015; Haddara et al., 2015). Pressures from the business environment and emerging technological opportunities prompted the evolution of ERP systems toward a modular structure, where a distinct module was responsible for seamless integration and data flow between individual modules (Lupeikiene et al., 2014). This shift allowed organizations to incorporate modules from different vendors, reducing their reliance on a single provider. Recognizing this transformation, Gartner introduced a new class of information systems called "postmodern ERP" (Gartner, 2019a; Hardcastle, 2014). These systems departed from the monolithic structure, favouring a "loosely coupled decentralization" of administrative and operational modules (Gartner IT Glossary, nd). A postmodern ERP strategy aims to leverage the best applications in each specific area while ensuring effective integration when needed. This approach enables users to select the most suitable traditional ERP modules such as finance, production, or human resources and incorporate various hyper-automation technologies not provided by ERP vendors. Examples of such technologies include integration with IoT sensors, OCR for text recognition, QR code scanning, speech recognition, software robotics, and AI-driven decision support offered by leading companies in this rapidly evolving IT sector (Gartner, 2019b).

While ERP systems are conceptually designed to integrate business processes within an organization (Nazemi et al., 2012), even postmodern ERP systems primarily function as transactional systems focused on recording and monitoring transactions rather than facilitating the design and execution of end-to-end business processes (Gartner, 2019a). In acknowledgement of this limitation, ERP system providers are making efforts to integrate with business process management by incorporating internal business process modellers (e.g., Microsoft Dynamics AX) or enabling the loading and operationalization of business process models using the Business Process Model and Notation (BPMN) from version 2.0 (e.g., SAP). The main envisioned paths for the evolution of ERP systems involve improved integration of AI, increased focus on cybersecurity, blockchain integration, virtual and augmented reality, and greater emphasis on sustainability, and circular economy.

3.1. Improved Integration of AI

The future of ERP systems lies in their increased integration with advanced AI, machine learning algorithms in particular. This integration will bring automation to allow tasks to be more complex, optimize processes, and provide more accurate predictions and recommendations. By harnessing the power of AI and machine learning, ERP systems can significantly enhance various aspects of enterprise resource planning. Potential areas where AI can be utilized to improve ERP are (Arunachalam et al., 2018; Dumas et al., 2023; Eid, Addas, 2017; Merenda et al., 2020; Ribeiro et al., 2021; van der Aa et al., 2018; Wang et al., 2016; Yathiraju, 2022; Yu et al., 2021):

- Intelligent Automation: AI can automate repetitive and rule-based tasks within ERP systems, such as data entry, reconciliation, and report generation. Machine learning algorithms can learn from historical data and make predictions or decisions, reducing manual effort and improving efficiency.

- Predictive Analytics: By analyzing historical data and patterns, machine learning algorithms can provide predictive insights to optimize inventory management, demand forecasting, and supply chain planning in ERP systems. This helps make more accurate forecasts, reduce costs, and improve decision-making.
- Anomaly Detection: AI algorithms can monitor ERP data in real-time to identify anomalies or unusual patterns that may indicate fraud, errors, or system failures. This proactive approach helps detect and mitigate risks early, improve data integrity, and ensure compliance.
- Natural Language Processing (NLP): NLP techniques enable ERP systems to understand and interpret unstructured data, such as customer feedback, emails, and support tickets. This improves customer service, sentiment analysis, and more effective organizational communication.
- Personalized experience: AI algorithms can learn from user behaviour and preferences to personalize the ERP user interface, making it more intuitive and tailored to individual users. This improves user adoption and productivity.

3.2. Increased Focus on Cybersecurity

ERP systems have played a vital role in increasing focus on cybersecurity by implementing various measures to protect sensitive data and mitigate cyber threats. This will cover, among others, the following areas (Knowles et al., 2015; Shang, Seddon, 2002; Wolden et al., 2015):

- Access Control and User Management: ERP systems incorporate robust access control mechanisms and user management features to ensure that only authorized individuals can access critical data and functionalities. Role-based access control (RBAC) is commonly used to assign specific privileges to users based on their roles and responsibilities.
- Data Encryption and Secure Communication: ERP systems employ encryption techniques to safeguard data during transmission and storage. Encryption protocols such as Secure Sockets Layer (SSL) or Transport Layer Security (TLS) are utilized to protect data integrity and confidentiality.
- Security Monitoring and Incident Response: ERP systems integrate security monitoring capabilities, including intrusion detection systems (IDS) and security information and event management (SIEM) tools, to detect and respond to potential security incidents. These systems provide real-time alerts and notifications, enabling timely incident response.
- Regular System Updates and Patches: ERP vendors release regular updates and patches to address security vulnerabilities and software flaws. Timely installation of these updates is crucial to protect ERP systems from known vulnerabilities.

- Employee Training and Awareness: ERP systems are supported by comprehensive training programs and security awareness initiatives to educate employees about best cybersecurity practices. This includes training on data handling, password management, and recognizing and reporting potential security threats.

3.3. Blockchain Integration

Integrating blockchain technology in ERP systems holds significant potential for enhancing various aspects of ERP functionality. This will cover, among others, the following areas (Asante et al., 2021; Batwa, Norrman, 2021; Min, 2019; Perboli et al., 2018; Queiroz et al., 2020):

- Enhanced Data Security and Integrity: The blockchain provides a decentralized and immutable ledger that ensures the integrity and transparency of data. By integrating the blockchain with ERP systems, organizations can enhance data security, reduce the risk of data tampering, and enable secure and auditable transactions.
- Improved Supply Chain Traceability: Blockchain integration in ERP systems can enable end-to-end traceability and transparency in supply chain operations. It allows tracking the movement of goods, verifying authenticity, and ensuring compliance with regulations. This can help organizations in product recalls, counterfeit prevention, and ethical sourcing.
- Streamlined Inter-organizational Processes: The blockchain enables secure and automated smart contracts that facilitate trust and transparency in inter-organizational collaborations. Organizations can automate procurement, invoicing, and payment processes by integrating the blockchain with ERP systems, reducing manual errors and improving efficiency.
- Efficient Data Sharing and Collaboration: Blockchain integration can enable secure and decentralized data sharing among stakeholders within an ERP ecosystem. It eliminates the need for intermediaries and allows real-time data access, leading to improved collaboration, streamlined workflows, and faster decision-making.
- Enhanced Auditing and Compliance: The transparent and immutable nature of the blockchain can facilitate auditing and compliance processes within ERP systems. It provides an auditable trail of transactions and ensures compliance with regulations such as data privacy (e.g., GDPR) and financial reporting standards.

3.4. Virtual and Augmented Reality

Virtual and Augmented Reality (VR/AR) technologies offer promising possibilities for enhancing ERP systems development and user experience. These include, among others (Gonzalez et al., 2022; Marino et al., 2021):

- Training and Simulation: VR/AR can provide immersive training environments for ERP system users. Employees can learn and practice ERP processes and workflows in a virtual setting, enabling them to gain hands-on experience without impacting live systems. This helps reduce training costs, improve user proficiency, and minimize errors.
- Data Visualization and Analytics: VR/AR interfaces can present complex ERP data visually and interactively. Users can navigate through virtual dashboards, charts, and graphs, allowing for better real-time data analysis, decision-making, and spotting patterns or anomalies.
- Remote Collaboration and Support: AR technologies enable remote collaboration by overlaying virtual information onto the physical world. In ERP systems, employees can receive real-time expert guidance and support through AR overlays, assisting them in troubleshooting, maintenance, or complex tasks.
- Enhanced User Interfaces: VR/AR interfaces can provide intuitive and immersive user experiences in ERP systems. Users can interact with ERP functionalities using gestures, voice commands, or spatial mapping, enhancing usability and reducing the learning curve associated with traditional interfaces.
- Data Integration and Visualization in the Field: AR can overlay ERP data onto physical objects or environments in real time. For instance, field service technicians can visualize equipment maintenance history, repair instructions, or IoT sensor data overlaid onto physical equipment, enabling them to perform tasks efficiently and accurately.

3.5. Greater Focus on Sustainability and Circular Economy

In the future, ERP systems can be crucial in promoting sustainability and supporting circular economy practices. Supply Chain Visibility: ERP systems can incorporate features to provide comprehensive visibility into the supply chain, allowing organizations to track and trace products throughout their lifecycle. This visibility enables better monitoring of the environmental impact of raw material sourcing, production processes, transportation, and end-of-life management. These include, among others (Manavalan, Jayakrishna, 2019; Queiroz et al., 2020; Wichaisri, Sopadang, 2018; Wynn, Jones, 2022):

- Eco-design and Product Lifecycle Management: ERP systems can integrate modules for eco-design and product lifecycle management (PLM). These modules can enable organizations to assess the environmental impact of products, facilitate the use of sustainable materials, optimize product life cycles, and support circular product design principles such as recycling, remanufacturing, and refurbishment.
- Waste Management and Recycling: ERP systems can incorporate functionalities to manage waste and recycling processes efficiently. This can include tracking waste generation, managing recycling workflows, monitoring compliance with waste

management regulations, and facilitating the circular flow of materials within the organization.

- Energy and Resource Management: ERP systems can integrate energy and resource management modules to monitor and optimize resource consumption across the organization. These modules can enable organizations to track energy usage, identify energy-saving opportunities, manage water consumption, and promote resource-efficient practices.
- Reporting and Analytics: ERP systems can enhance sustainability reporting capabilities by incorporating features that capture and analyze sustainability-related data. This can enable organizations to generate comprehensive sustainability reports, measure key performance indicators, and make data-driven decisions to improve their sustainability and circular economy practices.

4. Business Process Management Systems

When discussing the development of BPMS, it is worth starting with the evolution of data-driven workflow systems in the 1970s and 1980s. However, the evolution of BPMS began in the 1990s (Figure 2).

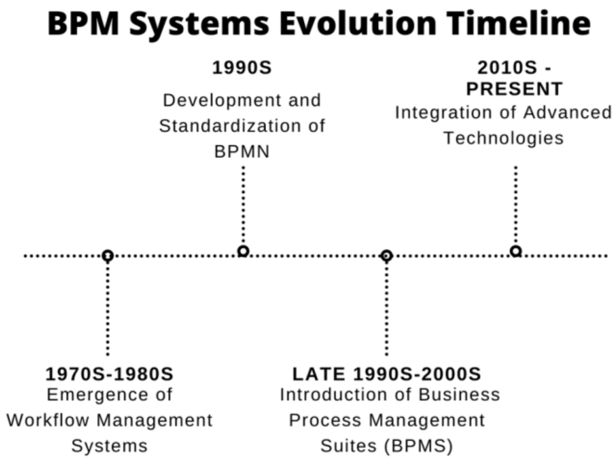

Figure 2. The evolution of ERP systems.

In the 1990s, there was a widespread belief that workflow management systems would be the logical progression in supporting office work, following other tools like database management systems, spreadsheets, and email systems (van der Aalst et al., 1994). This prediction turned out to be accurate, as workflow management (WFM) and document management (DM) systems proved effective in organizing people and documents and automating specific stages of processes, particularly in small and medium-sized companies and administration. However, these systems primarily focused on automating predefined, repetitive workflows and offered limited support for process analysis, optimization, and end-to-end process management. To address the need for comprehensive management and greater flexibility in supporting implemented processes, Business BPMS emerged. BPMS combined information technology with knowledge from management sciences and applied them to operational business processes (Bitkowska et al., 2022; Gartner IT Glossary, nd; van der Aalst 2022). BPMS can be defined as an application infrastructure that supports BPM projects and programs, encompassing the entire execution and improvement lifecycle, from process identification and modelling to design, implementation, analysis, and continuous improvement (Dumas et al., 2018; Szelągowski, 2019).

BPMS is being embraced by organizations to enhance business process agility within a diverse application landscape (Koopman, Seymour, 2020). These suites offer several advantages, including increased visibility and transparency of processes, streamlined organizational rules and principles enforcement, and reduced workload through process automation. BPMS also enables flexible integration with numerous IT systems to support organizational work (Dumas et al., 2018). According to Capgemini (Capgemini, 2012), 96% of enterprises that implemented business process optimization systems experienced a significant return on investment, with at least 200% ROI achieved by 55% of them. However, according to the BPTrends report (Harmon, Garcia, 2020), while 93% of companies are engaged in various activities to improve their processes, only 52% of companies using BPM software expressed satisfaction with their specific tool.

BPMS has encountered limitations in handling the increasing volume of data and the complexity of real-time decision-making processes. The emergence of Industry 4.0 has led to replacing traditional business processes with dynamic processes, including partially structured processes with predefined fragments and unstructured processes, for which precise steps cannot be defined (Kemsley, 2011; Szelągowski, 2019; Wysokińska-Senkus et al., 2016). In this context, organizations must implement comprehensive company strategies, coordinate interactions across departments and external systems, and integrate various platforms such as CRM and ECM to facilitate management across departments, processes, and individuals. Managing business processes in the digital transformation era and Industry 4.0 requires a new approach, which is where Business Process Management Systems, also known as Business Process Management Suites or Business Process Management Software, prove valuable.

The development of BPM support software systems originated from two contrasting assumptions:

- Case Management Systems (CMS) - These systems were designed to handle processes characterized by unpredictable flows and a high level of knowledge intensity, even though the exact knowledge required for execution might not be fully known. CMS focuses on supporting such processes.

- Traditional BPMS - In contrast, traditional Business Process Management Systems (BPMS) were developed to support processes with a known and strictly repeated nature. These systems assume that all the necessary knowledge for process execution is available beforehand. Traditional BPMS aims to provide support for process groups regardless of their nature, unpredictability, or knowledge intensity (Di Ciccio et al., 2015).

A comprehensive analysis of intelligent Business Process Management Systems (iBPMS) and Dynamic Case Management Systems (CMS) revealed a notable trend of increasing convergence in their capabilities. Over the examined period, both types of systems demonstrated the following shared features:

- Dynamic Process Execution: Both iBPMS and dynamic CMS enabled the execution of processes flexibly and adaptively, accommodating changes in the operational context.
- Contextual Adaptation: These systems demonstrated the ability to adapt to the specific operational context in which processes are being executed, considering factors such as user roles, organizational rules, and environmental conditions.
- Rules Processing Integration: iBPMS and dynamic CMS incorporated rules processing capabilities, allowing for enforcing organizational rules and automating decision-making processes.
- Real-Time Data Access: These systems provided access to diverse data sources, empowering them to derive informed decisions in real-time, thereby enhancing the agility and responsiveness of processes.
- Process Redesign Support: Both iBPMS and dynamic CMS emphasized the importance of process automation and digitization, facilitating process redesign efforts to streamline operations and leverage technological advancements (Szelągowski, Lupeikiene, 2020; Szelągowski et al., 2022).

Intelligent BPMS (iBPMS) has emerged as a solution to address these challenges (Gartner, 2012). An iBPMS is a high-productivity application development platform that empowers organizations to change their operating models, processes, and procedures dynamically. These changes are documented as models and directly drive the execution of business operations, allowing business users to make frequent or ad hoc process modifications independently of IT-managed technical assets, such as integration with external systems and security administration (Gartner, 2015).

iBPMS solutions typically encompass advanced capabilities, including enterprise document management, business rules, case management, advanced integration features based on Service-Oriented Architecture (SOA), cloud computing, social collaboration features, and responsive mobile user interfaces (Cheng, 2012). According to Gartner (2015), the iBPMS market comprises vendors offering an integrated set of technologies that coordinate people, machines, and things. These systems enable collaboration between "citizen developers" (usually business analysts and end users) and professional developers to enhance and transform business processes. iBPMS products provide real-time optimization capabilities for specific work tasks, allowing emergent practices to quickly scale across functions or the entire enterprise.

The essential capabilities of iBPMS platforms are built around six primary use cases, as identified by Gartner (2019):

- Composition of Intelligent Process-Centered Applications: iBPMS platforms enable the development of process-centered applications that leverage intelligence, automation, and integration capabilities to streamline and optimize business processes.
- Continuous Process Improvement: These platforms support ongoing process improvement initiatives by providing tools and features for process monitoring, analysis, and optimization. They facilitate the identification of bottlenecks, inefficiencies, and opportunities for enhancing process performance.
- Business Transformation: iBPMS platforms are crucial in enabling business transformation initiatives. They provide the necessary tools and technologies to model, design, and implement new processes that align with the organization's strategic objectives and help drive significant changes across the business.
- Digitized Processes: iBPMS platforms enable the digitization of processes by leveraging technologies such as robotic process automation (RPA), artificial intelligence (AI), and machine learning (ML). This allows organizations to automate manual tasks, improve data accuracy, and enhance process efficiency.
- Citizen Developer Application Composition: These platforms empower non-technical business users, often called citizen developers, to create and compose process-centric applications without extensive coding knowledge. They provide intuitive interfaces, low-code or no-code development capabilities, and pre-built components for rapid application development.
- Adaptive Case Management: iBPMS platforms support managing complex and unstructured processes through adaptive case management capabilities. These features enable knowledge workers to handle cases that require flexibility, collaboration, and decision-making based on contextual information.

BPMS systems are continuously developing to meet the evolving demands of the business environment. While intelligent business process management platforms consider aspects of business transformation and digitization, advancements in technology and the drive for digital transformation push the evolution of BPM software even further (Belev, 2018). These changes aim to provide a tool that enables effective competition in the present and establishes a competitive position for the future.

In practice, the emergence of Industry 4.0 and the upcoming Industry 5.0 emphasize the close integration of BPM with various ICTs (Information and Communication Technologies). These technologies are implemented as standalone applications but increasingly as components of comprehensive BPMS packages (van der Aalst et al., 2016). The diverse requirements of users based on the nature and context of their business processes necessitate the flexibility of BPMS systems to integrate different technologies and devices. This integration ensures the organization's ability to achieve its business objectives. The main forecasted directions of BPMS development are Pervasive Artificial Intelligence, Improved Human-Machine Collaboration, Blockchain-based Process Management, Adaptive and Context-Aware BPMS, Greater Focus on Sustainability and Circular Economy, and Industry-Specific and Customizable Solutions.

4.1. Pervasive Artificial Intelligence

BPMS will increasingly integrate artificial intelligence (AI) and machine learning algorithms, facilitating greater automation, advanced analytics, and more accurate predictions. These technologies have a wide range of applications across various industries. The main directions of development are (Davenport, 2018; Merenda et al., 2020; Ribeiro et al., 2021; van der Aa et al., 2018; Wang et al., 2016; Yathiraju, 2022; Yu et al., 2021):

- Intelligent Process Automation: Pervasive AI in BPMS can automate routine and repetitive tasks, allowing organizations to streamline processes, improve efficiency, and reduce manual errors.
- Predictive Analytics: AI-powered BPMS can leverage historical data to make accurate predictions about future trends, customer behaviour, and process outcomes. This helps organizations make data-driven decisions and optimize their processes.
- Natural Language Processing (NLP): AI-driven NLP capabilities in BPMS enable better understanding and interpretation of unstructured data, such as customer feedback, emails, and social media interactions. This helps organizations gain insights and take appropriate actions based on the analyzed text.
- Intelligent Decision Support: Pervasive AI in BPMS can support decisions by analyzing data, identifying patterns, and recommending optimal actions. This assists users in making informed decisions and improving overall performance.
- Real-time Process Monitoring: AI integrated into BPMS enables real-time monitoring of processes, allowing organizations to track process performance, identify deviations, and take timely corrective actions. This enhances process visibility and control.

According to existing research, Pervasive AI and Machine Learning Business Process Management Systems (BPMS) exhibit various applications in diverse domains such as the Internet of Things (IoT), smart homes, intelligent buildings, and Industry 4.0. The challenges associated with achieving resource efficiency in distributed artificial intelligence within pervasive systems have been acknowledged. Various architectures and platforms have been put forth to facilitate the implementation of machine learning-driven applications in intelligent buildings. The significance of smart resource scheduling in Internet of Things (IoT) devices and infrastructure is underscored to mitigate communication and computation overheads and guarantee optimal performance.

Artificial intelligence (AI) is widely acknowledged as highly compatible with business process management (BPM). It can be effectively utilized across various subtopics within BPM, including Reference Model Mining, Predictive Process Monitoring, and Process Discovery. Nevertheless, the market encounters multiple obstacles that must be addressed, including surmounting limitations on organizational structure, personnel capabilities, social dynamics, and technological constraints. Additionally, challenges related to model scalability and distributed computing further compound the complexities faced by the market. Considering internal and external challenges in the extensive implementation of AI technologies is underscored. In general, although the Pervasive AI and Machine Learning BPMS market exhibits promising opportunities, it also presents particular challenges that necessitate attention to fully actualize its potential (Merenda et al., 2020; Ribeiro et al., 2021; van der Aa et al., 2018; Wang et al., 2016; Yathiraju, 2022; Yu et al., 2021).

4.2. Improved Human-Machine Collaboration

BPMS can promote more effective human-machine collaboration by leveraging AI and automation capabilities in several ways (Khan et al., 2010; Koopman, Seymour, 2020; Marino et al., 2021; Merenda et al., 2020; Ribeiro et al., 2021; Ubaid, Dweiri, 2020; Van de Meerendonk et al., 2010; van der Aa et al., 2018; Venerella, 2019):

- Intelligent Task Allocation: BPM systems powered by AI can analyze task requirements, employee skills, and availability to assign tasks to the most suitable individuals intelligently. This improves task allocation efficiency and ensures the right people are given assignments.
- Automated Routine Tasks: AI and automation capabilities in BPM systems can handle repetitive and rule-based tasks, freeing up human employees to focus on higher-value activities that require creativity, problem-solving, and critical thinking. This leads to more effective collaboration between humans and machines.
- Intelligent Decision Support: AI algorithms integrated into BPM systems can analyze data and provide real-time insights and recommendations to human employees. This assists them in making informed decisions, accelerating decision-making processes, and promoting collaboration between humans and intelligent systems.
- Natural Language Processing (NLP): NLP capabilities in BPM systems enable seamless communication between humans and machines. Users can interact with the system using natural language, making it easier for employees to collaborate with the system, retrieve information, and give instructions.

- Process Optimization and Recommendation: AI-powered analytics in BPM systems can analyze process data, identify bottlenecks, and recommend process improvements. This collaborative approach allows human employees and the system to work together in optimizing processes and achieving better outcomes.

4.3. Blockchain-based Process Management

BPMS will incorporate blockchain technology, providing secure, transparent, decentralized process management. This will improve stakeholder trust and collaboration and enable more efficient auditing and compliance. The use of blockchain technology in BPM will specifically focus on process mining and auditing capabilities (Asante et al., 2021; Batwa, Norrman, 2021; Perboli et al., 2018; Queiroz et al., 2020).

4.4. Adaptive and Context-Aware BPMS

Future BPMS (Business Process Management Systems) are expected to become more adaptive and context-aware, enabling dynamic process adjustments based on real-time data and changing circumstances. This enhanced capability will contribute to the agility and resilience of organizations, allowing them to respond effectively to disruptions and market changes (Bhattacharya et al., 2023; Helbin, Van Looy, 2019; Szelągowski, Lupeikiene, 2020; Szelągowski et al., 2022).

4.5. Greater Focus on Sustainability and Circular Economy

BPMS will increasingly emphasize sustainability and circular economy principles, helping organizations optimize resource utilization, reduce waste, and make data-driven decisions to minimize their environmental impact, in particular through (Garcia-Muiña et al., 2019; Manavalan, Jayakrishna, 2019; Queiroz et al., 2020; Wichaisri, Sopadang, 2018; Wynn, Jones, 2022):

- Resource Optimization: BPMS can contribute to sustainability efforts by optimizing resource utilization within business processes. Organizations can identify inefficiencies and implement measures to reduce resource consumption by analyzing and monitoring resource usage.
- Waste Reduction: BPMS can help organizations adopt circular economy principles by minimizing waste generation and facilitating waste recovery and recycling. Through process analysis and optimization, BPMS can identify opportunities to reduce waste and promote circularity.
- Data-Driven Decision Making: BPMS can enable data-driven decision-making considering sustainability factors. By integrating environmental data and performance indicators into process management, organizations can make informed decisions prioritizing sustainable practices.

- Environmental Impact Assessment: BPMS can incorporate ecological impact assessment tools to evaluate the sustainability of processes. By considering factors such as carbon footprint, energy consumption, and material waste, organizations can identify areas for improvement and implement sustainable practices.
- Stakeholder Engagement: BPMS can facilitate stakeholder engagement in sustainability initiatives. Organizations can promote awareness, collaboration, and shared responsibility for sustainability goals by involving employees, customers, and partners in process management.

4.6. Industry-Specific and Customizable Solutions

BPMS will continue to evolve and cater to the unique requirements of various industries, offering customizable features and modules that address specific business needs and challenges (Bjelland, Haddara, 2018; Cieciora et al., 2020; Gavali, Halder, 2020; Haddara et al., 2015; Hardcastle, 2014; Kralijc, Kralijc, 2017; Rashid et al., 2002; Teltumbde, 2000; van der Aalst et al., 1994). Especially:

- Industry-Specific Optimization: BPMS can be tailored to meet the unique requirements of different industries, enabling organizations to optimize processes specific to their sector. Customizable features and modules allow industry-specific workflows, regulations, and best practices to be incorporated into the BPMS.
- Flexibility for Diverse Business Needs: BPMS provides flexibility to address diverse business needs within different industries. Customizable features enable organizations to adapt the system to specific processes, organizational structures, and integration requirements.
- Compliance and Regulatory Support: Industry-specific BPMS solutions can incorporate compliance and regulatory frameworks relevant to particular sectors. Customizable modules can ensure adherence to industry-specific standards, regulations, and governance requirements.
- Addressing Sector Challenges: Industry-specific BPMS solutions can help organizations tackle unique challenges within their sectors. Customizable features and modules can assist in overcoming industry-specific complexities, improving efficiency, and achieving competitive advantage.
- Best Practice Incorporation: BPMS can integrate industry-specific best practices and guidelines into process models. Customizable solutions allow organizations to align their processes with industry standards and leverage proven approaches for improved performance.

5. ERP and BPMS integration

Organizations in Industry 4.0 and Industry 5.0, employ ERP and BPMS systems. However, these two system classes' purposes have changed in the last 10-15 years. Previously, ERP systems were primarily utilized for resource management, while BPMS (or its predecessor, WFM) supported the implementation of business processes. The requirements and drivers for developing and architecting these system classes also varied (Nazemi et al., 2012).

A decade ago, the success of implementing BPM was assessed based on the simplicity, quality, and flexibility of business processes within the organization (Dabaghkashani et al., 2012). Industry 5.0 has shifted the focus away from technology, recognizing that true development potential lies in the collaboration between humans and machines. During the era of digital transformation, an organization's success is measured by its current efficiency, the development potential of its products and services, and the ability to leverage and cultivate its intellectual capital. This approach requires continuous BPM ambidexterity, impossible in Industry 4.0/5.0 without ensuring effective cooperation between machines (including AI elements) and well-trained and innovative employees (Helbin, Van Looy, 2019; Nahavandi, 2019).

The strategic objectives of implementing and utilizing ERP and BPMS systems are undoubtedly similar. However, during the 90s and 2000s, the specific applications, goals, requirements, and critical success factors differed between these system classes. Technological limitations, particularly internal system integration flexibility, also contributed to differentiation. The advent of digital transformation and changes like value-generating business processes, including the rise of dynamically managed processes, have altered both system classes' requirements and critical success factors. Management perspectives consider a successful ERP implementation as one that reduces workload, costs, and time while improving the quality and flexibility of value-generating business processes (Leyh, Sander, 2015). Simultaneously, managers expect BPMS implementations, with its embedded hyper-automation technologies, to ensure seamless and flexible information exchange, efficient execution of production or service-oriented processes, workload reduction through robotization and automation, and timely provision of detailed analytical reporting data (Karimi et al., 2007). Analyzing the critical success factors (CSFs) for both system classes brings similar findings:

1. Strategic coherence,
    a. Strategic alignment (Bosilj et al., 2018; Castro et al., 2020; Gabryelczvk, 2018; Koopman, Seymour, 2020; Syed et al., 2018; Ubaid, Dweiri, 2020; Zendehdel Nobari et al., 2022).
    b. Business vision and mission (Gavali, Halder, 2020; Koopman, Seymour, 2020; Kralijc, Kralijc, 2017; Syed et al., 2018).

   c. Business process effectiveness (Bosilj et al., 2018; Cieciora et al., 2020; Gabryelczyk, Roztocki, 2018; Hasan et al., 2019; Ubaid, Dweiri, 2020).
2. Governance,
   a. Top management support (Bosilj et al., 2018; Castro et al., 2020; Esteves, Pastor, 2001; 2006; Ganesh et al., 2014; Gavali, Halder, 2020; Kapur et al., 2014; Nagpal et al., 2017; Vargas, Comuzzi, 2020).
   b. Effective change management (Ganesh et al., 2014; Kapur et al., 2014; Kralijc, Kralijc, 2017; Magpal et al., 2017; Syed et al., 2018; Ubaid, Dweiri, 2020; Vargas, Comuzzi, 2020; Zendehdel Nobari et al., 2022).
   c. Business process improvements implementation (Brkic et al., 2020; Ganesh et al., 2014; Kapur et al., 2014; Kralijc, Kralijc, 2017; Nagpal et al., 2017; Zhu et al., 2020).
   d. Continuous monitoring and improvement system Castro et al., 2020; Hasan et al., 2019; Ubaid, Dweiri, 2020).
3. Methods,
   a. Awareness and understanding of BPM (Brkic et al., 2020; Gavali, Halder, 2020; Kapur et al., 2014; Syed et al., 2018; Vargas, Comuzzi, 2020).
   b. Implementation strategy (Bosilj et al., 2018; Castro et al., 2020).
   c. Effective Project management (Esteves, Pastor, 2001; Ganesh et al., 2014; Gavali, Holder, 2020; Hasan et al., 2019; Nagpal et al., 2017; Syed et al., 2018; Vargas, Comuzzi, 2020; Zendehdel Nobari et al., 2022).
4. Technology,
   a. Evaluation of technology potential and limitations (Ganesh et al., 2014; Syed et al., 2018; Zendehdel Nobari et al., 2022).
   b. Architecture: flexibility and integration opportunities (Gavali, Holder, 2020; Kapur et al., 2014; Kralijc, Kralijc, 2017).
   c. Data analysis and conversion (Cieciora et al., 2020; Ganesh et al., 2014; Koopman, Seymour, 2020; Kralijc, Kralijc, 2017; Nagpal et al., 2017; Vargas, Comuzzi, 2020).
   d. Careful module selection Cieciora et al., 2020; Ganesh et al., 2014; Koopman, Seymour, 2020; Nagpal et al., 2017; Vargas, Comuzzi, 2020).
5. People,
   a. Empowerment (Syed et al., 2018; Ubaid, Dweiri, 2020).
   b. Expertise level (Castro et al., 2020; Ganesh et al., 2014; Koopman, Seymour, 2020; Vargas, Comuzzi, 2020).
   c. User engagement (Esteves and Pastor, 2001; Ganesh et al., 2014; Ubaid, Dweiri, 2020; Vargas, Comuzzi, 2020).

6. Culture,
    a. Corporate culture (Bosilj et al., 2018; Ganesh et al., 2014; Ubaid, Dweiri, 2020; Vargas, Comuzzi, 2020).
    b. Communication and collaboration (Gabryelczyk, Roztocki, 2018; Ganesh et al., 2014; Hasan et al., 2019; Kapur et al., 2014; Koopman, Seymour, 2020; Nagpal et al., 2017; Syed et al., 2018; Vargas, Comuzzi, 2020).

From a business standpoint, the requirements for both system classes are essentially the same. At the level of IT architecture, both classes of systems differ in how they use hyper-automation elements. While iBPMS includes them as an integral component, postmodern ERPs usually require external integration. Therefore, these two system classes' artificial division and separate development are increasingly losing significance. However, it is unlikely that one integrated system will soon encompass all the critical success factors, as it is a complex design problem with multiple criteria to consider.

Consequently, an organization's information system configuration will depend on its underlying business philosophy (Lupeikiene et al., 2014). For instance, a unified process ERP system would indicate that it is the dominant component for time-critical, product/service-oriented businesses. Such an ERP system should encompass advanced planning and supply chain management to achieve the desired outcomes. In this scenario, the BPM system should focus on the "behavioural" aspect to ensure the attainment of established goals and act as a subordinate to the ERP system. Nevertheless, to make the system more transparent and more straightforward for the user and to better support the business, we can expect the following possible directions of integration:

- API-Based Integration: Application Programming Interfaces (APIs) are crucial in system integration. In the future, ERP and BPMS vendors may provide standardized APIs that allow seamless data exchange and process integration between the two systems. This would enable organizations to connect and coordinate data and workflows between ERP and BPMS systems more efficiently.
- Middleware Solutions: Middleware software acts as a bridge between different systems, facilitating communication and data transfer. In the future, specialized middleware solutions (improved data or service buses) may emerge to facilitate integration between ERP and BPMS systems. These solutions could handle data transformation, coordination, and business process orchestration between the two systems.
- Unified Platform Solutions: Some vendors may develop unified platforms combining ERP and BPMS functionalities into one integrated solution. This approach would provide a cohesive user experience and enable seamless data and process integration between ERP and BPMS. Organizations would benefit from a comprehensive system that caters to resource management and business process execution.

- Data Integration and Analytics: Integrating data from ERP and BPMS systems can provide organizations valuable insights. In the future, integration may focus on combining data from both systems to drive advanced analytics and reporting capabilities. By correlating data from ERP's resource management with BPMS's process execution data, organizations can gain deeper insights into operational efficiency, cost optimization, and process improvement.

The research findings hold significant practical implications for organizations navigating Industry 4.0 and Industry 5.0, employing both ERP and BPMS systems. The strategic objectives for implementing ERP and BPMS systems remain similar, but the specific applications, goals, and critical success factors have evolved. Technological limitations that once differentiated them are diminishing. From a practical standpoint, organizations should focus on strategic alignment, top management support, effective change management, awareness and understanding of BPM, evaluation of technology potential, empowerment, and corporate culture. As organizations transition from the historical separation of ERP and BPMS systems to a more integrated approach, these findings guide practical decision-making. Whether through standardized APIs, middleware solutions, unified platforms, or advanced analytics, organizations can strategically align their systems to meet evolving business objectives in the dynamic landscape of Industry 4.0 and Industry 5.0.

6. Conclusions

This study demonstrates that from a strategic perspective, businesses pursue identical objectives for ERP and BPMS systems, as evidenced by the overlap in their critical success factors (CSFs) (Ganesh et al., 2014; Kapur et al., 2014; Syed et al., 2018). While traditionally the choice between these systems was determined by organizational size (Cieciora et al., 2020; Rashid et al., 2002), digital transformation has changed requirements, necessitating capabilities like dynamic process management regardless of a company's scale (Helbin, Van Looy, 2019; Szelągowski, 2019).

Although ERP and BPMS have technically evolved separately, from a business standpoint their CSFs align, spanning factors like top management commitment, effective change management, business-IT alignment, and user training (Esteves, Pastor, 2001; Nagpal et al., 2017; Zendehdel Nobari et al., 2022). This indicates that differentiating between ERP and BPMS may become less relevant in the future.

Technically, ERP and BPMS remain distinct in their native handling of technologies like AI and RPA (Hofmann et al., 2020; van der Aalst, 2022). However, postmodern ERP employs APIs and microservices to enable flexible integration of these innovations (Gartner, 2019b; López-Muñoz, Escribá-Esteve, 2019; Weske, 2012). With appropriate enterprise architecture, ERP's transactional capabilities can be combined with BPMS's dynamic process support (Lupeikiene et al., 2014; Teltumbde, 2000).

Therefore, while historically seen as disparate systems, the analysis in this research suggests ERP and BPMS's business objectives and CSFs are converging. This supports integrating their strengths into a unified platform, providing organizations with the needed transaction support, flexibility, and innovation (Dubey et al., 2019; van der Aalst et al., 2016). Further studies validating this integrated approach via case studies or prototype development would offer additional empirical evidence.

Overall, by reviewing ERP and BPMS's evolution and critically comparing their CSFs, this study provides valuable and novel insights into their current status and future trajectory (Asante et al., 2021; Szelągowski et al., 2022). The findings can guide organizations in leveraging these systems effectively amid ongoing digital transformation.

The comparative CSF analysis in this study provides insights that organizations and ERP consultants can leverage to inform their integration strategies and improve implementation outcomes. The identified CSFs highlight key areas that organizations should focus on when adopting ERP, BPMS, or pursuing integration between these systems. For instance, factors like top management commitment, change management, business-IT alignment, and user training emerge as vital for implementation success regardless of the system. Organizations should devote appropriate resources and planning to address these high-priority areas. The findings help consultants guide clients to factor in these critical areas when formulating implementation plans and system integration roadmaps. Thus, the research provides a strategic lens for organizations and consultants to evaluate integration options and optimize ERP and BPMS deployments based on business objectives.

Unlike prior literature which has examined ERP and BPMS systems individually, this study provides original perspectives by conducting a direct comparative analysis of the critical success factors for each system class. The side-by-side comparison of the CSFs necessary for ERP and BPMS implementation success represents a novel framework for investigating the alignment of their strategic objectives. By comprehensively reviewing and contrasting the factors vital for the adoption of each system, this research offers new insights into the convergence of ERP and BPMS from a business-focused lens. The findings lead to informed conclusions about potentially integrating their capabilities into a unified platform that meets modern organizations' needs. Thus, the comparative CSF analysis approach enables this study to contribute unique insights into the current status and future trajectory of ERP and BPMS systems.

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