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PROCESS MAPPING LINKED TO KNOWLEDGE MANAGEMENT IN MANUFACTURING ENVIRONMENTS: A SYSTEMATIC REVIEW

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ABSTRACT

The Business Process Model and Notation (BPMN) is a graphical notation for business process modeling and emerged in the early 2000s. Knowledge management (KM) is an interdisciplinary area, with significant development from the twentieth century onwards, which began through the perception of organizations regarding the value of knowledge. Manufacturing production lines are systems that organize physical, human, and informational resources for the manufacture of products. They work by dividing labor into repetitive and standardized tasks, which are performed by workers or machines. This article presents a literature review on the use of business process modeling (BPM) and knowledge management (KM) in manufacturing environments. Seven articles published between 2019 and 2023, from different countries and segments, were analyzed. The results of the literature review show that BPM and KM are complementary areas that can be used to improve the efficiency and effectiveness of manufacturing processes. The integration between BPM and KM is a promising area of research that can contribute to improving the efficiency and effectiveness of manufacturing processes. However, it is important to consider the challenges associated with this integration so that it can be successful.

Keywords: Process Mapping. BPMN. Production Line. Knowledge Management. Organizations.

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INTRODUCTION

The Business Process Model and Notation (BPMN) is a graphical notation for modeling business processes, which are activities and behaviors defined and governed through business rules, whose objective is to achieve good results (BPM CBOK, 2013). It emerged in the early 2000s, from the combination of other existing notations, such as IDEF0, UML, and ARIS. It is a tool that allows the visualization, communication, documentation, and analysis of processes and activities clearly and concisely, as well as possible automation, whether of new or existing processes and activities. BPMN carries with it the possibility of adding significant improvements in the efficiency and effectiveness of the management of products, projects, people, and business processes and activities. It is used globally, regardless of the size or segment of the company, and today has a wide network of tools and resources as support (integrations with other tools, for example). Some of the benefits pertinent to the use of BPMN are: cost reduction, reduction of execution time of activities/processes, optimization of process assertiveness, and traceability, thus enabling future audits and the dissemination and sharing of knowledge. Process management is complex and involves, as a rule, the following phases: identification, analysis, redesign, implementation, and monitoring.

Knowledge management (KM) is an interdisciplinary area, with significant development from the twentieth century onwards, which began through the perception of organizations regarding the value of knowledge, which is an asset as precious as or more precious than the other resources characterized and conceptualized as facilitators to achieve success. Over time, several scholars have developed research and disseminated the results, to generate new definitions of KM. More recently, KM has come to be considered as the application of a systematic approach to capturing, structuring, managing, and disseminating knowledge in the organization, making it possible to reduce the workload, accelerate its completion time, improve decision-making, create good practices, etc (DALKIR, 2013). With digital transformation, the changes have gone beyond the business context and organizations, reaching consumption habits and behavior among customers, suppliers, and consumers (MUNIZ et al., 2021), thus opening a gap involving differentials and competitiveness (ROMANO et al., 2014), highlighting knowledge as a key point for any organizations, regardless of their revenue, founding date or number of employees, to ensure competitiveness and good results in the short, medium and long term.

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Manufacturing production lines are systems that organize physical, human, and informational resources for the manufacture of products. They work through the division of labor into repetitive and standardized tasks, which are performed by workers or machines (MOURA, R. C.; TOLEDO, J. C.; COSTA, A. C., 2022). The current scenario of manufacturing production lines is marked by increasing automation and digitalization. Machines are increasingly sophisticated and capable of performing complex tasks, which reduces the need for human labor. In addition, information technology is being used to integrate and control the different stages of the production process. These trends are leading to an increase in the efficiency and productivity of manufacturing production lines (CAMPOS et al., 2022). However, they also bring challenges, such as the need to qualify the workforce and adapt workers to new technologies.

The evolution of industries and their manufacturing processes, from the Industrial Revolution to today, can be divided into 3 phases (MOURA, R. C.; TOLEDO, J. C.; COSTA, A. C., 2022), being: Phase 1 (1800 - 1900) - the industrial revolution marked the beginning of mass production, with the replacement of human labor by machines and the division of labor into repetitive and standardized tasks; Phase 2 (1900 - 1970) – this is the second phase of the industrial revolution, and was marked by the development of automation, which increased the efficiency and productivity of production lines; Phase 3 (1970 – present day): it would be the third phase of the industrial revolution, and was marked by digitalization, which is revolutionizing manufacturing processes, along with the development of technologies such as the "internet of things" (IoT), artificial intelligence (AI), Big Data, Machine Learning, and augmented reality (VR).

METHODOLOGY

This literature review seeks to summarize the research findings found on the proposed topic, to inform future research, policy, and practice (ARKSEY, H.; O'Malley, 2005; COLQUHOUN, 2014). To this end, this study applied the methodology proposed by (PETERS, 2020), as well as following the recommended process through the PICO approach, as shown in Chart 01.

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Chart 01: Acronym of the PICO approach of the literature review.

Acronym	
Q: Population or problem	Industries that use BPMN for mapping process flows in production environments;
I: Intervention	Integration between GC and BPMN;
C: Comparison	Comparison between the use of BPMN, with and without the integration of knowledge management;
O: Outcome	Analysis of the impact of the integration between BPMN and KM in manufacturing environments.

Source: Author, 2024

RESEARCH QUESTIONS

This literature review aims to analyze the application of BPMN in the mapping of processes for knowledge management in industries through a literature review. To this end, it was initially identified in the literature the studies that contemplated the industries that used the BPMN for process mapping and linked it to knowledge management. Permeating answers to the questions: how has KM incorporated BPMN? How are industries working KM? How has BPMN been treated within KM? What is the reduction in time in the execution of tasks before and after the implementation of BPMN? What is the impact obtained with the dissemination and sharing of the knowledge acquired?

DATA COLLECTION

Only the articles that fully covered the theme were selected, following the results obtained through the search using the keywords (knowledge management; *Knowledge Management*; BPMN), in quotation marks, with Boolean operators (OR for knowledge management and *Knowledge Management*) and (AND for BPMN), and within the 2019-2023 time frame (last 5 years). Of the 15 articles presented in the search, pre-selection was carried out through the analysis of titles, abstracts, and free/open access to these articles. The selection resulted in 7 articles for later complete reading. The Web of Science, Scielo, and Pubmed databases were used. And for the organization of all citations, including abstracts, will be imported into the Mendeley reference management software (MENDELEY, 2021). Finally, the selected studies were included in an Excel spreadsheet (2016), for data entry, validation, and coding. Data analysis was performed using Excel and Iramuteq software.

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ELIGIBILITY CRITERIA AND SELECTION OF ARTICLES

The selection of articles was limited only to peer-reviewed articles that met six criteria (keywords; knowledge management and BPMN). The first inclusion criterion was based on the search strategy. The second criterion was the publication schedule, that is, articles that were published within the proposed time frame (2019-2023). The third criterion consisted of studies that covered the manufacturing environment, that is, that addressed production processes, regardless of the segment, and that were replicable and scalable processes. The third criterion consisted of studies that addressed the theme of the use of BPMN linked to KM. Literature reviews, case reports, protocols, comments, dissertations, book chapters, letters, and conference abstracts were excluded.

The relevance of the articles identified in the selection stage went through a 3-stage process, after comparison and deduplication. The first stage consisted of the manual verification of the titles and abstracts, as shown in Chart 02. The second stage consisted of reading the objectives, results and conclusion, identifying the articles that covered the theme of knowledge management and BPMN.

Table 02: Registration of the selection of articles and eligibility criteria.

AUTHORS/DATE	ARTICLE TITLE	GENERAL OBJECTIVE	ELIGIBILITY CRITERIA		
			Is there a production process?	Is the process replicable?	Is the process scalable?
Juliana Salvadorinho, Leonor Teixeira/2021	Organizational knowledge in I4.0 using BPMN: a case study	The objective of this article is to leverage business process models to represent the knowledge associated with the tasks of operators on the shop floor of an organization belonging to the chemical industry, thus transforming the tacit knowledge of these employees into explicit knowledge (creating a knowledge repository).	Yes.	Yes.	Yes.
Amina Annane, Nathalie Aussenac-Gilles, Mouna Kamel/2019	BBO: BPMN 2.0-Based Ontology for Business Process Representation	Our ontology will only be used by a virtual assistant to monitor the execution of processes step by step and answer questions about these processes.	Yes.	Yes.	Yes.

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Jácint Duduka, Sérgio Guerreiro/2020	Systemic Simulation of Business Processes using Agent-Based Simulation and BPMN	We propose a solution that looks at the problem from a holistic perspective, in the sense that holistic modeling plays a vital role in the development of socio-technical systems (STS), due to the interaction between social and technical elements within these systems and the resulting emergent behavior.	Yes.	Yes.	Yes.
Monnique São Paio de Azeredo Esteves Veiga, Regina de Barros Cianconi/2020	Management and information flows in musical theatre production	As a general objective, the study sought to understand the functioning of Musical Theater Production, through the identification of the main teams that compose it, their functions and the relationship between them, the mapping of information flows, and the identification of activities that can be characterized as Information and Knowledge Management.	Yes.	Yes.	Yes.
Selina Y. Cho/2020	Capturing Tacit Knowledge in Security Operations Centers	The main goal is to explore different forms of thought processes that occur among analysts when an incident occurs.	Yes.	Yes.	Yes.
Mariam Ben Hassen, Mohamed Turki, Faïez Gargouri/2019	A multi-criteria assessment approach to selecting a sensitive business process modeling language for knowledge management	Our goal is to improve the location and identification of the crucial knowledge mobilized and created by these processes.	Yes.	Yes.	Yes.
M. Szel ̨agowski/2019	The implementation of dynamic business process management	The objective of this chapter is to present the results of studies on the greater efficiency of the implementation and execution of dynamic business process management, compared to its traditional counterpart.	Yes.	Yes.	Yes.

Source: Author, 2024

DATA ANALYSIS

The studies selected by the eligibility criteria were included in an Excel spreadsheet (2016), for data entry, validation, and coding. Data analysis was performed using Excel and

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Iramuteq software. The data extracted from the articles included title, author's name, year of publication, purpose of the study, and eligibility criteria. Other information that was extracted consisted of the tools used, positive impacts, and challenges presented. Analyzing the objectives of the 7 selected articles, we can identify the following main themes: BPM - this is the most recurrent theme, with four of the seven objectives related to BPM. Articles 1, 3, 6, and 7 address aspects of BPM, such as process modeling, knowledge management, and efficiency; Knowledge Management (KM): is also a recurring theme, being addressed in two of the seven objectives. Articles 1 and 4 address aspects of KM such as knowledge representation, mapping of information flows, and identification of KM activities; Thought processes: This topic is only addressed in article 5, which seeks to explore different forms of thought processes that occur between analysts when an incident occurs.

RESULTS AND DISCUSSION

Seven articles from different countries that fit the 2019-2023 time frame were analyzed. All of them address manufacturing environments, regardless of the segment, with passive replication and scalability processes, the use of process mapping via BPMN (or BPM), and Knowledge Management. The variation of countries brought the possibility of a more comprehensive look, a little outside the Brazilian reality, aggregating situations, needs, and uses of the objectives whose focus of this research was turned, that is, to the mapping of processes in manufacturing environments, to Knowledge Management and BPMN. Another point, but still dependent on the first, is that the variety of countries brought a diversity of segments, going from the IT to the chemical industry and reaching the theater. This generated a greater challenge regarding the combination of the results and common tools between them, as well as their vision and analysis.

The word cloud generated through the analysis of the results presented in the 7 selected articles, carried out in the Iramuteq software, helps in the graphic demonstration of the most used terms, as shown in Figure 01.

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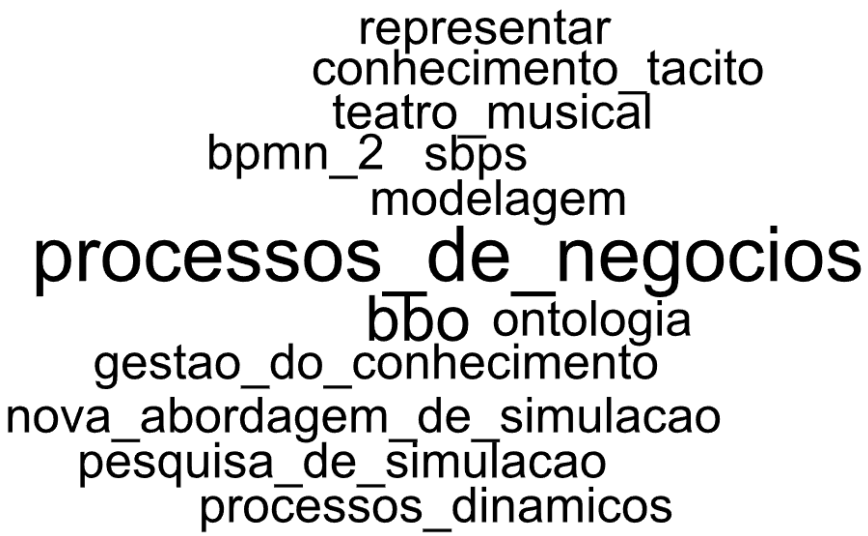
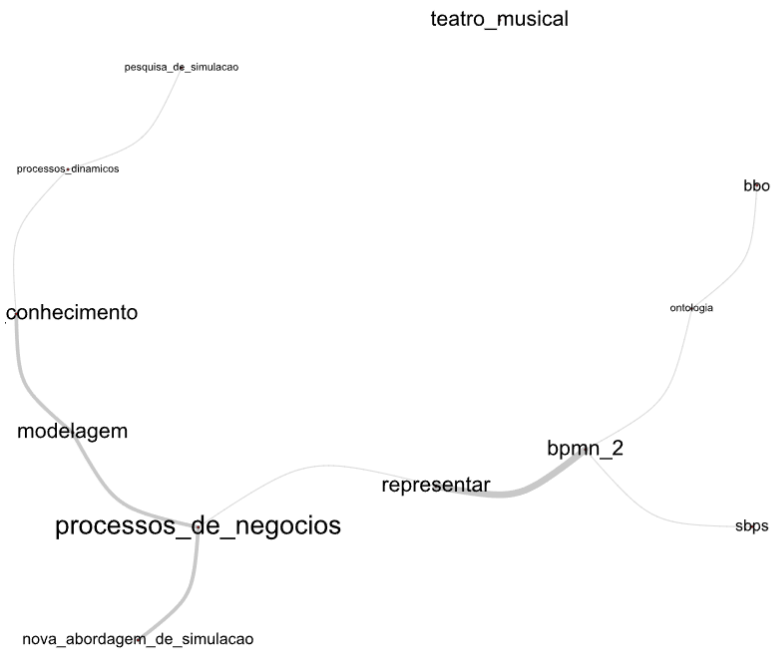
Figure 01: Word cloud with the results obtained.



Source: Iramuteq, 2024

Reinforcing the word cloud, the similarity analysis performed in the Iramuteq software allows a view of the relationship between the most cited terms, as shown in Figure 02.

Figure 02: Analysis of similarity with the results obtained.



Source: Iramuteq, 2024

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As for the results presented in each of the seven articles, after being compiled and analyzed individually, they were presented as follows: business process modeling (BPM) is an important tool to represent and analyze processes in an organization's environment; BPMN 2.0 is a standard and widely adopted business process modeling language; Knowledge Management (KM) is a process of identifying, capturing, organizing, storing, sharing, and using knowledge; BPM and KM are complementary areas that can be used to improve the efficiency and effectiveness of organizations; and business process modeling can be used to establish KM in an enterprise.

As the main positive impacts, improvements in knowledge transfer are pointed out, for two reasons: first, for the positive impact, due to the facilitation of the rapid and effective transfer of tacit knowledge in industrial environments; and second, related to the application of BPMN in the mapping of processes to ensure Knowledge Management. A greater representation and understanding of processes was observed, through a more detailed and understandable representation of business processes, as well as an advance in the representation of processes with ontologies and semantic web. It also identified the improvement in decision-making in complex environments, such as Security Operations Centers, and the integration of business process simulation with the use of tacit knowledge. Finally, efficiency in process management was presented, with the implementation of dynamic processes that resulted in greater efficiency compared to traditional approaches, as well as the implementation of dynamic processes and integration with Knowledge Management.

As for the challenges, cultural and organizational adoption is pointed out. Due to the implementation of dynamic processes, it requires significant cultural and organizational changes, including integration with Knowledge Management. As well as the complexity in representation and modeling, because it deals with the complexity of representing and modeling knowledge-sensitive processes, generating the improvement of the representation of knowledge-sensitive processes. In the same way, the coordination of knowledge management practices was observed, to coordinate and implement information management and knowledge management practices in production processes, resulting in the improvement of process management in specific contexts. Likewise, the selection of appropriate tools and languages was presented, with the choice of the most appropriate modeling tools and languages to represent knowledge-sensitive processes, thus generating the improvement of the representation of these knowledge-sensitive processes.

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And finally, the changes in the paradigm of process modeling, to overcome the traditional paradigm of modeling focused only on task sequence, and thus generate advances in the representation of processes with ontologies and semantic web.

CONCLUSION

This study aimed to analyze the application of BPMN in the mapping of processes in industrial contexts, regardless of the segment, and involving KM. In this sense, the results presented reveal a series of positive impacts, but also several challenges related to the application of BPMN in the context of integration between knowledge management and process mapping. A notable achievement is the significant improvement in tacit knowledge transfer in complex industrial environments. The use of BPMN for process mapping enables the rapid adaptation of new employees and promotes a more agile integration of artificial intelligence techniques, even favoring autonomous learning. In addition, the creation of knowledge repositories through process representation enables efficient knowledge transfer, especially in scenarios of high labor turnover, allowing the organization to retain valuable insights. However, implementing these benefits is not without its challenges.

Cultural and organizational adoption emerges as a significant obstacle, requiring profound changes in organizations' cultural and procedural structures for the successful incorporation of dynamic processes. In addition, the complexity inherent in the representation and modeling of knowledge-sensitive processes requires appropriate approaches and tools to deal with the diversity of information and interactions present. Careful selection of modeling tools and languages also proves crucial to ensure that knowledge-aware processes are accurately and completely represented. In parallel, the integration of agent-based simulation with business processes emerges as an opportunity to improve decision-making in complex contexts, such as Security Operations Centers (SOC), or even PMOs or managers of IT and ICT projects/products.

Another challenge is the effective coordination of Information Management and Knowledge Management practices, which indicate the need to coordinate and implement more structured practices to optimize the flow of information and ensure that tacit knowledge is always shared efficiently. Furthermore, the transition from the traditional paradigm of process modeling focused mainly on linear sequences of tasks, to a richer and more comprehensive approach based on ontologies and Semantic Web, presents an

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additional challenge. Overcoming this transition requires a fundamental review of the modeling mindset and a deeper understanding of the complex elements that influence organizational processes, i.e., people, processes, and technologies. In the context of the knowledge economy, the research underscores the importance of addressing these challenges to reap the benefits inherent in advanced process representation and effective knowledge management in ever-evolving industrial environments.

It is concluded that this study offered valuable insights into how the integration between BPMN and KM can be effectively used in the optimization of operational processes, in the promotion of organizational efficiency, and in the enhancement of KM practices in industrial organizations. The critical analysis of the collected evidence identified not only the advantages of this integration but also the common challenges faced and some proposed solutions. In addition, exemplary cases, good practices, and the provision of practical guidance were highlighted, aiming to assist professionals and companies that wish to implement BPMN as a strategic tool for mapping processes in industrial contexts, with a focus on enriching organizational knowledge management and its impacts on decision-making, innovation, and continuous learning. However, the need for new studies covering this same integration is emphasized, which present empirical evidence of the benefits extended to departments beyond production, which encompass the adoption of emerging technologies within daily processes and activities, which present the tools used for KM management in corporate environments, as well as the levels of impact, whether operational, tactical or strategic.

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