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A RAPID REVIEW ON ONTOLOGY- AND DATA-DRIVEN BUSINESS PROCESS MODELLING

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Abstract. In modern organizations, the ability to efficiently manage and adapt business processes is essential. Business process modelling (BPM) is widely used to visualize, analyse, and improve operational processes. As the complexity of business environments increases, the integration of ontological modelling and data-driven approaches becomes increasingly relevant. Ontologies offer a semantic foundation for organizing and structuring process-related information, while data-driven methods support evidence-based decision-making and enable the adaptation of processes to dynamic conditions. Although both approaches show promise, the academic literature still lacks a coherent view of how they are jointly applied within BPM. This research conducts a rapid review of recent scientific publications to investigate how ontological and data-based methods are being used, what challenges are most often identified, and which research directions are emerging. The analysis reveals that the integration of these methods could address issues such as semantic consistency, process automation, and real-time decision-making. The results highlight existing research gaps and provide a clearer understanding of how BPM methodologies can be advanced by combining these two perspectives. This research contributes to the theoretical development of BPM by mapping current practices and offering insights for future researches.

Keywords: ontology, business process, modelling, data-driven, integration, rapid review.

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1. Introduction

Business process modelling (BPM), is one of the primary approaches used to organize, maximize, and enhance an organization's performance. Ontology-based representations enhance the semantic consistency and flexibility of business process (BP) models, which contributes to their better understanding, analysis, and adaptability (Adams et al., 2021). For contemporary businesses that need to quickly adjust to shifting market conditions and technological breakthroughs, integration of ontology-based approaches into business process modelling (BPM) is becoming increasingly important. These methods contribute to more flexible, semantically consistent process representations and support better understanding and decision-making (Adams et al., 2021). But even with its extensive use, BPM frequently encounters significant difficulties in guaranteeing semantic compatibility and efficient data integration.

Although Kumar and Sharma discuss ontology-based methods in information retrieval, their research highlights the broader importance of semantic consistency, which is often underutilized in traditional BPM approaches (Adams et al., 2021). This limitation usually results in inefficiencies in dynamic and complex organizational settings where prompt and accurate

decision-making is essential (Adams et al., 2021). Furthermore, there is a glaring lack of ontological approaches applied to these problems. Although ontologies offer a semantic structural basis for interpreting the relationships between processes and their meanings, BPM has yet to fully leverage their potential (Romero et al., 2022). Another related issue is the complexity created by the increasing volume of data and its diverse sources (Romero et al., 2022). In order to swiftly extract actionable insights, modern organizations must employ advanced analytical tools to handle the massive amounts of data (Big Data) that are generated and processed on a daily basis (Moulouel et al., 2023). Despite the great potential of data-driven approaches to improve operational effectiveness and decision-making, their integration with BPM approaches has been limited. Current approaches often fail to integrate the benefits of ontologies and data analytics to produce a coherent framework that can meet the dynamic and flexible needs of organizations (Wilk et al., 2020). Although the integration of ontology and data-driven methods into BPM shows promise for improving decision-making, semantic consistency, and data management, current research often examines these approaches separately. This fragmented perspective limits the understanding of how both methodologies can complement each other to enhance BPM efficiency in dynamic organizational settings. Moreover, there is a lack of synthesized knowledge about how such integration is being pursued, what challenges persist, and what research directions are being developed.

Ontology is an "Explicit, Formal Specification of a Shared Conceptualization" (Abhilash & Mahesh, 2023)

Ontology-based business process modelling (BPM) refers to the practice of using formal, structured vocabularies—ontologies—to describe business processes in a way that captures their precise meaning. This allows for greater consistency, easier reuse of process elements, and a shared understanding between systems and stakeholders. In parallel, data-driven BPM relies on insights from real-time or historical data to improve, adjust, and manage business processes more effectively. Both approaches offer unique strengths: ontology-based methods improve semantic clarity, while data-driven techniques add adaptability and responsiveness. When combined, they can significantly enhance the flexibility and precision of BPM. However, integrating these methods also brings challenges, such as increased system complexity, technical compatibility issues, and questions around scalability.

The main objective is to summarize the existing literature on ontology and data-driven business process modelling by carrying out a rapid review of academic articles published between 2020 and 2024. This research maps out prior research using important variables such applicable methods, data sources, semantic modelling strategies, and application regions. By doing this, it identifies gaps in the field, points up areas for further research, and provides a structured overview of it. The findings of this research will help researchers and practitioners to better understand how ontology-based and data-driven methods are used together in business process modelling (BPM), and how such integration can help improve process efficiency, ensure semantic consistency, and support decision-making in real business environments. These concepts may be helpful to researchers and practitioners who are developing data-driven, semantically consistent BPM systems suitable for complex business environments. The rest of the paper is structured as follows. Section 2 presents related works on the analysed topic. Section 3 describes the methodology of the research. Section 4 presents the obtained results. Section 5 concludes the paper.

2. Related works

Some relevant articles are analysed in this section as follows.

Adams et al. (2021) proposed a system based on advanced ontologies to improve semantic alignment in BP models. The main goal of the system is to generate dynamic visual representations that maintain semantic consistency while allowing for process customization. Semantic reasoning and ontology integration methods are applied to improve the clarity and structure of BP. The methodology was validated through a supply chain management case research using real-world process data, demonstrating its practical relevance. Although the research highlights the potential of ontology-based approaches in improving flexibility and semantic precision, it does not provide detailed implementation strategies. The authors also acknowledge limitations in scalability, particularly in large-scale or multi-organizational contexts. Nevertheless, the research contributes valuable insights into the integration of ontological reasoning within BPM and emphasizes the importance of combining semantic and data-driven approaches to address the growing complexity of business environments.

Alotaibi (2020) provided an in-depth analysis of BPM languages, standards, and methodologies, focusing on their compatibility with data and ontology-based approaches. The main objective of the research is a thorough analysis of BPM methodologies, describing their benefits and weaknesses and making recommendations on how they could be integrated into ontological systems. The main advantage of this method is that it includes a number of modern BPM standards that allow researchers to evaluate and select the most effective methods. However, the lack of experimental approval limits the practical applicability of the document. Since the research is essentially a theoretical review, no specific methods, algorithms or tools are used. In addition, there are no experiments or case research that support the conclusions, and therefore cannot be tested in a real environment. No data sets or tools are used, as the research is fully based on literature. Despite these limitations, the analysis provides a solid theoretical basis for understanding the compatibility of BPM standards with methods based on ontology. Offering a systematic comparison of BPM methods, this article highlights the importance of aligning methods with semantic and data-driven requirements in BPM. This is very important for achieving progress in this area of research.

Lyu et al. (2021) offer a system that integrates ontology to enable "Control as a Service" in industry 4.0 environments. The main goal of the research is the automation of process management and the optimization of resource allocation by combining the integration of ontology and methods of process extraction. One of the strengths of the system is its ability to simplify operations and improve the efficiency of the production workflow. However, the main limitation is its dependence on standardized data formats, which reduces its applicability to heterogeneous data sources. The method shall be verified by means of industrial case research, in which real-world production datasets are used to assess its effectiveness. The experiments focus on system efficiency in evaluating automation and resource optimization. While specific ontology modelling tools are not comprehensive, the research uses modelling software to validate the method. This research highlights the potential of ontology-based approaches in dynamic BP environments and provides valuable insights into industry 4.0 workflow optimization.

Romero et al. (2022) introduced a hybrid system that combines deep learning algorithms and ontology-based approaches to assess the possibilities of BP. The main goal of the research is the combination of semantic models with machine learning (ML) methods in order to accurately and reliably assess the effectiveness of the process. This approach provides clear advantages, such as greater accuracy of assessments and a more detailed semantic understanding of BP. However, the main disadvantage is the high demand for system computing resources, which can make it difficult to apply it in an environment of limited capacity. The research improves competence assessment using deep learning algorithms and semantic models based on ontology. The system is tested by experiments with the company's BP logs, which are the main data set. These tests are designed to determine the correctness and effectiveness of the proposed hybrid strategy. Although the research does not specify which tools were used for execution, the combination of semantic reasoning and ML shows a promise for better process modelling. This research complements the understanding of hybrid methods that use ontology and deep learning to improve the modelling and evaluation of BP. The conclusions emphasize the importance of semantic and computational methodologies in increasing accuracy and optimizing the company's activities.

Moulouel et al. (2023) proposed a hybrid common sense reasoning system that combines ontology-based techniques with probabilistic algorithms to eliminate contextual violations in undefined and partially noticeable contexts. The main goal of the research is its ability to manage inconsistencies and uncertainties in contextual information, while improving decision-making processes. The effectiveness of the system in solving complex situations with partial data is a great advantage. Nevertheless, its reliance on structured data limits its application in more heterogeneous or unstructured situations. To reconcile contextual violations, the system uses ontology-based semantic reasoning and probabilistic modelling. Verification is carried out using modelling to test the system's ability to identify and eliminate contextual inconsistencies in a controlled environment. The experiments focus on assessing the accuracy of decision-making and the adaptability of the system to varying levels of uncertainty. The tools used in the research include reasoning engines and custom ontological models, although specific implementation platforms are not comprehensive. Modelled datasets provide contextual information necessary to test the proposed method.

Sánchez et al. (2020) are analysing the use of an ontology-based approach to align BP with web services to promote system interoperability. The main goal of the research is to bridge semantic gaps between process models and services, using BPMN models and web service metadata to validate the proposed alignment strategy. While the method improves semantic accuracy, it also introduces complexity due to extensive mapping requirements. Despite limited detail on specific tools, the research highlights how semantic tuning can optimize process integration. The findings contribute to a deeper understanding of ontology-based interoperability in BPM.

In Wu et al. (2024), authors present a design ontology aimed at enhancing traceability management in cognitive systems, with a focus on engineering processes. The approach enables structured semantic representation and supports process optimization through improved traceability. Validated using modelled datasets from engineering projects, the system

demonstrates effectiveness in managing complex workflows. However, its applicability is limited due to its domain-specific orientation. While specific implementation metrics are not detailed, the research offers valuable insights into the role of ontologies in traceability and contributes to broader research in semantic workflow optimization and BPM.

Dhillon and Singh (2022) propose an ontology-oriented service system to enhance semantic integration and management of IoT applications. The research focuses on structuring IoT services using ontological methods to improve scalability and interoperability. While the system shows promising results in simulated IoT environments, particularly in aligning and managing services, the complexity and time required for ontology development remain key challenges. Although the research does not emphasize specific tools, it demonstrates the value of semantic structuring in supporting integration within modern, interconnected IoT ecosystems.

Pinheiro et al. (2024) offered a lightweight ontology system for extracting the company's architecture from the API gateway logs. The main goal of their work is a simplified and effective API data analysis method that allows you to better understand the architecture of the enterprise. By applying ontology-based structuring, the system successfully organizes and interprets log data, as demonstrated through case researches using real-world API logs. However, its functionality remains limited due to the absence of broader semantic modelling capabilities and integration with heterogeneous data sources. Despite this, the research underscores the potential of lightweight ontologies in enhancing BP analysis and contributes valuable insights to ontology-driven BPM methodologies.

Wilk et al. (2020) propose an ontology-based system for the dynamic formation of interdisciplinary health care teams. The main goal of the research is its ability to increase adaptability and the efficiency of the workflow by structuring the formation of a team by methods based on ontology. The main advantage of the system is its ability to automate the creation of dynamic teams, improving coordination and efficiency in health care workflows. However, the specificity of the system to health care contexts limits its application to other industries. The research uses custom ontology systems to model team building and validate its method using simulated healthcare scenarios. Experiments include testing the system's ability to optimize workflow efficiency and the adaptability of the team to various conditions. Healthcare process logs are used as a primary dataset to evaluate the effectiveness of the system. This research demonstrates the potential of ontologies to support dynamic workflow automation by providing valuable insights into the application of ontology-based solutions to process optimization.

3. Methodology

This research applies the principles of a systematic literature analysis (SLA), but in the rapid form Hamel et al. (2021), to explore how ontology-based and data-driven methods are integrated into BPM in a short time not concentrating on the SLR protocol writing. According to Gordon et al. (2019), rapid literature review has some components of an SLA, but with a scope restrictions and a narrower search strategy in order to perform it in a shorter time.

Based on Smela et al. (2023), this rapid review consists of the following steps: 1) Definition, 2) Research question and searches, 3) Studies selection, 4) Data extraction and quality assessment, 5) Reporting. Consequently, those steps are described below.

At the beginning of the review, several research questions were formulated to help structure the analysis and make the review process more transparent and repeatable. The questions were as follows:

RQ1: How are ontology-based approaches currently used in business process modelling (BPM)?

RQ2: What role do data-driven methods play in improving BPM practices?

RQ3: How widely are integrated (ontology and data-driven) approaches applied in BPM research?

RQ4: What challenges and limitations are mentioned in the literature when combining ontology-based and data-driven methods in BPM?

These questions helped define the inclusion criteria, organize the structure for data extraction, and focus the analysis. They also made it easier to follow a clear process, which would allow the study to be repeated with the same steps in future research.

The main objective of this approach is to identify existing gaps, summarize current practices, and provide structured insights into the evolution of these methods within BPM contexts.

The selection of literature was guided by predefined inclusion criteria. These included relevance to the topic (ontology, data analysis, BPM), published in English, full-text accessible, and published between 2020 and 2024. Scientific articles were collected from reputable academic database Web of Science. A total of 20 articles that met these inclusion criteria were selected for further analysis. The used search string for the papers is as follows:

"ontolog" AND ("busines* proces*" OR "proces*") AND ("model*" OR "simul*") AND ("service*" OR "ITSM*")*

Each publication was reviewed using a structured table with eight columns: (1) reference, (2) research question or main problem, (3) proposed method, (4) field or application area, (5) data set used, (6) attributes for analysis, (7) method evaluation criteria, and (8) main results. This template allowed for consistent comparison and thematic synthesis across researches. This methodological approach did not aim to evaluate specific technologies, but rather to summarize how ontology-based and data-driven approaches are applied in BPM. The analysis enabled the identification of key research directions, commonly used methods, and practical challenges related to the integration of semantic and data-based models into BPM systems.

Based on the formulated research questions, Table 1 illustrates the relationship between the eight analytical columns used for data extraction and the four key research questions (RQ1–RQ4). This structure was designed to ensure that all collected data were directly aligned with the objectives of the review and contributed meaningfully to the overall analysis.

For example, the columns "Research question or major topic" and "Proposed method" are related to RQs 1 and 3, which investigate how ontology-based and data-driven methodologies are applied. The columns "Dataset used" and "Attributes for analysis" are relevant to RQs 2 and 4, since they indicate the types of data used and analytical features considered when implementing these techniques in BPM scenarios. Meanwhile, "Field or application area"

and "Method evaluation criteria" help to contextualize the studies and assess their practical relevance (RQs 3, 4). Finally, the "Main Results" column summarizes each paper's primary findings and addresses all four study topics.

This mapping ensures a logical connection between the structure of the analysis and the research questions, allowing for a consistent and transparent review process that facilitates reproducibility and clarity in the synthesis of findings.

Table 1. Relationship between columns and research questions

No.	Column	Related research question(s)
1	Reference	All (RQ1–RQ4)
2	Research question or main problem	RQ1, RQ2
3	Proposed method	RQ1, RQ3
4	Field or application area	RQ3, RQ4
5	Dataset used	RQ2, RQ4
6	Attributes for analysis	RQ2
7	Method evaluation criteria	RQ4
8	Main results	All (RQ1–RQ4)

4. Results

Below the review results are presented in Table 2.

Table 2. Analysis of scientific articles on ontology and data-driven research of BPM

Reference	Main research question / problem	Proposed method	Research field / application area	Dataset used	Attributes for analysis	Method evaluation	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Alotaibi (2020)	How to apply BPM techniques, standards & tools in BP?	Literature review of BPM methods and standards	BPM	*BPM standards and methods	Process stages, strategies, modelling standards	Evaluated by BPM techniques and method suitability	Classification of BPM techniques by effectiveness and integration
Sánchez et al. (2020)	How can semantic transformations improve service interoperability?	Semantic alignment model	BP and web service integration	Sample datasets from BPM repositories (Sánchez et al., 2020)	Process and semantic attributes	Evaluated by semantic alignment efficiency	Improved interoperability using semantic matching algorithms

Continue of Table 2

Reference	Main research question / problem	Proposed method	Research field / application area	Dataset used	Attributes for analysis	Method evaluation	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Wilk et al. (2020)	How can ontology help form diagnostic recommendations in healthcare?	Ontology-based dynamic recommendation formation	Healthcare team formation	Simulated healthcare team/process data from clinical scenarios (Wilk et al., 2020)	Team competence and expertise areas	Evaluated by flexibility and suitability	Improved team formation aligned with ontology-based competence modelling
Barcellos (2020)	How to support planning and quality in CSE?	Testing approaches, frameworks, and methods in CSE	Software engineering, CSE	*Literature review on CSE practices and cases	Continuous learning, interaction tools	Evaluated by usability and efficiency metrics	Developed a framework supporting integration and quality in CSE systems
Adams et al. (2021)	How to create an ontology-based BPM method with semantic elements?	Ontology-based BPM method	BPM	*YAWL Process management methodology	Process activities, roles, and views	Use case analysis and comparative evaluation	Method integrates multiple BPM perspectives, including semantics
Li et al. (2021)	How can ontology be used for context-sensitive web service composition?	Domain ontology-based service composition	Domain ontology applications	Domain-specific data (open dataset provided by GroupLens (Li et al., 2021))	Context variables and semantic relations	Evaluated by semantic correctness and relevance	Improved context-sensitive semantic web service composition
Lyu et al. (2021)	How can ontology improve service/process management in Industry 4.0?	Ontology-based model for CaaS	Industry 4.0, service and process management	*Service process and management models	Process parameters, control points	Performance analysis and real-world validation	Improved process and service management using ontology in Industry 4.0
Romero et al. (2022)	How can hybrid deep learning methods evaluate BP performance?	Ontology & ML hybrid model	BP and performance evaluation	Text data from chemical sample management process at the research institute (Romero et al., 2022)	Process efficiency and activity indicators	Evaluated by accuracy, precision, and effectiveness	Enhanced evaluation through hybrid ontology and deep learning

Continue of Table 2

Reference	Main research question / problem	Proposed method	Research field / application area	Dataset used	Attributes for analysis	Method evaluation	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
H. F. Wu et al. (2022)	How can ontology-based architecture improve competencies in IoT, manufacturing, and fog computing?	Ontology-based architecture for fog computing	IoT, manufacturing, and data analysis	*Manufacturing and IoT data	Data synchronization, attributes, and time	Evaluated in several scenarios with different latency levels	Improved semantic competencies and reduced data transmission delays
Dhillon and Singh (2022)	How can an ontology-based service system support social IoT services?	Ontology-based service system	Social IoT services	*Social IoT interactions and relationship data	Service relationships, service attributes	Evaluated based on service quality indicators	Improved service relationships and quality within the IoT environment
Kumar and Sharma (2023)	How to combine semantic web tech with ML for text retrieval?	Hybrid: semantic technologies and ML	Text information retrieval	Textual datasets (data sources like WordNet, Wikipedia, and Text Retrieval Conference (Kumar & Sharma, 2023))	Semantic relations, text attributes	Evaluated by accuracy and retrieval efficiency	Enhanced semantic-based text information retrieval with higher efficiency
Moulouel et al. (2023)	How can ontology-based analysis address context-sensitive decision-making?	Hybrid ontology-based semantic analysis method	Context-sensitive decision-making	Contextual business and social data (Orange-4Home & SIMADL public datasets (Moulouel et al., 2023))	Contextual variables, associated indicators	Evaluated by system performance metrics	Improved decision-making through semantic reasoning and context alignment
Zaringhalam et al. (2023)	How can the STEP standard model support product design in cloud services?	STEP-based product design and collaboration system	Cloud services, product design processes	Manufacturing processes and product design data (dataset: comprehensive case study (Zaringhalam et al., 2023))	Product components, design versions	Evaluated by collaborative effectiveness	Improved design, management, and cloud-based collaboration between teams

Continue of Table 2

Reference	Main research question / problem	Proposed method	Research field / application area	Dataset used	Attributes for analysis	Method evaluation	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liu et al. (2023)	How to evaluate metadata standards for better model integration?	Metadata analysis and modelling frameworks	Metadata and information system management	*Metadata models and systems	Descriptive and contextual attributes	Evaluated by integration effectiveness	Enhanced metadata standards and modelling for improved system integration
Durán-Polanco and Siller (2023)	How to tailor decision-making frameworks for IoT systems?	Task-oriented framework for IoT system processes	IoT (data-driven decision-making)	*Task-oriented framework for IoT systems	Decision-making processes, IoT data types	Evaluated based on decision-making accuracy and structural optimization	Developed a framework that supports IoT systems, enabling task-oriented and effective process management
Gharibi et al. (2024)	How can ontology and recommendation systems improve satisfaction in e-shopping?	Ontology-based recommendation system with CNN models	E-commerce and recommendation systems	Public dataset used for ontology-based recommender system (Gharibi et al., 2024)	Textual and visual product attributes	Evaluated by RMSE, MAE, and user feedback	Improved recommendation accuracy and alignment with user preferences using ontology-based methods
Ge et al. (2024)	How can ontology be used to improve autonomous robotics and task management in AI?	Ontology-supported autonomous robotics and task management	Robot task management and environmental data	Robot task execution data from real-time operations (Ge et al., 2024)	Task-specific attributes and environment factors	Evaluated based on task execution accuracy and scope	Improved task execution and decision-making in robotics through ontology-based alignment
S. X. Wu et al. (2024)	How can ontology support integration of system models?	Ontology-based support for system design	Systems engineering and operational data	*Ontology-based system design models	Cognitive and coordination features	Evaluated based on coordination, design goals, and precision	Improved alignment of design and operational goals through the integration of cognitive and ontology features

End of Table 2

Reference	Main research question / problem	Proposed method	Research field / application area	Dataset used	Attributes for analysis	Method evaluation	Result
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Anuraj et al. (2024)	What are key semantic & dynamic aspects in IoT coordination?	Systematic literature review and evaluation	IoT devices, engineering processes, and coordination aspects	*Literature sources on IoT and semantic analysis	Semantic features, dynamic coordination aspects	Evaluated based on flexibility and response time	Identified practical use cases and solutions for coordinating IoT systems efficiently
Pinheiro et al. (2024)	How can ontology improve API-based EA insights?	Ontology tailored for EA (Enterprise Architecture) data	Insights and management of API data	Real-world API Gateway logs from enterprise system (Pinheiro et al., 2024)	API calls, data attributes	Evaluated by efficiency and predictive capabilities	Improved EA processes by enabling API-based data assessment and insights
Ranjgar et al. (2024)	What are key factors for managing cultural heritage information?	Literature review of heritage methods and standards	Cultural heritage information management	*Literature review (cultural heritage methods)	Search queries, semantic, and ontological links	Evaluated using existing methodologies and perspectives	Identified trends and preservation methods in ontology-driven heritage management
Tao et al. (2024)	How to develop ontology for geological info analysis?	Domain ontology-driven geological data model	Geoscience and geological information analysis	Geoscience Report Collection (Tao et al., 2024)	Spatial and temporal attributes, terrain indicators	Evaluated by efficiency and accuracy	Developed ontology integrating spatial and temporal data for geological contexts
Moskalenko (2024)	How can hierarchical models support intelligent process management?	Hierarchical graph and database modelling	Intelligent process and service management	*Hierarchical graph and database model	Hierarchical links, usage efficiency	Evaluated by system efficiency and complexity	Designed platform model using hierarchical structure for intelligent process management
Kosse et al. (2024)	How can semantic twins support planning & optimization in I4.0?	Semantic digital twin models for Industry 4.0 processes	Production planning, Industry 4.0	Real-world production scheduling data from precast concrete manufacturing (Kosse et al., 2024)	Product and process semantic views	Evaluated based on planning accuracy and optimization effectiveness	Enhanced management, planning, and supply chain optimization using a semantic model

Note: *The research did not specify or reference any particular dataset.

4.1. Main questions and problems in research

The research questions of the analysed works (Table 1, Column 2) are focused on ontology and data-driven modelling of BP. These questions relate primarily to the use of ontological subjects in BP management (Adams et al., 2021) and the integration of data analysis (Alotaibi, 2020) to increase the efficiency of the process. The authors raise questions about how ontology could structure BP and improve their management (Adams et al., 2021). Some analysed papers examine the impact of ontology and data methods on decision-making and process optimization, such as how to incorporate semantic relationships to increase process compatibility (Moulouel et al., 2023). 11 articles examine the application of ontological models to the organization of BP, while 8 articles analyse the importance of data integration for data management and efficiency (Lyu et al., 2021). It is clear that the authors highlight the different functions of ontology, such as semantic compatibility, structuring information, and ensuring the availability of data (Romero et al., 2022). Process automation and more efficient resource management are research problems, and ontology is the main structural tool (Wilk et al., 2020). Some research also examine how ontology affects the availability of process data and the transparency of BP (Sánchez et al., 2020). In general, research topics reveal the possibilities of integrating ontological and data methods into BP, especially in the field of process optimization and decision-making (Alotaibi, 2020).

4.2. Proposed methods in research

The described research methods include both theoretical and empirical methods of optimizing BP using ontological tools and data analysis (Table 1. Column 3). Many articles apply ontological modelling, which allows you to create a structural semantic system of process management by integrating advanced analytical tools (Adams et al., 2021). Based on a detailed analysis of BPM standards, techniques, and languages, about ten articles automate decision-making and process management through hybrid methods that include ontology and data analysis, often combined with artificial intelligence (AI) and ML (Alotaibi, 2020). While some researches rely on case research that highlight the useful relationship between ontology and data, others emphasize the synergy between ontology and AI to improve decision-making (Wu et al., 2022). The range of methods allows for a wider application of ontology in BP research, such as process efficiency analysis and data quality improvement (Lyu et al., 2021). Several research analyse the use of unstructured data, which helps optimize decision-making processes (Moulouel et al., 2023). Techniques are also used that rely on semantic modelling to improve the quality and structure of data, adapting to the needs of different processes. Research methods highlight the importance of data integration and structuring in order to achieve greater efficiency in BP (Romero et al., 2022).

4.3. Field and application areas in research

The presented areas of research include BPM, information systems integration, and data management (Table 1. Column 4). Most of the articles analyse the application of ontologies in BP management, paying special attention to the aspect of semantic compatibility (Dhillon & Singh, 2022). About 15 articles focus on modelling BP to optimize data availability and

compatibility (Lyu et al., 2021). Research areas also include data analysis, complemented by ontological models to improve the structure and effectiveness of data (Wu et al., 2022). It is noted that in these areas of research, special attention is paid to the practical application of data management in order to achieve better management and supervisory results (Anuraj et al., 2024). In conclusion, the research areas emphasize the importance of ontology in the management of BP and decision-making, creating an adapted semantic and structural basis.

4.4. Dataset used in research

The presented datasets (Table 1. Column 5) are diverse, covering real data on the activities of enterprises and theoretical experimental data (Ge et al., 2024). Many articles use real BP data to better understand the practical cases and possibilities of applying ontologies (Pinheiro et al., 2024). It is noted that various data attributes, such as data flows, process logs, and semantic relationships, provide the basis for deeper data analysis (Gharibi et al., 2024). Research using real data tend to focus on increasing process efficiency and evaluating performance indicators (Lyu et al., 2021). Some research examines heterogeneous data sources to improve data integration, which provides additional opportunities for improving process management (Wu et al., 2022). Data sets form the basis for semantic analysis and assessment of the application of ontologies in BP.

4.5. Attributes used for prediction in research

The described attributes (Table 1. Column 6), which are used in various research, include semantic and structural relationships in BP management (Moulouel et al., 2023). About 10 articles focus on semantic attributes that allow you to structure processes according to semantic relationships (Dhillon & Singh, 2022). Some research analysis the effectiveness of processes through performance indicators such as productivity, transparency and accuracy (Wilk et al., 2020). Other research analyses the traceability and transparency of processes using data flows and process logs (Alotaibi, 2020).

4.6. Method evaluations in research

An evaluation of the techniques is given in (Table 1. Column 7), with an emphasis on the interoperability and effectiveness criteria. Most research evaluate the effectiveness of ontological methods in the field of BP management, especially considering their ability to integrate with existing systems (Sánchez et al., 2020). About 8 articles examine the applicability of ontologies in organizations and their contribution to process optimization (Lyu et al., 2021). It has been observed that evaluation criteria often include interoperability with other systems, simplicity of integration and level of data compatibility (Romero et al., 2022). Several articles analyse the effectiveness of methods, taking into account their accuracy, resource efficiency and interoperability (Ge et al., 2024). Research have shown that ontological systems contribute to the analysis of BP and an increase in the efficiency of management, which allows to improve the productivity of the organization's work (Lyu et al., 2021). In conclusion, the evaluation criteria focus on the effectiveness and interoperability of methods with existing systems of the organization and the ability to facilitate the analysis of BP.

4.7. Results of the research

The last column (Table 1. Column 8) includes the main research results, which show that ontology and data-based methods provide a structural and semantic basis for modelling BP (Wu et al., 2022). Most of the articles reveal that ontology improves the efficiency of BP, especially when used to ensure semantic analysis and interoperability (Moulouel et al., 2023). About 12 articles claim that ontology contributes to the optimization of decision-making with the inclusion of structured and semantic relationships that improve the quality of process analysis (Romero et al., 2022). It has been observed that data analysis in combination with ontological models helps to create a structured information base that allows BP to be made more efficient (Anuraj et al., 2024). Other research show that ontology contributes to reducing the likelihood of data overload and reducing the likelihood of errors by providing a higher level of semantic compatibility (Gharibi et al., 2024). Some research indicate that ontology helps to optimize the productivity of the organization's work by integrating knowledge management systems with BP. In conclusion, the results show that ontology is an essential element that provides a structural basis and an adapted semantic level in the management of BP and decision-making.

An analysis of the scientific literature on the BPM ontological and data-driven approaches has shown that the current BPM approaches do not sufficiently integrate semantic modelling and data analysis, which raises the need to improve and expand process models in ontology and data in order to achieve greater efficiency of the methods.

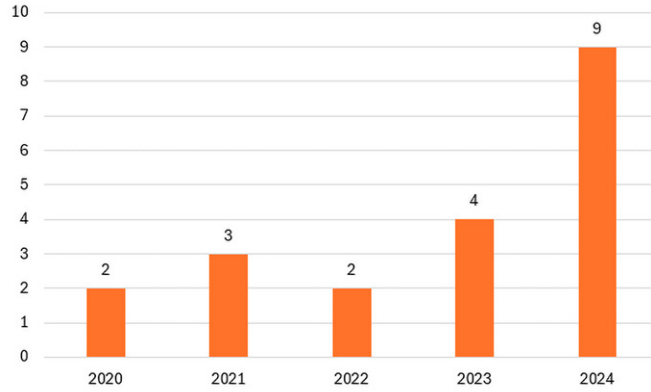

Figure 1. Scientific publications by year (2020–2024)

As shown in Figure 1, the number of relevant publications has steadily increased over the years, reaching its highest point in 2024. This indicates a growing academic focus on the integration of ontology-based and data-driven approaches in business process modelling. One possible explanation for this trend is the rising complexity of organizational environments, which calls for modelling solutions that are not only semantically coherent but also capable of adapting to data-driven decision-making needs (Romero et al., 2022; Lyu et al., 2021)

5. Conclusions

This research presents a rapid review of 24 scientific articles published between 2020 and 2024, focusing on the integration of ontology-based and data-driven approaches within BPM. The analysis shows that while these methods offer significant advantages – such as enhanced semantic consistency, process automation, and improved decision-making – their combined application in BPM remains limited and often inconsistent. Most researches highlight the role of ontology in clarifying semantic structures, whereas data-driven approaches provide adaptability and real-time analytical capabilities.

The findings indicate a growing interest in hybrid approaches that merge semantic modelling with advanced data analytics. Nonetheless, there are still notable challenges, particularly regarding the interoperability, scalability, and implementation of such integrated systems. This research contributes by summarizing dominant research directions, identifying existing gaps, and offering insights for future researches aimed at creating more cohesive BPM solutions. Continued investigation is needed to develop unified frameworks that combine semantic richness with data-awareness, especially in complex and dynamic business environments.

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