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# Auto-Generating Business Process Model From Heterogeneous Documents: A Comprehensive Literature Survey

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**Abstract**— Automatically generated business processes can be sourced from documents in the form of structured text or natural language. Although there have been several studies discussing generating business processes, there is still no research using systematically reviews as the source documents. This study presents a systematic literature review on document sources, methods, and challenges in generating business processes. We conducted a systematic literature review published from 2017 to early 2022 and identified 24 main studies discussing the sources of documents in generating business processes. We formulated and applied inclusion and exclusion criteria in two stages to determine the most relevant studies for our research goal. This literature review found that the most frequently used document sources were textual business rules (structured rules), using case diagrams (14 main studies), event logs (7 studies), and natural language text (3 studies) including customer feedback. In the aspect of the method, the most widely used method is in the field is natural language processing (NLP), followed by other methods such as semantic knowledge engineering (SKE), fuzzy, graph-based, deep learning, and the combination of NLP with deep learning. Meanwhile, the challenges faced in generating business processes include text preprocessing or document extraction, integration of business rules with business processes, and challenges in the form of time interval constraints, activity sequences, dummy activities, or invisible tasks that are generally found in event logs.

**Keywords**— systematic review, auto-generating, business process, document sources type.

## I. INTRODUCTION

The ways in which operations are carried out to accomplish corporate goals are described by a business process. A modeling notation can be used to describe a process, such as the Business Process Modeling Notation (BPMN). The process model can also describe the operational aspects of each task [1]. Business processes provide an overview of all operations of a service or product company. In general, companies have a large number of documents written in natural language or stored in an unstructured manner (text documents), including information related to the company's business processes. Building business process models of text documents may improve businesses' productivity and efficiency. Making business process models requires a lot of time and expertise so many companies rely solely on text

Business process modeling can be denoted using BPMN. BPMN is a business process modeling standard used by many companies [2]. The main goal of BPMN is to provide a notation that is easily understood by all business users [3].

BPMN can also bridge the gap between business process design and implementation (Kale, 2019). Business process modeling can also be notated in various forms, namely Unified Modeling Language (UML) [4], Semantics of Business Vocabulary and Business Rules (SBVR) [5] and Decision Model and Notation (DMN) [6].

Business process problems generally consist of modeling, discovering, automating, redesigning, extracting, and checking business process similarities. Business processes that are generated automatically from various documents are the most frequently found studies. Among them are research conducted by [7], [5] and [8] which propose a method for generating business processes from textual business rules and use case documents into notation. SBVR. Furthermore, research conducted by [9], [10] and [11] propose a transformation from textual business rule document sources and event logs to BPMN notation. In addition, a study conducted by [6] proposed a transformation from natural language texts to DMN notation.

Although the studies mentioned above provide insight into the transformation of business processes, little is known about the various sources of documents used. In addition to formal documents such as business rules or standard operating procedures in various forms, such as use cases, flow maps, narratives, or structured texts, there are other informal documents such as natural language in the form of user feedback or comments. This motivates us to address this knowledge gap.

The remainder of this paper is structured as follows: section 2 discusses the related works of business process model issues, and section 3 presents our research questions and the methods followed to review generating business processes. Section 4 summarizes the key findings of our study (the results), and section 5 provides a discussion of the results. Section 6 concludes the article, and provides the implications and limitations of this study.

## II. RELATED WORKS

There have been many systematic literature reviews (SLR) to identify business process model issues, including a review of the composition of the business process model [12], a review of the visualization of the business process model [13], a review of business process architecture [14] and a review of techniques for generating BPMN models [15],[16]. First, [12] did a literature review on meta-models in BPM to learn about the proposed meta-models, the components of the business

process model, and the topics that the literature currently deems pertinent to describe business processes.

Second, a literature review on the visualization of business process models conducted by [13]. It is well established that visualization enhances perception and comprehension of patterns and structures. Six categories were produced as a consequence of the review: "Augmentation of existing elements," "Creation of new elements," "Exploration of the 3D space," "Information visualization," "Visual feedback concerning flaws found in process models," and "Perspectives".

Third, [14] conducted an analysis of the design process and the business process architecture. The review identified vulnerable areas for additional research, including the identification and modeling of relationships between business processes, input specifications, standardization of models, notations, and tool support, consideration of managerial issues, fusion of knowledge from other fields, validation of methodological aspects, and product quality.

Fourth, [15] undertook a thorough assessment of the literature on modeling BPMN from textual requirements utilizing Natural Language Processing (NLP) techniques, tools, and trends. Meanwhile [16] conducted a literature review on process mining techniques from event logs.

Although there has been research on creating business process models, like the study by [15] and [16] mentioned above, there hasn't been research on identifying the kind of document as the source. The variety of documents in the research on automatically producing business processes makes this review intriguing. Based on that reason, it is planned to carry out a thorough survey to identify auto-generating business processes based on the source documents, which were done by researchers from 2017 to early 2022, and to examine the gaps between them.

### III. RESEARCH METHODS

This method adopts the stages of SLR (Systemic Literature Review) research conducted by [17] and [18] and generally consists of planning, implementing, and reporting the results of a survey or review.

#### A. Review Planning

Review planning begins with determining relevant research questions to achieve research objectives. The next step is to determine the search strategy and search based on keywords, and determine the inclusion and exclusion criteria.

Since the purpose of this study is to review the literature on auto-generating business processes, it is necessary to formulate search strategies and research questions related to document sources, methods, and challenges in auto-generating business processes. There are three research questions as follows:

- a) RQ1: What document sources are used in generating business processes?
- b) RQ2: What methods and tools are used in generating business processes?
- c) RQ3: What are the challenges or problems in generating business processes?

The literature search strategy was carried out by determining the source, type of literature, period of publication, and the language used. Besides, it also determines relevant keywords according to the research objectives and

performs snowballing techniques in the search. The literature search strategy is formulated in Table 1.

TABLE 1. SEARCH SOURCES

| Configuration      | Description   |
|--------------------|---|
| eDatabase          | Mendeley, IEEE Explorer, ACM Digital Library, Springer Link, Science Direct, Google Scholar |
| Type               | Journal, Proceedings  |
| Publication Period | 2017-2022   |
| Language           | English   |

#### B. Inclusion and exclusion criteria

Inclusion and exclusion criteria were used in the literature selection process to obtain relevant studies or literature. Inclusion criteria were as follows: (a) the sources are in the form of journal articles or proceedings, (b) they are published in 2017 to early 2022, (c) they are written in English, (d) they are related to search keywords describing the auto-generated business process by combining a series of words "generating process business". Exclusion criteria were: (a) the articles are in the form of short papers, doctoral symposium papers, a summary of conference keynotes, proposals, lecture notes, editorials, comments, and tutorials, and (b) they are published by predatory conferences or journals. To find out predatory journals or predatory proceedings is to identify their characteristics, such as an editorial board that is difficult to track, incurs a submission fee, and is not indexed by a reputable database.

Based on the inclusion and exclusion criteria for the initial inspection, the literature or publications are evaluated using the abstract, title, and keywords. The next step is to obtain the whole texts of the pertinent studies in order to review the inclusion and exclusion criteria once more and eliminate any that do not. The primary study is designated in the literature that satisfies the requirements.

#### C. Conducting the Review

This section presents the search results, literature selection, and the results of the literature quality assessment. Search and study selection using a combination of keywords relevant to generate-discovery-design-process-business-BPMN". The snowball technique (back and forth technique) is used by checking the reference list to get the relevant literature and checking the citation of the selected literature in a digital database [18]. The search results obtained 85 papers which were filtered by eliminating duplicate and less relevant papers based on inclusion criteria, and identified 24 papers as the main study.

TABLE 2. PAPER QUALITY ASSESSMENT INSTRUMENT

| Criteria | Assessment Criteria                                      | Grade            |
|----------|--|------------------|
| C1       | The research objectives are clearly stated in this paper | 23 studies, 96%  |
| C2       | The proposed method is described in detail               | 22 studies, 92%  |
| C3       | The proposed method is validated                         | 24 studies, 100% |
| C4       | There is an opinion or point of view of the author       | 23 studies, 96%  |
| C5       | This paper was cited by other papers                     | 14 studies, 58%  |

This study uses a paper quality assessment to evaluate the methodological quality of the main paper, which was adopted

from the study [19]. The quality assessment instruments for each main paper are shown in Table 2. Criteria 1 to 4 (C1 - C4) are assessed with a score of = 1 if "Yes"; score = 0 if "Partial"; score = -1 if "No". Meanwhile, criteria 5 is assessed with a score = -1 if the number of citations is 0; score = 0 if the number of citations is 1 to 5; score = 1 if the number of citations > 5.

The results of the assessment of all major papers showed that 0.89 responded positively, meaning that 89% gave a score of 1, and 11% gave a score of 0 and no one gave a negative response. The details of obtaining positive value for each assessment item (C1 to C5) are shown in Figure 1.

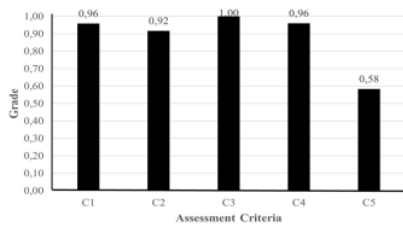


Fig.1. Percentage of positive value

Figure 1 shows that C3 (the proposed method is validated) has the largest and absolute positive response, and C5 has the smallest positive response of only 58%. C3 is the assessment criteria for the aspect of "the proposed method has been validated". C5 is the assessment criteria for the aspect of "this paper was cited by other papers".

#### IV. FINDING OF OUR REVIEW

In this section, the findings from the review based on the research questions previously described. This study identified 24 literatures as the primary study. Table 3 shows the distribution of papers by type of publication, 83% published in journals and 17% in proceedings.

Table 3 shows that the main studies were published in many sources. This indicates that there is no single source chosen by the authors. The discussion topics can be grouped into two aspects, namely 79% on the aspect of building (extract, transform, discover, generate), and 21% on the aspect of repairing (redesign, repairing) using various approaches.

Another highlight is the affiliation of the authors, which is spread across the continents of South America, Europe, Africa, and Asia. These countries are Colombia, Morocco, Spain, Belgium, Poland, Germany, Lithuania, China, Pakistan, and Indonesia. Table 3 illustrates the distribution of publication type and affiliation of authors.

The next explanation deals with the explanation of the answer to each research problem raised. Each research problem was further elaborated as follows.

##### A. RQ1: What Document Sources Are Used In Generating Business Processes?

This study found several types of document sources used in generating business processes, consisting of structured text such as use case diagrams, business rules, standard operating procedures, and unstructured text such as natural languages (user feedbacks) and event logs.

TABLE 3. MAIN STUDY DISTRIBUTION

| Publication   | Type       | # | Affiliation              |
|---|------------|---|--------------------------|
| IEEE Access   | Journal    | 4 | Morocco, Pakistan, China |
| Information Technology and Control  | Journal    | 1 | Lithuania                |
| Data and Knowledge Engineering  | Journal    | 2 | Spain, Lithuania         |
| Applied Science   | Journal    | 1 | Lithuania                |
| Communications in Computer and Information Science                        | Journal    | 1 | Pakistan                 |
| International Conference on Innovative Computing Technology               | Proceeding | 1 | Pakistan                 |
| Information Systems Frontiers   | Journal    | 1 | Poland                   |
| Journal of Systems and Software   | Journal    | 1 | Lithuania                |
| International Journal of Intelligent Engineering and Systems              | Proceeding | 3 | Morocco, Indonesia       |
| Software Evolution Process  | Journal    | 1 | Morocco                  |
| Information and Software Technology                                       | Journal    | 1 | Poland                   |
| Decision Support System   | Journal    | 1 | Colombia                 |
| Business & Information Systems Engineering                                | Journal    | 1 | Germany                  |
| Telecommunication, Computing, Electronics and Control                     | Journal    | 1 | Indonesia                |
| International Conference on Knowledge Science, Engineering and Management | Proceeding | 1 | Poland                   |
| International Conference on Business Process Management                   | Proceeding | 1 | Belgium                  |
| Automated Software Engineering  | Journal    | 1 | Pakistan                 |
| Knowledge and Information Systems   | Journal    | 1 | China                    |

- Use case is a description of the interaction that occurs between the system and its environment. Several studies have used case diagrams as document sources [10],[5].
- Business process execution is often tracked by events that are stored in event logs. This type of document is used by [9],[20],[21],[22].
- Another source of documents used in generating business processes is business rules. The company operates according to a set of rules, laws, policies, and industry standards. According to the Business Rules Group (1993), business rules are statements that define or limit some aspects of a business, which are intended to define the structure of a business or to control business behavior. Business rules are used as a source document in generating business processes [23],[1],[24],[25].
- Natural language is the language used by humans in communicating with each other. Natural language in the context of business processes can be in the form of a description of business decisions or in the form of user's feedback [26],[27],[6],[11].

##### B. RQ2: What Methods And Tools Are Used In Generating Business Processes?

This study also found that the methods used in the main research consisted of Natural Language Processing (NLP),

Semantic Knowledge Engineering (SKE), Fuzzy-miner, Alpha-miner, ontology-based, graph-based, optimization, and deep learning methods. Taxonomy of methods for generating business processes based on document source is shown in Fig. 2.

- NLP is a branch of artificial intelligence that focuses on natural language processing. The deep NLP method is a combination of the NLP method and the deep learning method used by [5],[25],[11].
- Semantics is an explanation of the meaning of a sentence. Several Semantic Knowledge-based methods have been developed and used in business process research, including [1],[28].
- Fuzzy-miner or Alpha-miner or graph-based methods are generally used in event log document sources [29],[30],[20],[21],[31].
- Other methods used are similarity checking, optimization, and ontology [23],[24],[27].

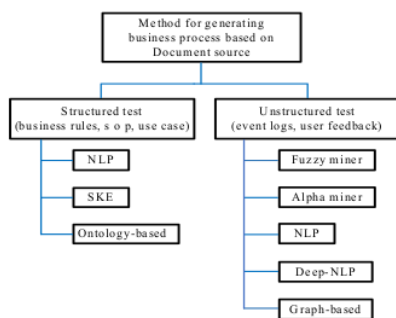


Fig. 2 Taxonomy of method for generating business process

### C. RQ3: What Are The Challenges Or Problems In Generating Business Processes?

Challenges in the transformation to modeling notation found in these 24 main studies consist of challenges at the preprocessing stage of text from source documents to modeling notation, challenges in integrating business rules with business processes, and challenges in implementing methods.

- The challenge at the text preprocessing stage occurs when a text is extracted from the document source which is then processed and used in the next transformation step [3],[30],[11]. Another challenge at the preprocessing stage is finding time interval constraints, activity sequences, dummy activities or invisible tasks, which are commonly found in event log document types [22],[9],[20],[21].
- Challenges in integrating business rules with business processes is transformed into modeling notation encountered by [23],[26],[1],[24],[25].
- The next challenge is choosing, implementing, including combining several methods used to auto-generate business processes [25],[11].

### V. DISCUSSION OF THE RESULTS

Author's affiliation, which is dispersed across the continents of South America, Europe, Africa, and Asia, is one of 24 significant studies on business processes of generation that are analyzed. It is odd that none of the authors are from the United States of America knowing that OMG (Object

Management Group), a global collaboration of BPMN developers, is situated in the USA.

Furthermore, we have identified document sources as structured text and natural text (unstructured text) in response to RQ1. Document sources in the form of structured text such as business rules and use cases are more widely used. While unstructured documents such as event logs, business decision descriptions, and user feedback (natural text language) are used less frequently. This could be due to the longer transformation stages of the natural text language. On the other hand, this is an opportunity to develop research on other informal document sources.

Next, we have identified the methods used in response to RQ1. The NLP method is generally applied to generate business process models from textual requirements automatically [15]. The NLP method can also accommodate semantic problems (SKE). In addition, NLP can be combined with deep learning methods, the combination is very appropriate to use for sentiment analysis based on business process user feedback. One of the main studies [11] proposed an NLP method combined with deep learning to redesign business processes based on customer feedback. The results of the study are in the form of automatic annotation guidelines for the classification of user feedback which can then be used in the redesign of business processes. This research has the potential to be further developed into a modeling notation that can be validated by experts in related fields.

Last, we have identified the challenges in response to RQ3. Challenges in generating business process consist of challenges in preprocessing text from source documents to modeling notation, challenges in integrating business rules with business processes and challenges in implementing methods. The challenges are still possible to develop. Challenges in text preprocessing can occur in informal documents such as the results of interviews with users. Missing link problems and similarity accuracy can appear when integrating business rules with business processes. Meanwhile, challenges in the method aspect can be in developing methods such as quantum deep learning.

### VI. CONCLUSIONS

This paper presents a systematic review of literature on document source, methods and challenges in generating business process. The first author's nation is spread over three continents, Europe, Africa, and Asia, according to the analysis of 24 major research. It was also discovered that the author's most frequently used document sources were textual business rules (structured rules), which included case 914 studies) event logs (7 studies), and natural language text (3 studies) including customer feedback.

In the aspect of the method, the most widely used method is NLP (24 studies), followed by other methods such as SKE, fuzzy, graph-based, deep learning, and a combination of them, namely combining NLP with deep learning as done by [25] and [11]. This is reasonable considering that NLP is a method for analysing text data, where text is the most common source of documents found in making business process models, both structured and unstructured texts. Meanwhile, the challenges encountered in making business process models include preprocessing text or document extraction, integration of business rules with business processes, and challenges in the form of time interval constraints, activity sequences, dummy activities or invisible tasks which are generally found in event log documents [20],[9],[30].

The findings of this review have a number of implications for other scientists. The results of this research highlight the need for additional empirical investigations that incorporate the NLP approach with different techniques (aside from deep learning) that are frequently utilized to create business processes. A study that concentrates on outputs in different notations is also required, and it should use the findings of this review as a guide.

Although this study has several implications, we also acknowledge some limitations of this study. Given that the review has not connected the sources of automatically producing business processes with their outputs using different notations like SBVR, BPMN, and DMN, this research still needs to be improved. Additionally, the keyword combination utilized in the literature search may still be biased, preventing a totally automatic business process from producing all of the search results.

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