Toward a Context-aware Process Model Repository

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Abstract: Many challenges face the enterprises in constantly changing business environment. This requires them to continually consider the context(s) in which they operate to better respond to the challenges they face. Business Process Management (BPM) has become an important approach to create efficient business processes (BPs), which can evolve quickly to adapt to a rapidly changing business environment. The reuse of already designed BP models can improve the agility of defined BPs to address new issues that arise in today's rapidly evolving business environment. Involving context into the current process model repositories is a real challenge. In this paper, we propose an architecture for context-aware process model repository to improve the reusability of the BP models and better meet the expectations of its stakeholders. We also present in this paper a comparative study of the different context-aware BPM approaches, in addition to the contextual factors that influence the reuse of BP models in existing process model repositories.

1 INTRODUCTION

Nowadays, the business environment is very complex and in constant evolution. Today, enterprises face many challenges, including intense competition, economic globalization of markets, and a turbulent economic environment. This requires enterprises to continuously consider the business context(s) in which they operate in order to better meet the challenges they face. Business Process Management (BPM) has become one of the most important approaches to creating effective business processes (BPs), which can evolve rapidly to adapt to a rapidly changing business environment (Alotaibi et al., 2017; Badakhshan et al., 2019). BPM aims to manage the BPs of the enterprise in order to allow its stakeholders to collaborate in the definition, the scalability and the evolution of its BPs (Weske, 2012). The business process (BP) model is a key element of BPM as it allows us to better understand business concerns and thus, improves the communication among stakeholders (Van Der Aalst et al., 2003). Reusing already designed BP models can improve the quality and the agility of defined BPs to address new issues

that arise in today's rapidly evolving business environment (Yamamoto et al., 2018). The re-use of the BP model emphasizes the use of a BP model not only for one specific situation, but also for future situations related to different business contexts. Process model repositories have been designed to store BP models that serve as the knowledge base for their on-going BPM projects to enable re-use of BPs, such as SAP (Curran et al., 1997) and MIT (Malone et al., 2003). Despite the remarkable success of the current process model repositories, it seems that the functionalities of existing repositories are not sufficient to meet the expectations of their stakeholders. It was reported by Broke et al. (2021) in (Vom Brocke, Weber, et al., 2021) that stakeholders are seeking for additional process information to find useful BP models within the existing process repository. Also, it was mentioned that their current functionalities are not aligned with the expectations of a modern digital work experience. Moreover, providing BP models that can meet stakeholders' expectations in a given business context rather than in another is a real challenge. In addition, current repositories do not have advanced features that allow to their stakeholders to easily find the BP models that

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fit their business interests in a particular business context (Khider et al., 2020; Shahzad et al., 2019; Vom Brocke, Weber, et al., 2021; Yan et al., 2017). This is due to the limited experience of user and the limited tools of current process model repositories. Furthermore, most existing retrieval systems in the current process model repositories are based on queries (Wang et al., 2014) while the business context is often ignored in their search functionalities (Adomavicius et al., 2015).To address this issue, this paper presents an architecture for context-aware process model repository that facilitates and improves the reuse of BP model in modern enterprises.

The rest of this paper is organized as follows: Section 2 presents the theoretical background and motivation. In Section 3, work related to the context-aware BPM approaches is summarized. Section 4 comprises a comparative study and an analysis between the presented context-aware BPM approaches. In Section 5, we introduce our proposal for an architecture for context-aware process model repository. In Section 6, we conclude the paper with discussion, summary and perspectives.

2 BACKGROUND AND MOTIVATION

In this section we present a summarized background and our motivation.

2.1 Context Awareness

Context awareness has been a popular research area for a number of years in several disciplines such as mobile technology, artificial intelligence, knowledge management, and web systems engineering. Nowadays, investigating context awareness with BPM field is an important challenge. Context awareness has been recognized as vital in the BPM success (Denner et al., 2018; Santoro et al., 2017; Vom Brocke, Weber, et al., 2021) . According to Kerpedzhiev, et al. in (Kerpedzhiev et al., 2017) context awareness is one of the key characteristics of successful BPM in the digital age. According to Brocke et al. in (Vom Brocke et al., 2016) there are several advantages to context-aware BPM, such as increased process flexibility, better decision-making, and better risk management. Moreover, The motivation for an increased consideration of context in BP Modeling stage has been argued by many researchers (Rosemann et al., 2008; Saidani et al., 2009). Context as defined by Dey in (Dey, 2001) is "*any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves*".

In the context of BPM, Rosemann et al. in (Rosemann et al., 2008) have proposed a definition of context as "*the relevant subset of the entire situation of a business process that requires a business process to adapt to potential changes in the context variables*". Another more specific definition is provided by Born et al. in (Born et al., 2009) '*the context defines the environment in which a business process is used*". They define the business context as a description of a specific business circumstance. Another definition provided by Rosemann et al. in (Rosemann et al., 2008) which defines context as the minimum set of variables containing all relevant information impacting the design and the implementation of a business process.

2.2 BP Model

BP models are key artefacts to represent how work is performed in organizations (Kröschel, 2010). It is defined as a graphical representation of a *BP* or workflow and its related sub-processes that defines the ways in which operations are carried out to accomplish the intended objectives of an organization.

2.3 Process Model Repository

According to Bernstein et al. (1994) in (Bernstein et al., 1994), a process model repository is *"a shared database of information about engineered artefacts produced or used by an enterprise"*. It should provide a common database system for model creation, model modification, model retrieval, model version management. The main benefits of process model repositories are model reuse and knowledge exchange. Several solutions have been proposed to build process model repositories, such as MIT Process Handbook (Malone et al., 2003), SAP (Curran et al., 1997).

3 RELATED WORK: CONTEXT AWARE BPM APPROACHES

Recently, several researches have been proposed in the literature to address context awareness in BPM. Two main research streams are proposed (Denner et al., 2018; Santoro et al., 2017; Vom Brocke, Weber,

et al., 2021). The first one addresses context awareness in BPM by investigating various context dimensions and the second focuses on context-aware BPM as well as context-aware methods by explicitly stating the application context of a BPM method.

Recent researches have focused on how context can be considered in BPM (Denner et al., 2018; Vom Brocke, Baier, et al., 2021).

Others have been proposed to find the contextual factors in BPM research (Vom Brocke et al., 2016), while others have focused on the contextual factors influencing the BP performance (Kronsbein et al., 2014).

Other approaches have been proposed in context-aware process modeling (Bessai et al., 2008; El-Bouroumi et al., 2021; Rosemann et al., 2008, 2006; Saidani et al., 2009; Sofela et al., 2013; Weber et al., 2021).

Other related work has been proposed in context-aware process adaptation (Nunes et al., 2011; Serral et al., 2015) in which context is used to achieve process adaptation. Others have addressed the context aware process configuration (Delfmann et al., 2006; Rosemann et al., 2007).

Other research has proposed an architecture to manage the context-aware execution of processes (Janiesch et al., 2019).

Another context-aware BPM approach has been proposed to address reliability, performance, agility, and process innovation (Vom Brocke, Weber, et al., 2021).

4 CONTEXT AWARE BPM APPROACHES: A COMPARATIVE STUDY

In order to compare the context-aware BPM approaches that were presented in the previous section, several criteria are identified. These criteria concern all context-awareness aspects in BP, in addition to the aspect of BP reusability which is the aim of our research.

These criteria were selected by surveying the literature on context-awareness in BPM and the contextual factors that influence the BPs (Kronsbein et al., 2014; Vom Brocke et al., 2016; Vom Brocke, Weber, et al., 2021). The resulting criteria are presented in line one in the Table 1 below. Context-aware BPM approaches are presented in column one in the Table 1 in alphabetical order.

Table 1: Context-aware BPM approaches: Comparative study.

Context-aware BPM approaches / Context Awareness Aspects in BP	BP Performance	BP Configuration	BP Execution	BP Adaptation	BP Modeling	BP Reusability	BP Reliability	BP Agility	BP Innovation.
(Bessai et al., 2008)					x	none			
(Delfmann et al., 2006)		x				none			
(Denner et al., 2018)						none			
(El-Bouroumi et al., 2021)					x	none			
(Janiesch et al., 2019)			x			none			
(Kronsbein et al., 2014)	x				x	none			
(Rosemann et al., 2007)		x				none			
(Rosemann et al., 2006)					x	none			
(Rosemann et al., 2008)					x	none			
(Nunes et al., 2011)				x		none			
(Saidani et al., 2009)					x	none			
(Serral et al., 2015)				x		none			
(Sofela et al., 2013)					x	none			
(Vom Brocke et al., 2016)						none			
(Vom Brocke, Baier, et al., 2021)						none			
(Vom Brocke, Weber, et al., 2021)	x					none	x	x	x
(Weber et al., 2021)					x	none			

4.1 Comparative Study Analysis

The comparative study on the context-aware BPM approaches (i.e. presented in section: related work), have shown that these approaches do not address context in detail. Furthermore, most of these approaches focused on context as a factor to influence the performance of BP and none of them have considered it impact on the reusability of BP model, furthermore, yet none of these approaches presented a study on the contextual factors that may influence the reusability of BP models. Therefore, none of them has determined these factors yet. To our knowledge, no BPM approaches have considered context requirements as a main factor for improving and enhancing the BP models reusability in the existing process model repositories.

In the following section we propose an architecture for context-aware process model repository.

5 AN ARCHITECTURE FOR CONTEXT-AWARE PROCESS MODEL REPOSITORY

In this section, we introduce a conceptual architecture for context-aware process model repository, we present first a meta-model for context description to understand what context is for BP then, we present the contextual factors that influence the reusability of BP models in process model repositories.

5.1 Meta-model for Context Description

In this section, we present a metamodel for the description of context related to business process. This metamodel was adapted from (Rosemann et al., 2008). As illustrated in Figure 1 below, the context can be categorized into immediate, internal, external, environmental and business context (see Figure 1):

- Immediate context: includes input, output data, organizational resources (e.g. organizational unit, group, position, person and IT and related applications (e.g. middle-ware, web server, database system).
- Internal context: covers information on the internal environment of an organization that impacts the process.
- External context: capture elements that reside within the business network in which an organization operates in which design and behavior is beyond its control.
- Environmental context: comprising all external elements relevant to the process, such as competitors, suppliers, customers, etc.
- Business context: defines the business environment in which a business process is used, it includes factors specific to the industry in which a process is intended to work.
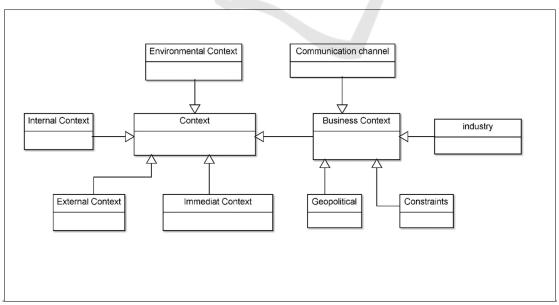

Figure 1: Meta-model for context description adapted from (Rosemann et al., 2008).

5.2 Contextual Factors

According to (Hadi Putra et al., 2020; Kronsbein et al., 2014) for an analysis of the impact of the context on BP. it is necessary to specify the context in the form of contextual factors.

In this section, we try to identify which contextual factors impact the reusability of BP models and how. For this purpose, we analyzed three significant research studies (Denner et al., 2018; Kerpedzhiev et al., 2017; Vom Brocke et al., 2016) on the role of context in BPM. On this basis, we identified the following contextual factors:

Business Environment: Business environment plays a crucial role in the decision-making of companies as it leads to and initiates strategic, dynamic and proactive corporate decision making (Idris et al., 2013; Ostos et al., 2017). The business environment is an external variable that impacts organizational strategies and the correlated strategic decision-making (Barkema et al., 2002). To help modern companies to better identify their context, researchers analyzed the fit between business environment and BPs as the most important contextual factor (Dumas et al., 2013; Vom Brocke et al., 2016).

Industry: Various context factors of an organization need to be considered, specifically the industry in which the organization operates (Denner et al., 2018). Moreover, Rosemann et al. (2008) in (Rosemann et al., 2008) emphasized the need to include industry-specific factors. Furthermore, according to Brocke et al. (2016) in (Vom Brocke et al., 2016) the important organizational contextual factor that can be derived from both BPM research and practice is the industry in which BPM is applied.

5.3 Our Proposed Architecture

This section presents our proposed architecture for a context-aware process model repository. The architecture follows Four-layer architecture composed of Presentation layer, Context layer which is the main layer in our proposal, Repository management layer and repository storage layer. Figure 2 depicts the key elements of each layer as follows:

Presentation Layer: Presents an interaction interface between the repository of process models and the user (i.e. process model repository stakeholder). This layer is composed from a graphic user interface (GUI) that allows each user of the process model repository to access all the functionalities provided by the repository. Each user

provides explicitly details on the business project in which he is involving via the project management component what allows us to get the project profile. This project profile constitutes a simplified description of the project, it business environment, and the industry to which it relates, in addition to definition of it purpose and it business goals.

The Data Extractor component is responsible for gathering data profile from both user profile and project profile respectively, for use as an entry to context extractor component.

Context Layer: This layer includes the following components:

- Context Extractor component: This component extracts context sensitive information.
- Context Filter component: This component is responsible for filtering context and keeping only more relevant contextual factors.
- Context Updater component: This component is responsible for updating the dynamic context.
- Context-aware search engine: This component is devoted to searching BP models by including contextual factors that match the stakeholders' expectations and fit the business context in which they currently operate.

Repository Management Layer: includes all functionalities provided in the process model repository, such as, an interface for searching and querying BP models, an interface to navigate and browse all BP model categories within the repository, in addition to version management, etc.

Repository Storage Layer: Stores the BP models contained in the process model repository in different formats (XML, BPMN) and their associated metadata.
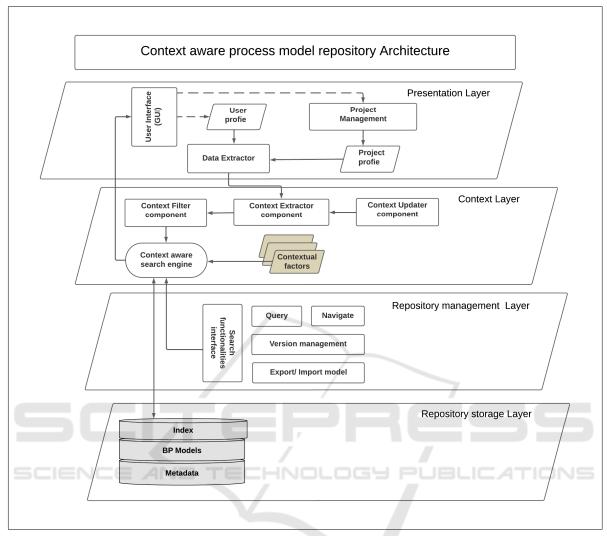
Figure 2: Context aware process model repository architecture.

6 CONCLUSIONS

In this paper, we have proposed an architecture for a context-aware process model repository. The proposed architecture includes advanced functionalities that consider the business context as a key factor in the reuse of BP models, which will better meet stakeholders' expectations in a given business context. One of the paper's significant contributions is the presentation of a comparative study of context-aware BPM approaches. The findings of this study showed that none of these approaches considered context as a key factor influencing the reusability of BP models. The comparative study also showed that none of these approaches provided studies on the contextual factors that may affect the reusability of

BP models within these repositories. Consequently, none of them have yet identified those factors. In this paper, we have identified the business environment and industry as the primary contextual factors that may affect and influence the reusability within existing process model repositories.

In future work, we intend to implement the proposed architecture to confirm these initial findings.

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