A critical review on business process concept, management & life-cycles

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The purpose of this paper is to explore the theoretical foundations of business process domain and to propose a conceptual unified and agile approach. The authors undertake a systematic examination of literature from a critical perspective on key business process aspects, introduced by the most influential approaches based on their citation impact. The review and interpretation of established business process definitions and the association of structural elements, lead to a conceptual business process structure with clear boundaries and interrelated components that considers business process as an ontological entity. The proposed structure encompasses continuous modification of its design, by acknowledging the particular context and the feedback it generates. Following, a similar analysis of BPM definitions and life-cycles results in matching the most frequently occurring cycle steps on specific components of the proposed structure, thus, bridging the gap between business process and BPM life-cycle models. Overall, the review process aims to clarify and connect core business process aspects and the proposed structure and life-cycle to assist organizations in apprehending the various set of stages towards utilizing appropriate and adaptive tools and phases.

Keywords: Business Process Specification; Business process management; BPM life-cycle; Critical Review.

1. Introduction

Introduced in the early 1990s, the concept of business processes emerged as core conceptualization for the design, analysis, and management of the critical parts of the organization that are harmonized for performance (Winter 2019). Professional and research communities embraced the concept based on this premise for continuous improvement and redesign (Harmon 2014), despite the ambiguity of what types of processes fall under the business process umbrella (Schafermeyer, Grgecic, and Rosenkranz 2010). Successful companies organize and implement their business

processes effectively to complete them on time and within the specified resource constraints. Nevertheless, following market rules necessitates companies to continually improve their effectiveness in an effort to be more efficient, and directs efforts towards quicker processes of higher quality and reduced cost (Hung 2006).

Business Process Management (BPM) is regarded as a best practice management principle to assist companies sustain competitive advantage (Tsakalidis and Vergidis 2017). The fact that BPM substantially optimizes overall performance by ensuring that business activities are better scheduled, executed, monitored, and coordinated (Jennings et al. 2000), is decisive in proving its significance for every organization (Becker, Kugeler, and Rosemann 2013). BPM typically consists of a sequence of discrete activities for the continual improvement of business processes, carried out within an iterative life cycle (Weske 2012). This emerging research field raised the interest of many cross-sectional communities such as academia and organizational experts (Rhee, Cho, and Bae 2010), leading to many interdisciplinary approaches in the last decades (Karim, Somers, and Bhattacherjee 2007).

The comprehension of the different tools, techniques, terminologies and features of BPM allowed for the conceptualization of what is referred to as BPM life-cycle (Lee and Lee 2009). BPM encompasses a set of methods, techniques, and tools for handling business processes (i.e. modeling, execution and analysis) of an organization (Weske 2007), which are organized in phases and steps, referred to as *BPM life-cycle* (Dumas et al. 2013). The latter is broadly identified as a schematic diagram that systematizes the methodology and steps of a BPM project, in an effort to manage effectively the organizational operations. Despite the fact that BPM life-cycles share common characteristics such as continuity (Ma and Leymann 2008) and the fact that they are consisted of activities (van der Aalst 2004), there are multiple variations and convergences throughout literature (Ruževičius,

Milinavičiūtė, and Klimas 2012).

The paper aims to address the ambiguity upon the aspects of business processes, BPM and BPM life-cycle, through a critical analysis of the most established approaches in literature. Business process and BPM are umbrella terms in contemporary business process literature (Looy, Backer, and Poels 2014), and the analysis of BPM life-cycle is necessary to achieve better understanding of BPM (Ko, Lee, and Wah Lee 2009). The conducted review intends to highlight common features and interfaces, and ultimately propose a novel business process structure, that is scalable to represent the life-cycle notion and emphasize the value of adaptability. The paper is structured as follows: Section 2 discusses the core concept of business processes, how they are defined in literature and the different perceptions regarding the concept's structure and elements. Section 3 presents the term BPM, the most influential definitions and classification schemes. In a similar manner a literature review is conducted in Section 4, aimed at prospecting papers about the BPM life-cycle. Section 5 introduced the business process entity and business process life-cycle with an analysis of the different structural elements and life-cycle steps accordingly. The paper concludes in Section 6, presenting the findings of the review process and benefits of the business process entity, along with future work and suggestions.

2. Business process concept, definition and deployment

In this section, the authors revisit the concept of business process as it emerges from established approaches and review the most prevalent definitions and common structural elements found in literature. This is performed in a critical perspective to highlight differences in perception and pave the way for discussing the emergence of context and adaptation of business processes. The goal of eliciting and modelling an organization's

business processes is to ensure consistent results and opportunities for improvement (Santoro et al. 2017). However, the concept of business process, both in terms of engagement (*what is a business process?)* and in terms of deployment (w*hat consists a business process?)* is inherently ambiguous proven by the plethora of approaches varying in level of insight and perception (Völkner and Werners 2000). The first definitions of business processes appeared in literature introducing business process as a novelty concept [(Davenport and Short 1990), (Davenport 1993), (Hammer and Champy 1993)]. These original approaches and those that followed, such as [(Havey 2005), (Weske 2007), (Dumas et al. 2013)] highlighted specific aspects without taking into consideration the inherent broad perspective and applicability of business processes. The authors compiled the most influential definitions of business processes (Table 1) that reflect the conceptual diversity that is commonly accepted (Lindsay, Downs, and Lunn 2003). The definitions are selected and sorted based on the citation count of the original work they were articulated.

Davenport and Short (Davenport and Short 1990) defined the concept of a business process by highlighting the execution constraints while a later definition by Davenport (Davenport 1993) introduced business process by capturing the relationship between activities and especially the order of execution, along with an emphasis on the clear input and output of the process. Another influencing definition emphasized on the preconditions (input) and post conditions (output) of the process, while maintaining a customer orientation of the procedure (Hammer and Champy 1993). A definition introduced by Havey (2005) focuses on the ordering of execution steps for the resolution of a specific business problem, an approach that focuses on directness for matters of convenience, while Wang and Wang (2005) concentrate on the method of controlling executed tasks through process knowledge. Weske (2007) suggested a definition that

provides the initiator of the process and the importance of coordination of acts during the execution. Moreover, there is a direct reference to the process objective along with the interaction between businesses. Lastly, a contemporary approach was introduced by Dumas et al. (2013) that define a business process through considering its basic structure that leads to the outcome in an attempt to focus on the customer or any other end result beneficiary.

Table 1. Business Process Definitions.

Author(s)	**Business Process Definitions**	**Citation Count**[1]
Hammer and Champy (1993)	Business process is a collection of activities that take one or more kinds of input and create an output that is of value to the customer.	18652
Davenport (1993)	Business process is a specific ordering of work activities across time and place, with a beginning, an end, and clearly identified inputs and outputs.	9364
Davenport and Short (1990)	Business process is a set of logically related tasks performed to achieve a defined business outcome.	5029
Havey (2005)	Business processes are step by step rules specific to the resolution of a business problem.	590
Weske (2007)	A business process consists of a set of activities that are performed in coordination in an organizational and technical environment. These activities jointly realize a business goal. Each business process is enacted by a single organization, but it may interact with business processes performed by other organizations.	3050
Dumas et al. (2013)	Business process is a collection of interrelated events, activities and decision points that involve a number of actors and objects, and that collectively lead to an outcome that is of value to at least one customer.	1229

This plethora of definitions has given rise to a number of issues regarding their generic

[1] As of 18/03/2019. The citation count alludes to the journal paper introducing the business process definition and not the references of the definition alone (Source: Google Scholar).

apprehension and value. Völkner and Werners (2000) believe that there is no generally accepted business process definition due to the fact the concept has been engaged by a number of different disciplines. Moreover, (Lindsay, Downs, and Lunn 2003) underline that business process definitions are based on machine metaphor type explorations of a process, suggesting that most of them are limited in depth, leading to constrained corresponding models. By reviewing Table I, many definitions tend to be similar in the elements they employ to convey business processes, as most of the aforementioned authors use the terms *activities*, *sequence*, *inputs*, *outputs* and *outcome* to describe the concept. These definitions underline the difficulty of setting the boundaries on what a business process encompasses. Based on the authors' understanding, there is the expectation of articulating structured and rigid *processes* in the diversity of a *business* environment, where a significant variety of heterogeneous complex operations takes place.

This becomes more apparent by inspecting the most frequent business process components reported in the relevant literature. Approaches such as (Weske 2007), (Dumas et al. 2013) attempt to rationalize the ambiguity in generic business process definitions by deploying a set of components that structure (or comprise) a business process. The purpose of a business process is the processing of various cases (e.g. online orders, sales and calculation of travel expenses) that can be either too simplistic when restricted to a functional unit of an organization or more complex by cutting across several business partners (Pourshahid et al. 2009). According to van der Aalst (1995) there are two important elements for a business process to be defined: (a) the activities, that are usually a set of tasks in a specific order, and (b) the allocation of resources to these tasks. Similarly, Dumas et al. (2013) indicate that a business process encompasses a number of events and activities, through illustrating a typical business process example.

Other perceived components are: (i) process structure (i.e. control flow, data flow dependencies and business rules that cover execution constraints), (ii) process goals, and (iii) structural elements such as resources, input and output (Zur Muehlen and Ho 2005). The combination of these components and their relationships construct a structure that attempts to formalize a business process and transfuse a much-desired uniqueness in terms of operations perspective. However, most of these approaches are not extensive on the components they employ (Van der Aalst 1995), they result in either too simplistic (Caetano, Silva, and Tribolet 2005) or too complex structures [(Tyndale-Biscoe et al. 2002), (Born 2012)] and undermine the capability for effectively redesigning a business process as they capture mostly static elements.

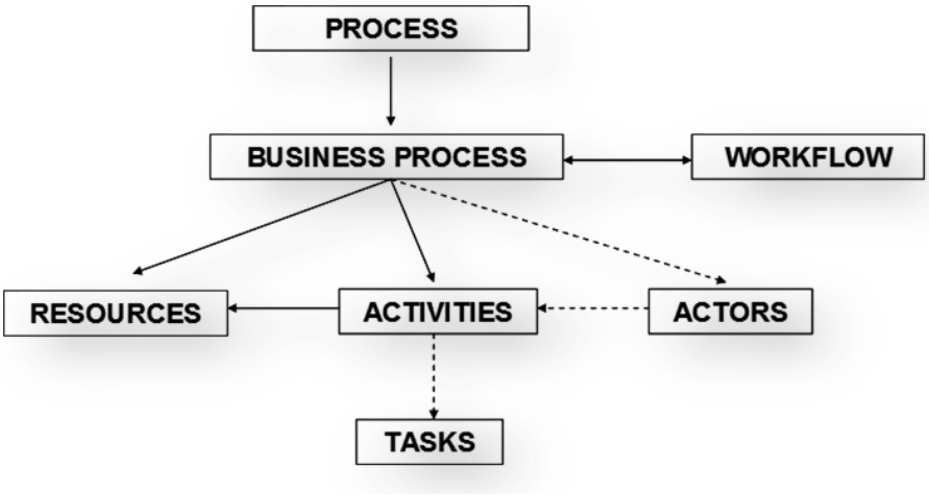

Figure 1. Schematic relationships of the main business process elements
(K. Vergidis 2008)

As an example, Vergidis (2008) proposes a layered business process formation that illustrates the interrelations between structural elements. These elements are placed hierarchically in the structure with arrows reflecting the possible coherences (Figure 1). The solid arrows represent the main elements of the schema while the dashed ones show the optional ones. This approach records -in all formality- the fact that business processes are a subclass of generic processes and, thus, they inherit characteristics such as structure

and flow. In the second level, business processes are placed in parallel with workflows, i.e. specific kind of executable processes, whose transitions between activities are controlled by an information system (Stohr and Zhao 2001). The third level of the business process schema consists of actors, activities and resources which are the main concepts involved in most business process definitions. Similar to Van der Aalst (1995) approach, Vergidis (2008) pinpoints that resources and activities are the compulsory elements, while actors are an optional element, due to their occasional perception as external entities that initiate or execute the actual process. A more contemporary and comprehensive business process structure is suggested by Dumas et al. (2013). The proposed structure (Figure 2) presents the different interconnections between the structural elements of a process. The link between business process and the elements of Event, Activity and Decision Point indicates that events trigger various activities while the different process routes rely upon the decisions taken at decision points. The activities are the only compulsory element of this approach, as both events and decision points can be zero, one or many, depending on the process complexity. The customer is a process actor that initiates the process.

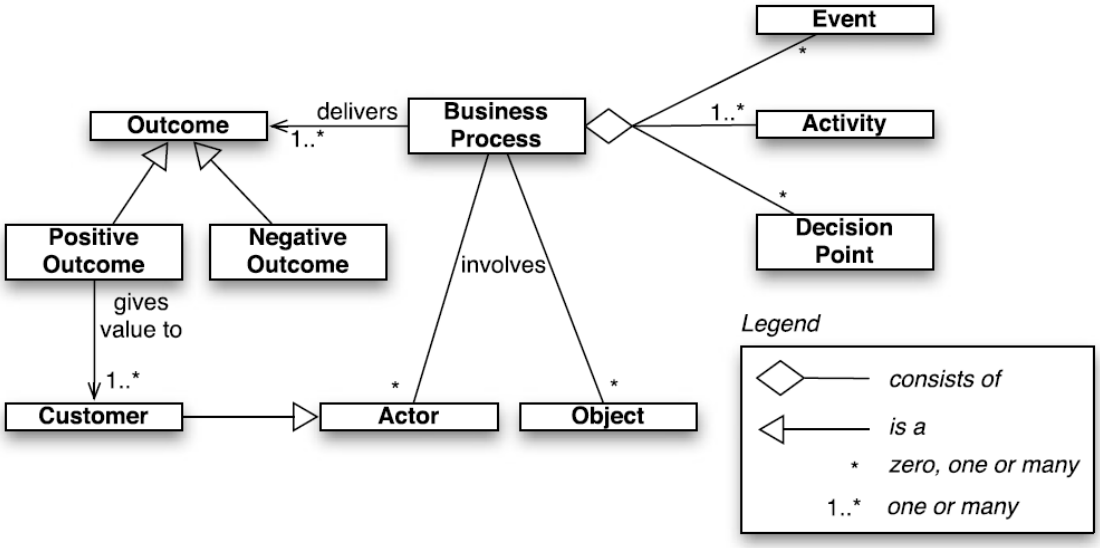

Figure 2. Business Process Structure by Dumas et al. (2013)

Another important structural element of a business process is the outcome(s). The outcome types are strongly influenced by a similar separation of activities based on the value they add to the customer. Accordingly, Dumas et al. (2013) suggest that a process outcome can be either positive when it adds value to the actor or negative when no value is gained or is partially achieved. This is plausible in e.g. an online sales process that results in a refund due to defective product and, thus, no value is added to both customer and supplier, suggesting a negative outcome. The positive outcome gives value to one or many customers, while a business process necessarily involves the actor(s) that initiates the process and the object(s), such as machinery that supports the fulfilment of activities and the product delivered to customer. Other approaches also define business process outcome following the same practice (Grönroos and Ravald 2011), while others provide a similar two-folded perspective of outcome, such as success and failure (Le et al. 2013).

There is a recent shift in perspective in the direction of business process adaptation; the act of customizing a process instance to fit in a specific context (Santoro et al. 2017). In the business process domain, context is the minimal set of variables, necessary for describing the current process state that contains all relevant information with an impact on process design and implementation (Rosemann, Recker, and Flender 2008). Despite being a relatively new field of business process research, context already plays an essential role in several scientific applications such as artificial intelligence, knowledge management and web systems engineering (Saidani and Nurcan 2007). The necessity to narrow the gap between model and reality has also intrigued scientists into combining procedures with additional information about constraints, deviations and operative scenarios that potentially influence how a particular process may unfold in a specific context (Antunes et al. 2013). Relevant research is still at an early stage which accentuates the necessity of a conceptual foundation towards building up systematic supports to

incorporating context awareness into business processes.

The definitions and structural elements examined in this section bring to light the challenges regarding these fundamental aspects of business processes. There are multiple approaches suggesting different definitions based on their generic comprehension and the particular discipline they originate from. Due to the repeatability of elements used in the reviewed definitions, the authors believe that a subset can be used in providing the basis for the delimitation of this aspect. The review also proved that the structural elements examined in this section do not appear to be oriented towards process flexibility (Simões, Antunes, and Carriço 2017) thus enabling redesign; they mostly focus on a static depiction of a reference process model that is not capable of capturing the dynamic instances, exceptions and fluctuations of a business process enacted in a particular context. This perspective has proven inadequate towards structured and automated approaches to defining and (re)designing a business process, which justifies the swift to ontology-based BPM (Aldin and Cesare 2011). In a following section, the authors suggest that business process should be treated as an entity composed of commonly accepted elements, forming a proposed structure that solidifies the concept and supports business process adaptation.

3. Business Process Management definition and classifications

In this section, the authors review the theoretical foundation of business process management concept by presenting the most prevalent definitions and classification schemes in literature. The authors shed light to different viewpoints, their characteristics and restrictions towards providing a critical prospect. Managing business processes has since emerged as a necessity for every organization that adopts the business process outlook (Becker et al. 2013) and there have been reported a variety of approaches inspired

by other management disciplines [(Jennings et al. 1996), (Weske 2012)]. The common goal is to organize and implement business processes effectively, to complete them on time and within the specified resource constraints (Smith and Fingar 2003). This viewpoint aims at improving overall performance by ensuring that business activities are better scheduled, executed, monitored, and coordinated (Jennings et al. 2000). As a result, Business Process Management (BPM) materialized as a combination of disciplines that consider a process-oriented approach suitable for significant improvements of compliance and performance of a system (Vom Brocke, Rosemann, and others 2010). This process-based approach claims to improve customer focus, avoid the limitations of managing by vertical functions and to identify opportunities for improvement (McAdam 1996). Many empirical researchers have underlined this positive outcome of BPM, through identifying critical success factors [(Bandara, Gable, and Rosemann 2005), (Kostas Vergidis, Tiwari, and Majeed 2008)] and theoretically grounding their findings (Trkman 2010). Nevertheless, although BPM is a popular concept among academics and professionals, its theory is not yet been fully founded (Trkman 2010).

Table 2 presents a selection of highly cited BPM definitions. According to Lee and Dale (Lee and Dale 1998) the early definitions of BPM shared common characteristics and perceived BPM as: (a) structured, (b) analytical, (c) cross-functional, and (d) aiming to a continuous improvement of processes. Elzinga et al. (1995) consider BPM as the mechanism used by enterprises to carry out their 'quality' programs (e.g., TQM, TQC, CQI). The quality of products and services is the direct reflection of the enterprise's capability to optimize its processes via BPM (Lee and Dale 1998). Zairi (1997) also pinpoints Quality as the centrepiece of BPM and describes it as the way in which key activities are managed and consequently improved to ensure a constant ability to deliver high quality standards of products and/or services.

Table 2. Business Process Management definitions.

Author(s)	BPM Definition	Citation Count[2]
W. M. Van Der Aalst, Ter Hofstede, and Weske (2003)	BPM is supporting business processes using methods, techniques, and software to design, enact, control, and analyse operational processes involving humans, organizations, applications, documents and other sources of information.	42
Dumas et al. (2013)	BPM is defined as a body of methods, techniques and tools to discover, analyse, redesign, execute and monitor business processes.	1229
Zairi (1997)	BPM is a structured approach to analyse and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operations.	657
Elzinga et al. (1995)	BPM is a systematic, structured approach to analyse, improve, control, and manage processes with the aim of improving the quality of products and services.	379
Vom Brocke, Rosemann, and others (2010)	BPM is a comprehensive system for managing and transforming organizational operations.	267
Weske (2007)	BPM consists of as concepts, methods and techniques to support the design, administration, configuration, enactment and analysis of the business processes.	3050

In more recent definitions, authors focus on specific aspects of BPM. Vom Brocke, Rosemann, and others (2010) perceive BPM as a customer-centric approach to organizational management and define it as a system for managing and transforming operations based on a set of novel ideas about organizational performance. Weske (2007) on the other hand gives value to the most important goals of BPM and suggests that the basis of BPM is the explicit representation of business processes with their performed activities along with the execution constraints between them. Dumas et al. (2013) set business process as the focal point of BPM and indicate that certain BPM features are involved in the process life-cycle, highlighting the importance of management for a

[2] As of 18/03/2019. The citation count alludes to the journal paper introducing the BPM definition and not the references of the definition alone. (Google Scholar).

successful business process implementation. A different perspective is demonstrated by W. M. Van Der Aalst, Ter Hofstede, and Weske (2003) that uses workflow terminology to define BPM due to the far-reaching involvement of Workflow Management (WFM) to BPM procedures. As an outcome, their definition is restricted to operational processes, meaning that the ones at strategic level, or ones that cannot be seemingly formulated, are not embraced by the BPM definition.

According to Goeke and Antonucci (2013), the goal of BPM is to create a process-centric, customer-focused organization that integrates management, people, process and technology for both operational and strategic improvement. To achieve this goal, BPM encompasses diverse attributes and attempts to achieve separate fragmented amendments in isolated parts of a business process usually result in sub-optimal solutions (Hung 2006). Accordingly, BPM includes different methodologies and techniques for process definition (e.g. process specification and modeling), analysis (e.g., Six Sigma, TQM), optimisation (e.g., BPR, JIT, Lean Thinking), execution (e.g., Process-aware Information Systems) and process monitoring and control (e.g., Business Activity Monitoring, technical monitoring). Several BPM methodologies exist following typical process life cycles, the most popular of which can serve as examples: ARIS methodology, IBM web sphere methodology, Ultimus BPM suite methodology, Savvion business manager methodology (Born et al. 2007).

It is evident that the attempt to create a framework that manages business processes is subjective and it is down to an inclination in tools and methodologies that create a different mix. This is the reason why BPM research is not equally addressing the field weaknesses in a structured and systematic way (Harmon 2010). W. M. Van Der Aalst, Ter Hofstede, and Weske (2003) for example, introduced twenty use cases referring to the practical / intended use of BPM techniques and tools to examine which of them is

encountered frequently in practice and which ones need further development. This survey filtered 283 BPM papers and resulted in six key concerns (process modeling languages, process enactment infrastructures, process model analysis, process mining, process flexibility, and process reuse) that highlighted the imbalance of BPM.

The research inference underlines that BPM has aroused as a holistic management discipline that requires a plenitude of facets to be addressed for its successful and sustainable application (Rosemann and vom Brocke 2015). This plethora of approaches has given rise to the necessity of discriminating: (a) The overall research domains that reflect different phenomena of interest, research methods and corresponding evaluation criteria, and (b) the varying methods forming sets of rules and guidelines on proceeding into the various stages of BPM (Bucher and Winter 2010). The sweeping research field of BPM has accordingly transformed the research agenda to accommodate for this broad diversity. To reflect this, the 16th International Conference on BPM (2018)[3] introduced a new structure, based on three tracks that cover different research methods and which employs different evaluation criteria:

- *Foundations (Track I)*, covering the investigation of the underlying principles of BPM systems, computational theories, algorithms, and methods for modeling and analysis of business processes;

- *Engineering (Track II)*, encompassing information systems engineering methods, with a focus on the investigation of artifacts and systems in business environments, following the design science approach; and

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[3] A Conference series providing the most prestigious forum for researchers and practitioners in the field of Business Process Management.

- *Management (Track III)*, aiming towards advancing the comprehension of BPM and examining the application and impact of BPM methods and tools for delivering actual business value.

This ad hoc segregation of BPM research areas, apart from administering issues of topic assignment from formal methods in computer science, to techniques in information systems engineering and management science methods, also serves as a fundamental discrete categorization including all aspects of the broad business process management discipline. On the other hand, more typical approaches towards clustering the available methods into groups with common characteristics ratify the subjective perspective of each author. Hammer (2015) for example proposed the demarcation of these methods in three distinct levels: (a) process-specific individual techniques needed for business intelligence regarding modeling, analysis, simulation, animation, improvement and automation of business processes, (b) methods aiming to encompass all aspects of BPM life-cycle (e.g. Six Sigma, Lean Management), and (c) methods guiding the enterprise towards rolling out of BPM as a corporate competence. The three categories considerably vary in body of knowledge a fact that underlines possibilities for future work to address the research gap. Kostas Vergidis, Tiwari, and Majeed (2008), introduced a classification scheme for business process models according to their structural characteristics and their capabilities for analysis and optimization. The scheme is composed of three sets to classify business process modeling techniques: (a) Diagrammatic models involving models that depict a business process through a visual diagram, (b) Mathematical models referring to models in which all features have a mathematical or a formal foundation, and (c) Business Process Languages, regarding software-based languages that support business process modeling. The classification of modeling techniques, through Venn diagram

demonstration, also applies to the different analysis types and Improvement/optimisation capabilities with considerable efficacy, which cultivates a potential for further application for the classification of BPM approaches.

What is evident from the plethora of BPM definitions, techniques and the attempts in providing some sense-making classifications is that there is no generally accepted way of assessing and evaluating a BPM approach. It is important to set commonly accepted goals and identify opportunities for improvement through maintaining an orientation towards BPM flexibility. In a later section, the authors propose an initial set of criteria for classification and evaluation of BPM approaches and techniques based on the work presented in this paper.

4. Business Process Management Life-cycles review

This section presents Business Process Management (BPM) Life-cycles introduced by the most influential researchers in the field. The authors briefly present the particular focus of each life-cycle which determines the rationality of the selected phases and their interrelations. Business Process Management (BPM) encompasses a set of methods, techniques, and tools for handling business processes (i.e. modeling, execution and analysis) of an organization (Weske 2007), which are organized in phases and steps, referred to as *BPM life-cycle* (Dumas et al. 2013). Advocates of the BPM life-cycles propagate schematic diagrams that systematize the methodology and steps of a BPM project, in an effort to manage effectively the organizational operations. Several BPM life-cycle models are relatively similar due to the use of comparable structures or phases (Alotaibi and Liu 2017). The main elements of a typical BPM life-cycle include: (a) process identification, (b) process analysis, (c) process redesign, (d) process implementation and (e) process monitoring and controlling, as shown in figure 3a (Dumas

et al. 2013). In Figure 3b, the BPM life-cycle is compared to a visualization of the different phase coverage in BPM conference papers (Mendling 2016). One can observe that the different phases are covered to a different extent. Most published conference papers bring up queries associated with process discovery and implementation phases. On the other hand, the least covered phases are topics associated with monitoring and redesign. De Morais et al. (Macedo de Morais et al. 2014) conducted a search and selection process narrowed for studies on BPM life-cycles from 2000 until April 2012 and focused in eight (8) life-cycle models:

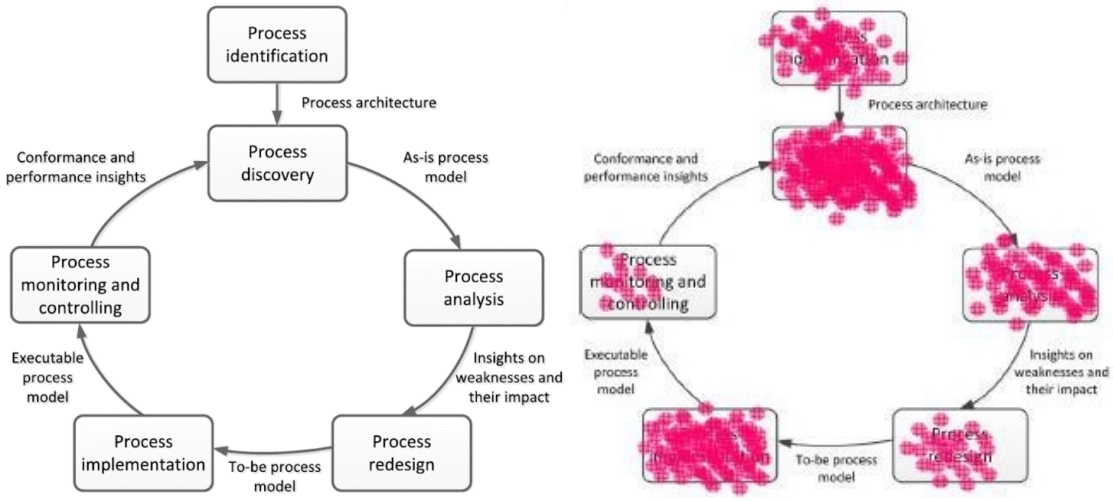

Figure 3. (a) A typical BPM Life-cycle (Dumas et al. 2013) and (b) the relevant research focus (Mendling 2016)

(1) *Van der Aalst Model* (2004). By taking into consideration the relationship between Workflow Management (WFM) and BPM, Van der Aalst model describes the various phases aiming to support operational business processes. This life-cycle model extends the traditional perspective of Workflow management by incorporating the diagnosis phase, in which the operational processes are analysed to identify problems and possible improvements.

(2) *ZurMuehlen and Ho Model* (2005). The authors initially discussed the risks that

participate in the particular phases of BPM life-cycles. By mapping the life-cycle risks to an applicable framework, the authors identified that a series of risks are specific to individual life-cycle phases, while system, leadership, strategy-related and resource risks affect the life-cycle as a whole. The result of this analysis is an iterative approach in form of a continuous process management life-cycle that intends to help organizations achieve, maintain, and improve the quality of their processes.

(3) *Netjes, Reijers, and van der Aalst Model* (2006). The Netjes et al. model is a combination of W. M. Van Der Aalst, Ter Hofstede, and Weske (2003) and Reijers and van Hee (2004) models. The scientific purposes of this approach were to analyze whether BPM systems[4] actually support an introduced BPM Life-cycle. Following the authors evaluation, BPM Systems provide strong support for the phases of configuration, execution and control in the BPM life-cycle. On the other hand, the support is less explicit for the diagnosis and design phase. These results also signify that opportunities exist to improve the support offered by the so-called BPM systems to the entire execution of the BPM life-cycle.

(4) *Weske Model* (2007). The phases of Weske model are organized in a cyclical structure, showing logical dependencies with no strict temporal ordering regarding their execution. The author suggests that the business process life-cycle takes a rather technical view, because it addresses technologies used in BPM and relates them to each other. On the other hand, in a later book section the author takes a broader project-oriented view through investigating the phases required for developing

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[4] The authors evaluated one specific system (FileNet P8 BPM Suite Version 3.5) in detail as it was considered a leading commercial BPM system at that time.

business process applications.

(5) *Hallerbach, Bauer, and Reichert Model* (2008). The authors initially present an approach (PROcess Variants by Options) for managing a large number of process variants in one model. Further on, they discuss major requirements for managing these process variants in a proposed process life-cycle, consisting of three main phases with a (feedback) loop during which the process is optimized to deal with evolving needs. The requirements identified by the authors were among others modeling of process variants, the way they attach to process context, execution in a WfMS, and continuous optimization to attain adaptation. These findings confirmed the viewpoint that the requirements are related to the whole process life cycle.

(6) *Verma Model* (2009). The author affirms the plethora of approaches for conducting a life cycle for the perpetual improvement of processes and regards BPM as an excellent initiative for process improvement. The proposed life-cycle has a large number of steps due to the highly detailed initial steps of planning, analysis and modeling. In this case, the last four phases are the ones forming a cyclical pattern, as the procedure of specifying organizational objectives, the identification and classification of processes precede the actual application of the life-cycle.

(7) *ABPMP Model* (2009). This model consists of distinct steps and feedback that inaugurates a managerial practice for the organization, which is essential for the organization to maintain a process of continual improvement and to secure the alignment of its processes with the strategic objectives. As a business process progressively passes through the life-cycle phases, it can be enabled or be held back by multiple factors, the fundamental of which are Leadership, Values, Culture and Beliefs. Moreover, the examination of business process maturity levels through

proposed models[5], includes the identification of a number of known success factors (e.g. process awareness and responsibility). These are conveyed through ring-shaped features in the life-cycle model, while each of them encompasses questions that organizations should examine to assess their level of business process management maturity.

(8) *Houy, Fettke, and Loos Model* (2010). This model is considered an aggregation of concepts for effectively managing the business processes. According to Houy, Fettke, and Loos (2010) the life-cycle and the various phase sequences depend on the author's perspective. Nevertheless, in their proposed model, one can discern many commonalities with the ABPMP model, due to the fact that the last serves as a reference point. The authors also suggested that despite differences in the number and codification of phases, the actual definitions do not vary fundamentally.

De Morais et al. (2014) claim that the model proposed by The Association of Business Process Management Professionals (ABPMP) can be used as a reference point for the purposes of further research as it is developed by practitioners in the BPM field. Based on comparative analysis of ABPMP model with the rest models and examination of alignment between business strategy and processes, De Morais et al. (2014) proposed a framework that further elaborates the BPM life-cycle with an emphasis on strategy.

From April 2012 until January 2017, prominent BPM life-cycles were also proposed by W. M. Van Der Aalst, Ter Hofstede, and Weske (2013) and Dumas et al. (2013). W. M. Van Der Aalst, Ter Hofstede, and Weske (2013) consists of three phases: (1) (re)design

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[5] Several business process maturity models are based on the Capability Maturity Model® (CMM) developed by Carnegie Mellon University's Software Engineering Institute.

in which the process model is designed, (2) implement/configure that transforms the process into a running system, and (3) run and adjust for the enactment and modification for reasons of adjustment. During the life-cycle phases two types of analysis take place: model-based analysis and data-based analysis. The event data deriving from process execution are collected and used to e.g. discover bottlenecks and deviations which serve as input for the (re)design phase (Van Der Aalst, Ter Hofstede, and Weske 2013). Consequently, a model-based analysis is performed through (a) validation, i.e. testing whether the process behaves as expected, (b) verification, i.e. examining the accuracy of process definition and (c) performance analysis, i.e. evaluating the ability to meet requirements (Van der Aalst 2007).

The Dumas et al. (2013) life-cycle model is based on an integrated viewpoint that intends to bring together system engineers with process analysts, for them to comprehend the main issues affecting a given process, and how to best address these issues, either by means of automation or by other means. Dumas et al. (2013) view BPM as continuous cycle comprising: process identification, discovery, analysis, redesign, implementation, monitoring and controlling. A complementary viewpoint on the BPM life-cycle is given by introducing the "Stakeholders in the BPM life-cycle", a field that summarizes the roles in a company that are involved in BPM initiatives either directly or indirectly. Of the life-cycles emerging at this time frame, other were focusing on specific aspects, such as Bernardo et al. (2017) that extended Macedo de Morais et al. model (2014) through incorporating an external view into BPM through dynamic capabilities (DCs), and Schulte et al. model (2015) focusing on the infrastructural challenges of elastic BPM and elastic processes based on (Weske 2007).

What is apparent from the analysis of BPM life-cycles is that a representation capturing the complex interrelations between the various cycle steps is missing from the literature.

Researchers either propose simple sequential diagrams with rigid connections between the different life-cycle steps, or introduce illustrations with multi-faceted interfaces in an effort to achieve specific objectives. This variety of approaches underlines the absence of a unanimous point of view in the academic and business community, which results in limited and fragmented benefits depending on the respective interest. Also, other researchers follow the practice of elaborating in existing life-cycles non-critical elements putting forward yet another customized approach in the pile of BPM life-cycles.

5. Business process as an entity: a proposed conceptual structure

Based on the findings as those were elaborated in the previous sections, the authors propose a contextual business process structure (figure 4) that encompasses business process as a unique entity and also caters for effective management and accurate depiction of the life-cycle. The proposed approach is based on the description provided by Lindsay, Downs, and Lunn (2003): *Sustainable business processes carried out by human operators are a balancing act between learning from the past and experimenting with and adapting to the future, and between rules and constraints versus freedom and flexibility.* The proposed entity is separated in three distinct sets of components: (i) the prerequisite components, (ii) the process and contextual components, and (iii) the goal components.

We argue that for designing a business process, the prerequisite components are essential in determining the scope and the outcome: *(a) who is the recipient of the outcome?* The customer (external or internal to the organization) is the initiator of a particular business process instance and the recipient of its outcome so it is crucial to have a clear picture on who the process serves. (b) *what is the expected outcome of the process (i.e. product, service or a combination)?* The desired outcome(s) of the process should be explicitly documented including the cases that they fail to be produced. Designing a business

process without clear indication of what it produces or when it concludes is a recipe for disaster (Leth 1994). *(c) What are the required resources and conditions for the outcome to be produced and the customer to be satisfied?* This prerequisite is about specifying the necessary resources and conditions for the process to run smoothly and document the effect of their absence to a process instance. Completing the specification of the first set of components, the process designer has a clear idea on the business process: who is intended for, what is the outcome and what is required for its enactment.

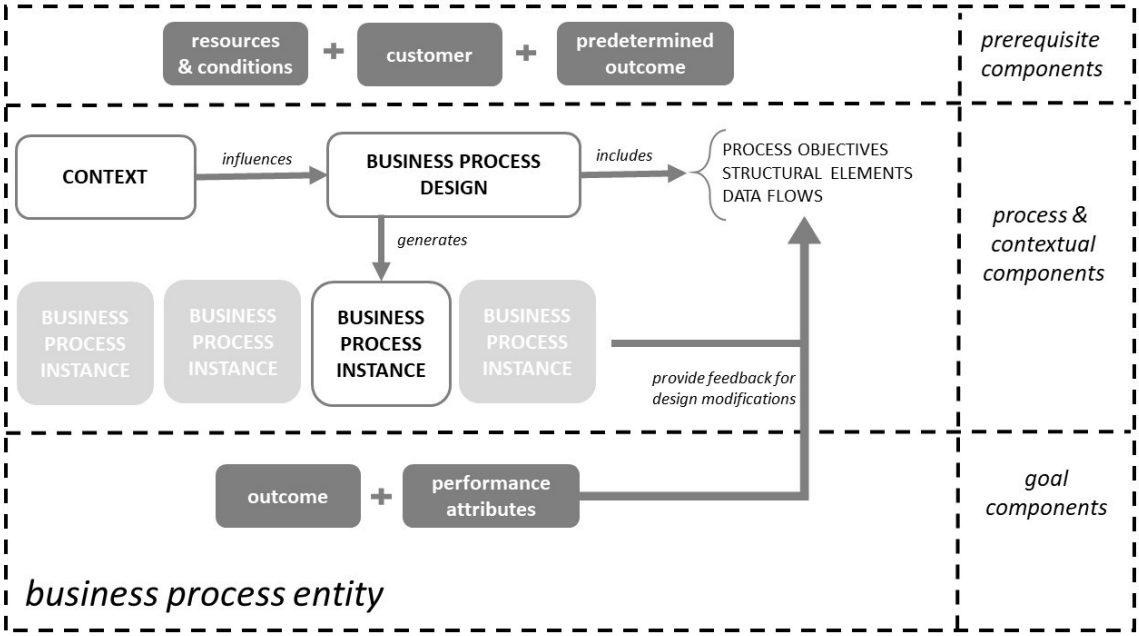

Figure 4. Structure of the business process entity

The second set of components includes the realization of the process design along with the capturing of contextual elements. Examples of how context is incorporated in the business process specification include frameworks that describe context factors with relevance to BPM projects based on their settings (vom Brocke, Zelt, and Schmiedel 2016), and select methods and mechanisms to work together for supporting context-aware BPM (Zhao and Mafuz 2015). The other component is business process design that incorporates: (i) the business objectives (qualitative or quantitative) upon which the process is evaluated; (ii) the particular arrangement of its structural elements (e.g.

activities and other artifacts); and (iii) the data flows, i.e. the circulation of data throughout execution between entities, processes and data (Le Vie and Donald 2000).

The business process instance is a specific enactment and implementation of the business process design, depending on the particular process inputs (Draheim 2010). During a single execution, specific decisions are taken, following the actual events that lead to the performance of explicit activities. The combination of these elements produces each time a unique blueprint based on the initial design. It is important to acknowledge the static nature of a business process design, no matter how accurately describes an operation, and the dynamic knowledge-intensive nature of its generated instances that can provide a better understanding of the capacity for flexibility that a business process can actually demonstrate.

The goal components include: (i) the final outcome; complete or incomplete in relation to the predetermined one, and (ii) the performance attributes; multiple factors and measurement criteria, such as process efficiency, effectiveness and flexibility, policy adherence and traceability (Edwards 2013). These attributes assess each process instance and provide feedback for design modifications. Note that the design should be continuously *modified* based on the feedback of the goal components. Regarding design modification, we avoided using the words ‘improvement, ‘optimization’ and ‘redesign’ as they require specific criteria, objectives and techniques. The aim of the proposed structure is to portray that the business process entity should encompass a continuous modification and evolution of its design based on the feedback it generates. The specific approach towards design modification (whether it is redesign, improvement, restructuring, optimization) is open to different disciplines and methodologies.

The business process entity also accommodates the notion of the cycle-steps being part of a *business process life-cycle*. Based on the survey of the BPM life-cycles, the authors suggest a comprehensive set of steps that compose the business process life-cycle:

(1) *Specification*; This step encompasses the prior specification of scope, i.e. the predetermined outcome the customer intends for, along with the identification of explicit conditions and resources needed to be in place for a continual process execution. This step also serves as a primary conformance check that inspects the organizational capacity required for the next step.

(2) *Design and modelling*; this step determines the artefacts, business objectives and data flows. Design refers to aligning the scope of the process to specific business operations, departments and tasks, whereas modelling refers to capturing the process using structured techniques with formal syntax. At this step, the particular organizational goals are specifically determined following a distinct orientation to customer-centric process management.

(3) *Contextualization (or configuration)* involves system selection and testing through selecting the subjective elements that influence the business process in a particular context. This phase takes place before the actual business process implementation and once it is completed, the system is launched in its context where the design is fine-tuned in accordance to the environment that the process will be enacted (Weske 2007).

(4) *Implementation, Execution and Monitoring;* the selected variant design is translated to an actual workflow taking place in the organization with the assistance of a Business Process Management System (BPMS). A process is enacted each time in the form of a unique process instance containing additional run-time information that can provide feedback for the evaluation of performance. This step also encompasses the

capability of switching variants during runtime to adapt to context changes (Hallerbach, Bauer, and Reichert 2008).

(5) *Performance analysis and evaluation;* The execution data collected from the various process instances in the previous step, are collected in log file format and evaluated based on specific criteria that can be qualitative or quantitative. The competence of the execution environment is also analysed for providing an assessment of contextual features.

(6) *Redesign;* this step occurs through the application of various techniques and approaches that result in modifying the process design based on the feedback for the process run-time and/or the performance attributes e.g., to adapt to current conditions or optimize according to a given objective function. This stage can result in both high- and low-level design modifications or complete overhaul of the business process depending on the technique utilized.

The selection of steps for the proposed business process life-cycle comprises an inclusive collection in comparison to the existing life-cycles. It should be highlighted that the steps selected are first class citizens in all models presented in the previous section, despite the fact that they are incorporated into these models in different ways. The two principal non-mutually exclusive ways in which they are modeled are: (a) directly through a specific component or by using a title with equivalent meaning (e.g. Process Implementation instead of Execution, and Refinement instead of Redesign), and (b) indirectly when the combination of steps pertains to a specific step from the ones proposed (e.g. the combination of Classify Process, Choose Process and Define Tool instead of Design & Modeling). Especially for the Redesign step an indirect reference is also observed through a feedback loop design approach: In such an approach, the phases of business process execution and design are called iteratively. In between these two phases, there may be

additional phases, e.g., dedicated to monitoring and diagnosis. The main rationale is that metadata, new insights and any kind of feedback generated during past executions can be leveraged to enhance the design of processes.

Figure 5 extends the proposed business process structure (Fig. 4) by matching the life-cycle steps with the business process elements identified in section 2. Vice versa, each step is elaborated to the particular activities it is composed of, resulting in a detailed and informative BPM life-cycle. This further showcases that a concise definition and structure of what consists a business process encompasses the various steps it evolves through its life-cycle alleviating the need to define processes and BPM life-cycles separately. Treating the life-cycle as a process itself will reveal a closer and more detailed interaction of the various cycle steps and will provide a clearer perspective of how a business process advances and what tools and technologies are better suited for each of its stages.

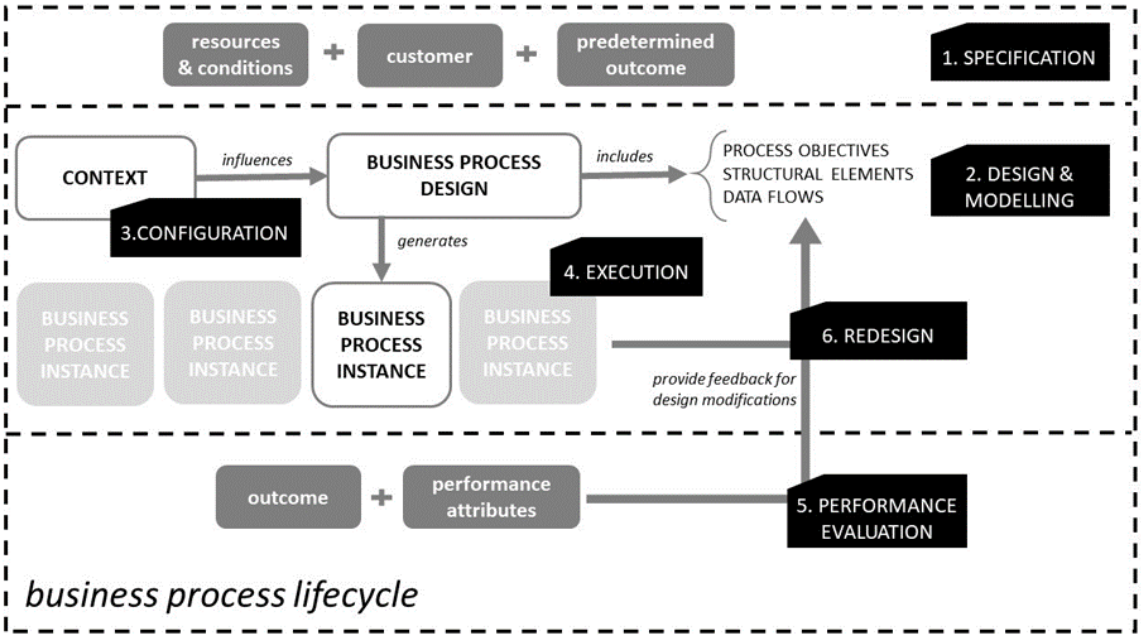

Figure 5. Steps of the business process life-cycle

6. Discussion and Conclusions

In this work, the authors critically examined core aspects of business processes; their definition and structure, management approaches and their classification and, finally, the elements of a business process life-cycle and their interrelations. What is evident in literature is that these fundamental aspects of business processes are not administered equally. There are multiple approaches suggesting different definitions based on their generic comprehension and the particular discipline they originate from. The review also proved that there is a repeatability of structural elements in the examined definitions, but do not appear to be oriented towards process flexibility, thus, enabling redesign. Given the plethora of BPM definitions, techniques and the attempts in providing some sense-making classifications, it is also rationally deduced that there is no generally accepted way of assessing and evaluating a BPM approach. Through critically reviewing these approaches, the importance of setting commonly accepted goals and identifying opportunities for improvement through BPM flexibility, is reinforced.

Likewise, BPM life-cycles found in literature are focusing on specific attributes based on the intended goal, e.g., on how to incorporate external factors into BPM or to align strategy to processes in BPM projects. In the authors' perspective the notion of BPM life-cycle incites misconceptions on structuring and managing an organization's business processes, hence the variety of proposals as previously discussed. *Life-cycle* should be attributed to a business process and the various stages (i.e. elicitation, modelling, enactment, redesign) it evolves through; not BPM as an entity. It is far easier to conceive and manage such perspective: an organization designs business processes by explicitly specifying the life-cycle, span and stages they evolve by utilizing the appropriate tools and methods in each phase. Many of the BPM life-cycles discussed in section 4 make more sense under this perspective.

The critical examination of the most influential theoretical statements of BPM motivated the authors to propose a contemporary business process structure with clear boundaries and interrelated components, that is consisted of the most repeatable contextual elements, and considers business process as an ontological entity. The aim of the structure is also to portray that the business process entity should encompass a continuous modification and evolution of its design based on the feedback it generates. Acknowledging context and incorporating it in the design adds flexibility and highlights the subjective nature of each instance, thus, sufficiently differentiating business process from other types of more rigid processes. The specific approach towards design modification (whether it is redesign, improvement, restructuring, optimization) enables the capability for continuous process improvement and the application of various disciplines and methodologies towards modifying/improving the business process. This conceptual entity and its rationale also comply with modelling business processes and, managing their life-cycle. As seen in section 4, most of the current approaches depict the cycle steps in a simple sequential manner failing to properly depict their complex interrelations. The proposed structure allows for a better layout of its encompassing steps by bridging the gap between business process models and BPM life-cycle models. In specific, it matches the various life-cycle steps to specific components of the business process and aims for a more comprehensive approach in managing the process life-cycle.

As a future direction, this approach will be further extended by modeling the interactions of the various steps through the life-cycle of a business process. Treating the life-cycle as a process itself will reveal a closer and more detailed interaction of the various cycle steps and will provide a clearer perspective of how a business process progresses and what tools and technologies are better suited for each of its stages. A next step would also be to yield a mechanism of recording and generating business process paradigms based on

the proposed structure. In addition, a known issue in evaluating qualitative and quantitative approaches is the lack of a library of comparable business process problems. An established library of theoretical problems is common in many disciplines in testing the performance and consistency of new algorithms and techniques. Having a mechanism to capture and generate business process paradigms will assist in better evaluating the various modelling and improvement approaches put forward by researchers and practitioners in providing comparable results. The proposed business process structure can be a starting point for creating test cases of business processes that can then be utilized in specific domains.

Finally, a promising methodology is to identify four pillars of evaluation of any BPM tool, approach and/or methodology in line with figure 5: (1) the step of the business process life-cycle that it targets, (2) the elements of the business process that it affects, (3) the originating discipline, and (4) the expected impact on the business process design and its type (i.e. qualitative/quantitative). These four criteria could form the basis for classifying and assessing heterogeneous BPM approaches and organizing them in a consistent way. The authors aim at elaborating on a BPM classification mechanism and provide a thorough classification and comparative evaluation of the established BPM approaches in the near future. The classification mechanism could potentially highlight the areas requiring more attention and provide opportunities for the adoption of new technologies in BPM.

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