

Association for Information Systems

AIS Electronic Library (AISeL)

ACIS 2019 Proceedings

Australasian (ACIS)

2019

Business Processes and Flexibility: A Theoretical Perspective

Pedro Antunes

Victoria University of Wellington, Pedro.Antunes@vuw.ac.nz

Mary Tate

Victoria University of Wellington, mary.tate@vuw.ac.nz

Jose A. Pino

Universidad de Chile, pinoemh@gmail.com

Follow this and additional works at: <https://aisel.aisnet.org/acis2019>

Recommended Citation

Antunes, Pedro; Tate, Mary; and Pino, Jose A., "Business Processes and Flexibility: A Theoretical Perspective" (2019). *ACIS 2019 Proceedings*. 7.

<https://aisel.aisnet.org/acis2019/7>

This material is brought to you by the Australasian (ACIS) at AIS Electronic Library (AISeL). It has been accepted for inclusion in ACIS 2019 Proceedings by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

Business Processes and Flexibility: A Theoretical Perspective

Full Paper

Pedro Antunes

School of Information Management
Victoria University of Wellington
Email: pedro.antunes@vuw.ac.nz

Mary Tate

School of Information Management
Victoria University of Wellington
Email: mary.tate@vuw.ac.nz

Jose A. Pino

Department of Computer Science
Universidad de Chile
Email: pinoemh@gmail.com

Abstract

We address the intractable problem of flexibility in business process management: how to deal with variations, unique cases and exceptions? We identify and characterise five conceptualisations of business process. We discuss the main elements and relationships, contracts, and existential and representational properties established by each conceptualisation. For each conceptualisation, we analyse how it impacts flexibility and discuss different strategies for increasing flexibility. Finally, we synthesise our findings in an integrated framework, which helps by relating different conceptualisations of business process with strategies to increase flexibility. This paper makes several conceptual and practical contributions. Considering the former, we disentangle various notions of business process, considering in particular differences between ex ante and ex post, and class and instance. We also highlight that flexibility requires integrating variety and a multi-view over the events defined by a process. Regarding contributions to practice, we propose a framework for organisations to analyse how business processes can be related to flexibility.

Keywords Flexibility, Business Process Management, Business Process, Process Modelling.

1 INTRODUCTION

The concept of business process has been discussed for a long time in various disciplines such as management, information systems (IS) and computer science. It can be traced back to Adam Smith's and Frederick Taylor's ideas related to the subdivision of labour (Fleischmann, Schmidt and Stary 2013). Later, the reengineering movement (Davenport and Short 1990; Hammer 1990) promoted the radical redesign of business processes in combination with IS to transform organisations. After going through several stages of interest, hype, disillusionment, and enlightenment (O'leary 2008), the process concept became a pillar of business process management (BPM) (Van Der Aalst 2013). Broadly speaking, business processes are collections of activities and relationships which together define models for reaching specific business goals (Weske 2007). These models can describe a wide range of organisational operations, including administration, production and services; and in many cases support the control and automation of processes. These capabilities have been important drivers of BPM success, as they help managing complex structures using a small set of descriptive elements.

Unfortunately, organisations may find issues with the model aspect of business processes. Recently, researchers started considering the problem of change (Harmon 2019; Pentland, Hærem and Hillison 2011; Pentland, Recker and Kim 2017). We focus on the related problem of flexibility, which concerns how organisations need to react and adapt to exceptions, unique cases and variations (Reichert and Weber 2012). Flexibility is regarded as an important organisational property, which ultimately can be a determinant of survival (Golden and Powell 2000).

On the IS side, research on improving IS support to flexibility has been intensive (Mejri, Ayachi-Ghannouchi and Martinho 2018; Reichert 2018; Reichert, Hallerbach and Bauer 2015; Vom Brocke, Zelt and Schmiedel 2016). However, the discussion has been mainly focussed on the technical (Reichert 2018) and organisational (Albuquerque and Christ 2015) enablers of flexibility. For instance, the taxonomies of process flexibility proposed by Reichert and Weber (2012) and Schonenberg, Mans, Russell, Mulyar and Van Der Aalst (2008) do not consider the process conceptualisation.

Therefore, we find that process conceptualisation and its impact of flexibility has not yet been sufficiently analysed. And yet, different conceptualisations may result in different understandings and approaches to flexibility. In this essay, we consider two research goals. The first goal is to re-assess some of the fundamental theoretical underpinnings of the process view with the purpose to better understand how they relate to flexibility. The second goal is synthesising a framework for understanding various conceptualisations of business process and flexibility.

2 RESEARCH APPROACH

Method. We adopt the essay approach to delineate some different views about business processes sourced in the related literature. The literature review is embedded in the narrative of different conceptualisations, starting with the most prevalent nowadays, which serves as a baseline for discussion. The review is strictly focussed on the main elements and relationships that, from our point of view, characterise a business process.

IS context. Besides the managerial upbringing discussed in the introduction, the BPM origins can also be linked to IS practice, initially addressing two IS functions: circulation of documents, and control of production chains. From there, the area evolved to cover a wide range of functions such as sales, customer relationships, procurement, and quality control. No less important, the concept was extended to integrate human-human, human-system and system-system information flows, thus providing an integrated information management infrastructure (Van Der Aalst 2013).

The process concept is also intertwined with the model concept, to the point of being almost indistinguishable. Even though—strictly speaking—a process is a particular view of reality, and a process model is a conceptual representation of that view, both processes and models also create their own realities, as artefacts of knowing (Ewenstein and Whyte 2007); and more so if adopted as templates for organisational behaviour. In fact, when organisations embed process models in other “real” artefacts, and then use them to manage operations, process models will recursively become part of reality. In such cases, for the users, either internal or external to the organisation, the distinctions between process and model, process and reality, or model and reality, seem blurred.

The BPM community uses formalisms such as workflow patterns (Van Der Aalst, Ter Hofstede, Kiepuszewski and Barros 2003) and BPMN (Chinosi and Trombetta 2012) to describe processes. Such formalisms have been inspired by mathematical formalisms such as Petri nets to standardise fundamental aspects of business processes. In particular, control-flow defines the execution ordering of activities using a set of constructs (Van Der Aalst, Ter Hofstede, Kiepuszewski and Barros 2003). These

formalisms are required for computational support, but they also foster the development of methods, tools and systems supporting the design, modelling, management, instantiation, and execution of business processes. Therefore, the concept of business process is also related with formal modelling.

Research problem. The flexibility problem is essentially a dilemma of choice regarding the role of processes in organisations. As views/representations of reality, processes have necessarily to filter out certain aspects of reality. By itself, this is not a problem—If processes do not become part of reality. However, as noted earlier, organisations are often tempted to turn processes real through automation and regulation (Bilinkis, Zueva and Zaytseva 2017). In these cases, the reality created by the process will necessarily clash with the reality lived by human beings (Cabitza and Simone 2013). Furthermore, the reality faced by humans is constantly changing, while the reality constructed by processes strives for stability (Pentland, Recker and Kim 2017). Therefore, the dilemma of choice is to decide what role to assign to a process: view/representation of reality, reality itself, or something in between. For example, organisations may have to accommodate strategy and tactics, relying on processes to plot and control the operations. Or guidance and control, using processes as best practices and enforceable rules. Or people and technology, concerning human action and automation. Different choices concern different conceptualisations and have different implications on flexibility.

In this paper, we take a theoretical perspective over this problem. We analyse the conceptualisations of business process proposed in the literature from a flexibility viewpoint, and then derive implications and challenges for organisations. We ask the following questions:

- Which conceptualisations of business process have been proposed in the literature?
- Within each conceptualisation, how has flexibility been considered, and which are the limitations?
- How can we synthesise the different conceptualisations and implications to flexibility into an integrated framework?

Practical impact. We suggest the flexibility problem may be one of the reasons leading to a perceived stagnation, if not decline, of the BPM method. Consider for instance the periodical reports about the state of the BPM field (Harmon and Wolf 2016). Some identified trends suggest that documenting and automating processes have stagnated, and modelling has declined significantly. Given the maturity of the BPM method, this stagnation highlights that most organisations have possibly exhausted the BPM method, i.e. they have already applied it to all processes deserving it. If that is the case, then organisations still have a large number of processes (around 50%; Harmon and Wolf (2016)) not yet subject to the approach, and there may be rational reasons for not doing it, which may be related to conceptual limitations of business processes.

The decline in modelling reported by Harmon and Wolf (2016) is also striking, as it suggests that organisations have decreased their interest in formally representing their operations. Two reasons may contribute to explain this situation. One is they may have decided to use standardised processes supplied by vendors, instead of designing their own, to avoid customisation costs (Momoh, Roy and Shehab 2010). Research identifies several pains related to complexity (Alanne, Kähkönen and Niemi 2014), and suggests that adopting off-the-shelf solutions is financially wise (Elragal and Haddara 2012; Ghobakhloo, Azar and Tang 2019). However, such an approach definitely represents a significant lack of flexibility (and lack of distinctiveness and innovativeness). The other reason may be the perceived impact of formalising too much, as organisations needing change face the associated costs. In both cases, the lack of flexibility may be a compounding problem. This reason is reinforced by the adoption of other, less formal approaches and tools, such as service design and customer journey mapping (Iriarte, Alberdi, Urrutia and Justel 2017). We suggest that addressing the flexibility problem may foster a new interest for the BPM method, as it may contribute to expand its reach to other parts of the organisation requiring a less rigid approach.

3 FIVE CONCEPTUALISATIONS OF BUSINESS PROCESS

The most prevalent view of business processes, widely adopted by the BPM community, is centred on the notion of activity. According to this view, business processes seek to organise the operational activities performed by organisations, and to improve the understanding of their relationships (Weske 2007). Even though various types of relationships have been considered (e.g., data-flow), the one that is foundational to BPM is control-flow (Van Der Aalst 2013): control flows define the order of execution of activities using causal dependencies. We designate this conceptualisation as the **activity model**. The activity model defines a template for executing processes. Therefore, the process must exist *ex ante*: without a template, execution cannot start. This requirement derives from the specific nature of BPM,

which seeks to support business processes through technology. It also explains the emphasis on formally modelling business processes, as a pre-condition for IS support.

An alternative conceptualisation of business process moves away from activities, giving primacy to the actors participating in the process. According to this view, a business process seeks to organise the actors performing activities, and to improve the understanding of their relationships (Fleischmann, Schmidt, Stary, Obermeier and Brger 2012). Actors can be either people or technology. We designate this conceptualisation as the **actor model**. The type of relationship at the core of this model is the communication line, which allows actors to exchange messages. Communication lines are required for the process to advance. Unlike control flows, which are causal, message flows do not have to be ordered and can be multi-directional.

The activity and actor models reflect very different ways to organise work. The activity model organises work using an input-process-output contract: activities wait for inputs to be activated, then process information, and generate outputs. Also part of this contract is the control-flow semantics: when an activity is completed, a token is passed to the activities down the chain, notifying they can start (Chinosi and Trombetta 2012). Quite differently, the actor model establishes a contract centred on responsibilities: actors commit to fulfil certain responsibilities deemed necessary to execute the process. Such responsibilities are activated by exchanging messages. However, the actor model does not specify which activities have to be performed within the scope of assigned responsibilities. That is, while responsibilities are explicit, activities are implicit. Furthermore, since the relationships between actors rely on messaging, they are semantically richer than relying on tokens.

The activity model tends to emphasise the decisional aspects of the process, showing how it may flow in different directions. This allows a business process to explicitly codify the knowledge required to execute the process. On the other hand, the actor model emphasises the collaborative dimension of the process, highlighting that business processes advance through collaboration. A characteristic of the actor model that is shared with the activity model is that both must exist *ex ante*.

A contrasting conceptualisation of business process emphasises the representation of what happens *ex post*, i.e. the process only exists after it has been completed, as a rational account of the real course of events (Biazzo 2000). For that reason, we define the existential property of business processes as a property stating if a process is required to exist before or after it has been executed.

Another property we define, which we designate as representational property, reflects differences between the notions of class and instance. The term ‘class’ means a category of things, while ‘instance’ refers to a thing belonging to a class (Parsons and Wand 2000). Considering these properties, the activity model regards the process as a class: an idealised collection of activities and relationships, which can be instantiated multiple times. The actor model also regard process as a class: an idealised orchestration of actors and communications lines, which can also be instantiated multiple times.

Conversely, some researchers adopt the notion of instance to conceptualise business processes as instantiated activities (Lukyanenko, Parsons and Samuel 2019; Wang and Wang 2006). We designate this approach as the **instance model**. By definition, an instance model can only exist *ex post*: the model describes exactly what happened in a case, instead of describing an abstract case. This model reflects a particular view over work structure, which is based on case handling (Van Der Aalst, Weske and Grunbauer 2005), instead of organising work by rules (as defined by the activity model) or collaborations (as defined by the actor model). Although we have not seen the instance concept applied to the actor model, we do not find any particular reason for not doing it. In that case, the process would characterise one particular case of collaboration between actors. The interest in process instances gained momentum in BPM because it aligns with process mining. Process mining involves synthesising process models from existing data and therefore is done *ex post* (Schönig, Gillitzer, Zeising and Jablonski 2015).

Pentland and Feldman (2007) propose a process view considering the integration of variations, each one describing a particular case, consisting of events and flows. These variations are then put together to define a network of events. We designate this conceptualisation as the **network model**. This model simultaneously describes what is stable (the network) and variable (events and flows) in a business process. The network model contains *ex ante* and *ex post* cases; and because it provides an abstract template describing the various ways in which a process can be executed, it adheres to the class representational property.

Empirical research suggests that organisations generate complex event networks (Pentland, Hærem and Hillison 2011). Consequently, the network model may be difficult to understand by organisations. Furthermore, as the network becomes the critical explanatory element of the business process, it may be difficult to highlight the abstract nature of the process. Pentland and Feldman (2007) recognise this limitation, noting that the approach may result in loss of meaning. Furthermore, they also note that the

network does not accommodate overlapping activities. Laid in between class and instance, the approach captures a common feature of both (the activity network) but also loses the unique views they provide.

The final conceptualisation of business process is primarily centred on individual cases, likewise the instance and network models. It adopts storytelling theory as a foundation for characterising business processes as stories (Antunes, Pino, Tate and Barros 2019; Antunes, Simões, Carriço and Pino 2013; Simões, Antunes and Carriço 2018). For that reason, we designate this conceptualisation as the **story model**.

The story model uses visual and textual narrative elements to describe events and relationships, along with other contextual information describing what happens in the process. Unlike the activity model, which uses explicit syntactical mechanisms to express the process elements, this model relies on the reader to analyse and interpret the events, identifying activities and actors. Therefore, a unique characteristic of the story model is that processes are implicitly defined (Simões, Antunes and Carriço 2018). Each story documents a single case, narrating a chronological series of events. Stories can be either *ex ante* or *ex post*, documenting either instantiated or idealised cases.

As with the network model, various stories referring the same process are related. Furthermore, several types of relationships between elements belonging to different stories can be defined (Antunes, Pino, Tate and Barros 2019): similarity, extension, refinement, generalisation, and contradiction. For instance, two activities belonging to different stories but semantically similar are connected through a similarity relationship; and an activity belonging to story A but not story B is connected to B through an extension relationship. These relationships support a conceptualisation of business process combining the notions of class and instance. By analysing how stories relate to each other, readers can build an abstract account of a business process, while simultaneously being able to analyse the individual aspects of each story. Unlike the network model, which merges the individual models, the story model preserves their uniqueness. In Table 1 we summarise the main properties of the various conceptualisations.

| Model | Elements | Main relationships | Contract | Existential property | Representational property |
|----------------|------------|---|---------------------------|---------------------------------------|---------------------------|
| Activity model | Activities | Control-flows | Input-process-output | Ex ante | Class |
| Actor model | Actors | Communication lines | Responsibilities | Ex ante | Class |
| Instance model | Activities | Control-flows | Input-process-output | Ex post | Instance |
| Network model | Events | Control-flows | Flows between events | May combine ex ante and ex post cases | Class with variations |
| Story model | Events | Narrative flow; relationships between stories | Flows must be interpreted | May combine ex ante and ex post cases | Class and instances |

Table 1. Existing conceptualisations of business process

4 FLEXIBILITY AND THE CONCEPTUALISATION OF BUSINESS PROCESS

Each conceptualisation of business process brings forward different views and approaches to the flexibility problem. We start discussing the activity model (see Table 2).

Since the activity model defines the process *ex ante*, a main concern is how it can represent reality. This concern puts emphasis on the limitations imposed by the process on the way in which the real events unfold. In this context, we find in the literature several strategies for handling process flexibility:

Looseness. It consists in either abstracting or under-specifying the details on how a process unfolds (Cognini, Corradini, Gnesi, Polini and Re 2018). This accommodates variations on how to get the work done (Kolb and Reichert 2013; Weidmann, Kötter, Kintz, Schleicher, Mietzner and Leymann 2011). By increasing abstraction, a process can become more strategic for the organisation; and by under-specifying, the process accommodates contextual changes. On the other hand, in both cases the process becomes less relevant for implementation and IS support.

Flexibility by design. It extends the process scope to describe how to react to exceptions, unique cases and variations (Schonenberg, Mans, Russell, Mulyar and Van Der Aalst 2008; Weidmann, Kötter, Kintz, Schleicher, Mietzner and Leymann 2011). This strategy is particularly adequate to increase IS support to flexibility. However, it also increases process complexity, thus making it more difficult to create and maintain. Quite paradoxically, flexibility by design may turn the process more difficult to change, and

therefore less flexible (Reichert 2018). Nevertheless, this strategy seems adequate to organisations seeking complete control over business processes.

| Model | How the model addresses flexibility | Strategies to increase flexibility | Positive aspects | Negative aspects |
|----------------|---|------------------------------------|---|---|
| Activity model | Representation: Represents variations, unique cases and exceptions | Looseness | Accommodates variations. Can increase strategic value | Decreases operational value and IS support |
| | | Flexibility by design | Increases IS support. Organisation retains control over the process | Decreases strategic value. Processes will become more complex, and difficult to create and maintain |
| | | Human control | Takes advantage of human decision making and problem-solving abilities | Breaks the contract. Decreases control over the process. The organisation may become unstable |
| Actor model | Responsibilities: Actors can be flexible within the scope of their responsibilities | On-the-fly design | Aligns well with interactive organisations. Maintains control, but representational property moves from class to instance | Decreases control. The organisation may end up operating in an ad hoc way |
| | | Social networking | Aligns well with collaborative organisations | Decreases control. The organisation may end up operating in an ad hoc way |
| Instance model | Uniqueness: Reports what really happened in a particular case | Not necessary | Well-aligned with process mining | Fragmented view of operations |
| Network model | Variety: Defines a variety of ways in which events may occur | Generative design | Well-aligned with process mining | Complexity decreases strategic value |
| Story model | Multi-view: Defines a variety of ways in which events can be described and analysed | Interpretive flexibility | Supports knowledge-oriented organisations | Decreases IS support, and precision and control over the process |
| | | Analytic flexibility | Organisations can select a process viewpoint depending on context | Can be conceptually complex. Depends on who analyses the process |

Table 2. Flexibility in the scope of business process conceptualisations

Human control. Since humans have the capacity to make contextual decisions, we can increase flexibility by transferring control from the process to humans. This strategy involves breaking the contract established by the activity model, either violating the input-process-output or the control-flow assumptions, or both. The organisation will then have the capacity to deviate from the process during execution (Schonenberg, Mans, Russell, Mulyar and Van Der Aalst 2008). For example, facing an exceptional event, the model-based execution can be cancelled and control transferred to a human (Reichert and Weber 2012). To increase stability, specific points or regions in the process can be specified where humans may take control (Antunes 2011; Antunes and Mourão 2011). This strategy seems adequate for organisations operating neither as bureaucracies nor as adhocracies, but in-between. However, if there are too many deviations, the organisation could become unstable.

The actor model significantly changes the overall discussion on flexibility. In fact, the main reason for converting from activities to actors is that actors have more freedom to contribute to the process, accommodating different activities within the scope of their responsibilities (Fleischmann, Schmidt, Stary, Obermeier and Brger 2012). For instance, work can be occasionally delegated to another actor without affecting the contract. Therefore, an organisation operating upon the actor model can be more flexible than operating upon the activity model (Fleischmann, Schmidt, Stary, Obermeier and Brger 2012). However, both the activity and actor models share the same constraint: since both define the process ex ante, organisations may find it difficult to accommodate discrepancies between what is idealised and what really happens.

The actor model also brings forward two new strategies for increasing flexibility:

On-the-fly design. At any point in the process, an actor may decide to change the responsibility structure, for instance selecting a different actor to communicate with. This effectively corresponds to designing the process on-the-fly (Gottanka and Meyer 2012; Rothschädl 2012). Interestingly, this strategy changes the representational property of the process from class to instance, and the existential property from *ex ante* to *ex post*. Even though the process is defined *ex ante*, it will not be enforced, because actors can dynamically change it. The process also becomes evolutionary, as it codifies change (Schiffner, Rothschädl and Meyer 2014).

Social networking. Since the process essentially depends on the relationships between human actors, they can network to share knowledge, collaborate and transfer responsibilities (Dorn, Dustdar and Osterweil 2014). Work can also emerge from the community (Mathiesen, Bandara and Watson 2013; Meyer and Schiffner 2014). Therefore, social networking makes the actor model even more collaborative. The process will exist *ex ante* but is not enforceable. Therefore, the strategic value of the process can be low.

Moving now to the instance model, we observe it is ultimately flexible because it always fits reality. In fact, instance models are not challenged by exceptions, unique cases and variations—they codify them. However, organisations operating under this model face some challenges. First, they have to deal with a fragmented view of operations, based on a multiplicity of processes. Second, the organisation has to deal with concrete instead of abstract cases. Finally, the organisation has to deal with processes that only exist *ex post*. Therefore, extreme flexibility comes with significant drawbacks. Lukyanenko, Parsons and Samuel (2019) recognised these drawbacks, noting challenges in analysing and capturing business requirements when conceptualising processes this way.

The network model eliminates most of the drawbacks associated to the instance model by integrating variations in the process. Organisations can execute business processes in a variety of ways and still conceive the process as unitary. Variety emerges from various cases in which the process has been executed, which means the process has hindsight from the real world. Such an approach seems adequate to organisations dealing with frequent exceptions, variations and unique cases, but nevertheless seeking to rationalise and learn from their behaviour.

The network model also affords an interesting new strategy for increasing flexibility:

Generative design. By integrating variations into the process, the network model defines new possibilities for executing the process that would not be available by looking at the individual cases. This characteristic is usually associated to generative design, i.e. the capacity to create new patterns (Pentland and Hærem 2015).

A known problem with the network model is that its maximalist approach may result in a complex network of events, which can make it difficult for the organisation to understand the abstract nature of its own work (Pentland, Hærem and Hillison 2011). A process may end up being a collection of events, where each one is connected to the others.

Finally, we consider the story model. As noted earlier, the story model exhibits both the class and instance representational properties of business processes. Therefore, it also addresses flexibility through variety: representing the various ways in which a process has been executed.

Furthermore, the story model also brings two new strategies for handling flexibility:

Interpretive flexibility. Since the process is described using narrative, it can be interpreted in multiple ways. This allows actors to apply their own judgement when executing the process, a viewpoint that seems adequate to knowledge-oriented organisations. On the other hand, the approach may decrease IS support, which requires formal and precise process definitions; and it decreases precision and control over the process.

Analytic flexibility. This strategy results from the variety of relationships that can be established between elements belonging to different stories, which may include similarity, extension, refinement, generalisation, and contradiction (Antunes, Pino, Tate and Barros 2019). By traversing these different relationships, organisations can view the process from various angles, including moving between different levels of abstraction, zooming in and out when analysing the process details, and exploring contradictions between cases. This allows organisations to dynamically select the viewpoint that best fits the specific context in which the process is or will be executed. On the negative side, the approach can be conceptually complex and, again, it depends on who analyses the process.

5 DISCUSSION AND CONCLUSION

We identified and analysed five viewpoints over the notion of business process, with a specific emphasis on conceptualising the phenomenon (e.g., elements, relationships and contracts). The focus on conceptualisation and the extent of covered viewpoints make this study unique in the BPM field. Furthermore, we specifically avoided situating the discussion on technology support (features, constraints, requirements, algorithms, types of systems, etc.), which tend to dominate the BPM field. Instead, we highlight how different conceptualisations of business process may impact the organisation.

In order to characterise business processes from a conceptual perspective, we propose five fundamental properties: main elements in the conceptualisation; main relationships established by the conceptualisation; contract; existential property; and representational property. In our study, we found out that these properties were sufficient to characterise in detail the selected conceptualisations of business processes. At this stage we cannot claim completeness, which would require a systematic literature review, but future research can use this study as a foundation for making such a claim or extending the framework.

We suggest that the existential and representational properties are essential to clearly distinguish different aspects of business processes that are often blurred. In particular, the existential property is key to understand if a process needs to exist before the events, after the events, or actually can encompass both. The representational property is also essential to understand to what phenomenon a process is referring to, i.e. a class of events, a particular instance of events, or eventually both. We suggest this differentiation provides a more defined characterisation of business processes.

In our study, we avoid committing to a clear separation between the notions of business process and process model. We find that in some cases, process can be related to reality, but this does not necessarily happen all time, because a process may represent a specific case that occurred in the past or may occur in the future. In some cases, the notion of process may be related to reality, while in other cases it may be related to an idealisation of reality, a summation of various realities, or even both. The notion of model may as well face the same challenges, either referring to abstract or concrete representations of events. We find the existential and representational properties help making more clear statements about processes.

The various properties, in particular the existential and representational properties, were also essential to analyse in detail the flexibility problem. We find it significant that, of the five conceptualisations, three address the flexibility problem by intervening on the existential property: moving from an *ex ante* to an *ex post* definition of process. According to this view, flexibility comes not from conceptualising what will/can happen in the process, but from reflecting on what happened. We also find it significant that some conceptualisations also combine the notions of class and instance to address flexibility, integrating the general with the specific.

The more detailed analysis of the conceptualisations of business process highlighted various strategies to increase flexibility. Clearly—in a very twisted way—the most flexible conceptualisation is provided by the instance model. Of course, we realise that flexibility is easy on hindsight. The actual difficulty is planning and facilitating variations, unique cases and exceptions. From a foresight viewpoint, the instance model offers very low flexibility.

We also find that both the activity and actor models score low on flexibility, even though the actor model scores better than the activity model. This happens because both models do not account for knowledge coming from instantiated processes.

However, although it seems tempting to rank the five conceptualisations, we recognise the selection of the best approach ultimately depends on the organisation. Organisations have different characteristics and goals, which may affect the selection of the best choice. For instance, it seems difficult to suggest that social networking is an adequate choice for increasing flexibility when the organisation may be looking to carefully regulate their operations. Therefore, our contribution is a framework highlighting the fundamental conceptual elements of business processes and the associated strategies to increase flexibility. Organisations may use this framework to identify which strategies best suit their specific needs and goals. Future research may consider integrating the multiple perspectives into an overarching conceptualisation.

Having said that, in abstract, we find the network and story models the most promising for supporting flexibility. The idea of generative design, i.e. extrapolating future events and relationships based on past events, seems to offer variety with the right balance between foresight and hindsight. The adoption of interpretive and analytic flexibility also seems interesting, as both suggest looking into variety from various angles: variety not only in what is done (event flows), but also in what is interpreted and valued.

Such multi-view perspective fosters deeper understanding of why a process flows in a certain way (e.g., by zooming in and out) and how it could flow either similarly or differently (e.g., regarding similarities and contradictions).

This study provides contributions to research and practice. Regarding research, we again highlight that no prior research has put together and compared the selected five conceptualisations of business process. The comparison uses a set of criteria that not only allow to characterise the major differences between the selected conceptualisations but bring forth some fundamental properties of business processes.

The discussion on how the various conceptualisations address flexibility, and within each conceptualisation, which strategies can increase flexibility, results in a new taxonomy of process flexibility. This study extends existing taxonomies on flexibility (e.g., Cognini, Corradini, Gnesi, Polini and Re (2018); Harmon (2019); Mejri, Ayachi-Ghannouchi and Martinho (2018); Schonenberg, Mans, Russell, Mulyar and Van Der Aalst (2008)). Furthermore, it enriches the theoretical discussion on flexibility (e.g., Reichert (2018); Reichert, Hallerbach and Bauer (2015); Reichert and Weber (2012)). In particular, we emphasise the separation between conceptualisation and IS support, highlighting that different conceptualisations afford different types of support.

Finally, we also highlight the potential contributions of this study to the development of new technological approaches to flexibility. Discussed ideas on how to integrate the notions of class and instance, ex ante and ex post, representation and responsibility, and variety and multi-view, bring interesting challenges for technology development. In particular, we would like to see IS more capable to deal with responsibilities (e.g., adopting on-the-fly modelling), uniqueness (e.g., managing both classes and instances of processes), variety (e.g., offering generative flows), and multi-variety (e.g., highlighting and managing similarities, contradictions, and different levels of abstraction). From the organisational perspective, our framework may also contribute to extend the BPM method to other processes in the organisation, which may require more nuanced approaches to the analysis, representation, modelling, and execution of processes.

Considering implications for practice, our framework for understanding the flexibility problem suggests that organisations should analyse the different ways in which the concept of business process can be presented, moving away from an exclusive view centred on activities, towards a multiplicity of views covering the variety of ways in which events may occur, may be described, and may be analysed. Even though we recognise the prevalence of viewing business processes as collections of related activities, our framework suggests that other conceptualisations can be integrated. Furthermore, by opening up the process view to new conceptualisations, organisations may explore new strategies to increase flexibility, which make use of the existential and representational properties of business processes. Our characterisation of business processes, along with the identified strategies to increase flexibility, provide a strategic tool for organisations to make decisions on how they model their operations, where the first step indeed consists in reassessing the actual meaning of "process model".

6 REFERENCES

- Alanne, A., Kähkönen, T., and Niemi, E. 2014. "Networks of Pain in ERP Development," *International Conference on Enterprise Information Systems*, pp. 257-266.
- Albuquerque, J., and Christ, M. 2015. "The Tension between Business Process Modelling and Flexibility: Revealing Multiple Dimensions with a Sociomaterial Approach," *The Journal of Strategic Information Systems* (24:3), pp 189-202.
- Antunes, P. 2011. "BPM and Exception Handling: Focus on Organizational Resilience," *IEEE Transactions on System, Man, and Cybernetics C: Applications and Reviews* (41:3), pp 383-392.
- Antunes, P., and Mourão, H. 2011. "Resilient Business Process Management: Framework and Services," *Expert Systems With Applications* (38:2), pp 1241-1254.
- Antunes, P., Pino, J., Tate, M., and Barros, A. 2019. "Eliciting Process Knowledge through Process Stories," *Information Systems Frontiers* (online first).
- Antunes, P., Simões, D., Carriço, L., and Pino, J. 2013. "An End-User Approach to Business Process Modeling," *Journal of Network and Computer Applications* (36:6), pp 1466-1479.
- Biazzo, S. 2000. "Approaches to Business Process Analysis: A Review," *Business process management journal* (6:2), pp 99-112.

- Bilinkis, J., Zueva, A., and Zaytseva, E. 2017. "Context-Aware Enterprise Modelling Towards Agile Models Development," *5th International Conference on Future Internet of Things and Cloud Workshops: IEEE*, pp. 79-87.
- Cabitza, F., and Simone, C. 2013. "Computational Coordination Mechanisms: A Tale of a Struggle for Flexibility," *Computer Supported Cooperative Work* (22:4-6), pp 475-529.
- Chinosi, M., and Trombetta, A. 2012. "BPMN: An Introduction to the Standard," *Computer Standards & Interfaces* (34), pp 124-134.
- Cognini, R., Corradini, F., Gnesi, S., Polini, A., and Re, B. 2018. "Business Process Flexibility. A Systematic Literature Review with a Software Systems Perspective," *Information Systems Frontiers* (20:2), pp 343-371.
- Davenport, T., and Short, J. 1990. "The New Industrial Engineering: Information Technology and Business Process Redesign," *Sloan Management Review* (31:4), pp 11-27.
- Dorn, C., Dustdar, S., and Osterweil, L. 2014. "Specifying Flexible Human Behavior in Interaction-Intensive Process Environments," in: *International Conference on Business Process Management*. Springer, pp. 366-373.
- Elragal, A., and Haddara, M. 2012. "The Future of ERP Systems: Look Backward before Moving Forward," *Procedia Technology* (5), pp 21-30.
- Ewenstein, B., and Whyte, J. 2007. "Visual Representations as 'Artefacts of Knowing'." *Building Research & Information* (35:1), pp 81-89.
- Fleischmann, A., Schmidt, W., and Stary, C. 2013. "(Re-) Justifying BPM: A Quest for the Interaction Turn Reviewing Subject-Oriented BPM," *15th Conference on Business Informatics: IEEE*, pp. 228-233.
- Fleischmann, A., Schmidt, W., Stary, C., Obermeier, S., and Brger, E. 2012. *Subject-Oriented Business Process Management*. Springer.
- Ghobakhloo, M., Azar, A., and Tang, S. 2019. "Business Value of Enterprise Resource Planning Spending and Scope: A Post-Implementation Perspective," *Kybernetes* (48:5), pp 967-989.
- Golden, W., and Powell, P. 2000. "Towards a Definition of Flexibility: In Search of the Holy Grail?," *Omega* (28:4), pp 373-384.
- Gottanka, R., and Meyer, N. 2012. "Modelasyougo:(Re-) Design of S-BPM Process Models During Execution Time," *International Conference on Subject-Oriented Business Process Management: Springer*, pp. 91-105.
- Hammer, M. 1990. "Reengineering Work: Don't Automate, Obliterate," *Harvard business review* (68:4), pp 104-112.
- Harmon, P. 2019. *Business Process Change: A Business Process Management Guide for Managers and Process Professionals*. Morgan Kaufmann.
- Harmon, P., and Wolf, C. 2016. "The State of Business Process Management 2016," *Business Process Trends*
- Iriarte, I., Alberdi, A., Urrutia, E., and Justel, D. 2017. "Beyond Customer Satisfaction. Supporting Organisational Change through Service Design. A Case Study in the Insurance Industry," *The Design Journal* (20), pp pp.S424-S434.
- Kolb, J., and Reichert, M. 2013. "A Flexible Approach for Abstracting and Personalizing Large Business Process Models," *ACM SIGAPP Applied Computing Review* (13:1), pp 6-18.
- Lukyanenko, R., Parsons, J., and Samuel, B. 2019. "Representing Instances: The Case for Reengineering Conceptual Modelling Grammars," *European Journal of Information Systems* (28:1), pp 68-90.
- Mathiesen, P., Bandara, W., and Watson, J. 2013. "The Affordances of Social Technology: A BPM Perspective," in: *Proceedings of 34th International Conference on Information Systems*. AIS.
- Mejri, A., Ayachi-Ghannouchi, S., and Martinho, R. 2018. "A Quantitative Approach for Measuring the Degree of Flexibility of Business Process Models," *Business Process Management Journal* (24:4), pp 1023-1049.
- Meyer, N., and Schiffner, S. 2014. "Democratizing Business Process Management: Empowering Process Participants to Contribute to the Enactment of Business Processes," in: *16th Conference on Business Informatics*. IEEE, pp. 93-100.
- Momoh, A., Roy, R., and Shehab, E. 2010. "Challenges in Enterprise Resource Planning Implementation: State-of-the-Art," *Business Process Management Journal* (16:4), pp 537-565.

- O'leary, D. 2008. "Gartner's Hype Cycle and Information System Research Issues," *International Journal of Accounting Information Systems* (9:4), pp 240-252.
- Parsons, J., and Wand, Y. 2000. "Emancipating Instances from the Tyranny of Classes in Information Modeling," *ACM Transactions on Database Systems* (25:2), pp 228-268.
- Pentland, B., and Feldman, M. 2007. "Narrative Networks: Patterns of Technology and Organization," *Organization Science* (18:5), pp 781-795.
- Pentland, B., and Hærem, T. 2015. "Organizational Routines as Patterns of Action: Implications for Organizational Behavior," *Annual Review of Organizational Psychology and Organizational Behavior* (2:1), pp 465-487.
- Pentland, B., Hærem, T., and Hillison, D. 2011. "The (N)Ever-Changing World: Stability and Change in Organizational Routines," *Organization Science* (22:6), pp 1369-1383.
- Pentland, B., Recker, J., and Kim, I. 2017. "Capturing Reality in Flight? Empirical Tools for Strong Process Theory," *Thirty Eighth International Conference on Information Systems*, Seoul.
- Reichert, M. 2018. "Enabling Flexible and Robust Business Process Automation for the Agile Enterprise," in: *The Essence of Software Engineering*. Cham: Springer, pp. 203-220.
- Reichert, M., Hallerbach, A., and Bauer, T. 2015. "Lifecycle Management of Business Process Variants," in: *Handbook on Business Process Management*. Berlin, Heidelberg: Springer, pp. 251-278.
- Reichert, M., and Weber, B. 2012. *Enabling Flexibility in Process-Aware Information Systems: Challenges, Methods, Technologies*. Heidelberg: Springer.
- Rothschädl, T. 2012. "Ad-Hoc Adaption of Subject-Oriented Business Processes at Runtime to Support Organizational Learning," *S-BPM ONE – Scientific Research*, pp. 22-32.
- Schiffner, S., Rothschädl, T., and Meyer, N. 2014. "Towards a Subject-Oriented Evolutionary Business Information System," in: *IEEE 18th International Enterprise Distributed Object Computing Conference Workshops and Demonstrations*. IEEE, pp. 381-388.
- Schonenberg, H., Mans, R., Russell, N., Mulyar, N., and Van Der Aalst, W. 2008. "Towards a Taxonomy of Process Flexibility," in: *CAiSE forum*. pp. 81-84.
- Schönig, S., Gillitzer, F., Zeising, M., and Jablonski, S. 2015. "Supporting Rule-Based Process Mining by User-Guided Discovery of Resource-Aware Frequent Patterns," in: *Service-Oriented Computing-Icsoc 2014 Workshops*. Springer, pp. 108-119.
- Simões, D., Antunes, P., and Carriço, L. 2018. "Eliciting and Modelling Business Process Stories: A Case Study," *Business & Information Systems Engineering* (60:2), pp 115–132.
- Van Der Aalst, W. 2013. "Business Process Management: A Comprehensive Survey," *ISRN Software Engineering*.
- Van Der Aalst, W., Ter Hofstede, A., Kiepuszewski, B., and Barros, A. 2003. "Workflow Patterns," *Distributed and Parallel Databases* (14), pp 5-51.
- Van Der Aalst, W., Weske, M., and Grunbauer, D. 2005. "Case Handling: A New Paradigm for Business Process Support," *Data & Knowledge Engineering* (53:2), pp 129-162.
- Vom Brocke, J., Zelt, S., and Schmiedel, T. 2016. "On the Role of Context in Business Process Management," *International Journal of Information Management* (36:3), pp 486-495.
- Wang, M., and Wang, H. 2006. "From Process Logic to Business Logic—a Cognitive Approach to Business Process Management," *Information & Management* (43:2), pp 179-193.
- Weidmann, M., Kötter, F., Kintz, M., Schleicher, D., Mietzner, R., and Leymann, F. 2011. "Adaptive Business Process Modeling in the Internet of Services (Abis)," in: *Proceedings of the Sixth International Conference on Internet and Web Applications and Services*.
- Weske, M. 2007. *Business Process Management: Concepts, Languages, Architectures*. Heidelberg: Springer.

Copyright: © 2019 Antunes, Tate & Pino. This is an open-access article distributed under the terms of the [Creative Commons Attribution-NonCommercial 3.0 Australia License](https://creativecommons.org/licenses/by-nc/3.0/au/), which permits non-commercial use, distribution, and reproduction in any medium, provided the original author and ACIS are credited.