Eliciting Process Knowledge Through Process Stories

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Abstract

There are often gaps between the lived experiences of end users and the official version of processes as espoused by the organization. To understand and address these gaps, we propose and evaluate process stories, a method to capture knowledge from end users based on organizational storytelling and visual narrative theories. The method addresses two dimensions related to business processes: 1) coordination knowledge, explaining how activities enfold over time; and 2) contextual knowledge, explaining how coordination depends on other contingency factors. The method is evaluated by comparing process stories against process models officially supported by the participating organizations. The results suggest that process stories identify more activities, events, and actors than official processes, which are supported by a diversity of contextual elements. We then qualitatively analyse these elements to identify the contributions of process stories to process knowledge. Based on the quantitative and qualitative analysis, we draw several implications for business process management.

Keywords: Business Processes; Process Knowledge; Process Stories

1. Introduction

The problem of achieving effective communication between technical experts and end users of technology has been an ongoing challenge for several decades. An important challenge arises concerning the process component where the divide between "official" procedures and end users can be extensive. This divide is spanned by knowledge elicitation – the suite of skills and techniques used by an organization to understand and represent the viewpoints of important stakeholders. In this study, we present an original process storytelling method and demonstrate its effectiveness in eliciting the user view of a process. We use the method to explore and gain insights about knowledge elicitation and the various sources of knowledge used to support process execution that can make knowledge elicitation more effective and reduce the gap between "official" processes and processes as experienced and understood by the end-user

Broadly speaking, business processes combine three major organisational components consisting of people, process and information technology (Ryan & Ko., 2009). The process component captures essential knowledge on how to coordinate end users and information technology, what both do, what resources both need, and other information that may be necessary to support the process goals. The process component can be used by organisations for multiple purposes such as business integration, service provisioning, business analysis, design and change management, decision-making, and communication. As a communication vehicle, it supports mutual understanding between process designers and end users. Regarding integration and provisioning, the process component provides a set of procedures for system support (Reichert & Weber, 2012b). When focussing on analysis, design, decision-making, and change, the process component provides scenarios, templates and procedures about how a business is and how it could be.

However, while organizations consider process scenarios, templates and procedures, end users access actual services. Put another way, end users do not willingly engage with business processes for their own sake, but as a means to access a service they require – they have a "job to be done" (M. Johnson et al., 2008). The majority of business processes exist to add value for a customer (who may be internal or external), and many require active interaction with customers. Therefore, business processes that require user interactions are an integral part of service delivery. In fact, service modelling tools such as service blueprinting, which model customer interactions with an organization, and process modelling tools such as BPMN have extensive areas of overlap (Milton & Johnson, 2012). At a detailed level, service specifications are frequently expressed as processes, with only slight differences of emphasis in terms of representing front and back office components (Milton & Johnson, 2012). Automation and self-service technologies blur the boundaries between organizational processes and customer services even further as customers frequently interact with the same systems and processes used by organization staff, eroding the sense of a "line of visibility" between back and front office (Tate & Johnstone, 2011). In this study, we take a process perspective, but in contexts where end users engage with organizational processes to access services they need or desire.

To the extent that there are gaps between the end users' "job to be done" and the organization-provided scenarios, templates and procedures, the end users are likely to perceive that they are experiencing a reduced level of service quality. These gaps can emerge for various reasons. One is that jobs in organisations are in a course of constantly "becoming" (Pentland et al., 2017), i.e. adjusting to unexpected events, changing needs and problem-solving abilities (König et al., 2018). Another is that social structures participating in organisational procedures are constantly drifting as a consequence of human agency (knowledge, skills, attitudes, behaviours, workarounds, etc.) (Beverungen, 2014; König et al., 2018). Finally, the organization may not have clearly understood the end user's expectations of the process in the first place. This is recognized in services marketing literature as the gap between customer expectations and management understanding of customer expectations (Parasuraman et al., 1991).

Understanding and bridging this gap has been the object of interest in many research areas. For instance, in the field of human-computer interaction, Norman (2013) identified the gulf of execution, which reflects the distance between what end users intend to do and what computers allows them to do, and the gulf of evaluation, which reflects the distance between the computer and end users' representations. In the collaboration field, Suchman (1987) explored the dichotomy between plans and situated action, or in other words, the clash between the system's generic constraints and rules, and the end users' actions, which are always contingent to the situation and may deviate from the rules. In the same field, Cabitza and Simone (2015) also highlighted the differences between design, which is done ex ante, and bricolage, which happens ex post. Even in the philosophy domain, researchers have for long discussed that a representation cannot mirror reality: any representation is always a selective filter over reality (Van Fraassen, 2010). The problem though is not the inability to completely mirror reality, but instead to create representations that trade away aspects of

reality in purposeful ways for end users. Others have also argued that often process knowledge is attributed to senior personnel (domain experts) to the disadvantage of end users, an assumption that can be philosophically challenged, e.g. using the notion of tacit knowledge (Riemer et al., 2013).

This debate is also particularly relevant to process thinking (Van der Aalst et al., 2016), because the process component plays an essential mediating role between end users and procedures, where process models take a central role. In this specific area, previous research has investigated how to model processes in a way that captures business policy (Green et al., 2011; Hashmi et al., 2016; Pentland et al., 2017; Recker et al., 2010; Recker et al., 2011; Weigand et al., 2011); how to design flexible processes (Dorn et al., 2014; Reichert & Weber, 2012a; W. Wang et al., 2018); and how to support business agility using process technology (Baghdadi, 2014; Bandara et al., 2018). However, a limitation of these studies is that they are mainly concerned with the technology side, emphasising either the design-time or the run-time (Rosa et al., 2017), but not the end users.

To increase focus on end users, we suggest that process thinking needs to better address the antecedents of process modelling, in particular, *process elicitation.* As noted by Riemer et al. (2013), "knowledge elicitation and representation are frequently taken as unproblematic due to deep and largely unexamined ontological and epistemological commitments held within the field". However, many existing knowledge representation approaches essentially give primacy to procedural issues (e.g. through analysis of constraints, rules and compliance). For instance, the review of representation theory provided by Burton-Jones et al. (2017a) identifies three models of representation theory – scripts, states and decompositions –, which are considered to reflect the essence of information systems. As noted by Burton-Jones et al. (2017a), representation theory "says little about the contexts in which information systems might be used". We suggest that an emphasis on eliciting and representing procedures leads to a biased (the "unproblematic" attitude referred by (Riemer et al., 2013)) approach to process thinking, which then undermines the end users' viewpoint.

In this paper, we contribute to this discussion by proposing and evaluating a new method for *process elicitation* named *process stories*. The method elicits elements related to two essential categories of process knowledge: *coordination knowledge* explains how activities enfold along time; and *contextual knowledge* explains how coordination depends on other contingency factors. Together, they provide rich descriptions of end user behaviour in business environments. A distinctive characteristic of the proposed method is that it uses storytelling theory (Morgan & Dennehy, 1997) and visual narrative theory (Cohn, 2013).

To evaluate our method, we adopt a comparative approach, contrasting process stories to a baseline, which we designate as *official process*. An official process is any process model sanctioned and implemented by an organization to manage its business. The evaluation uses qualitative techniques, which are also supported by quantitative techniques. The evaluation data concerns two processes belonging to two different organisations. The evaluation data was gathered from a diversity of end users involved in official processes.

We suggest that the proposed method *improves the understanding of business processes from the perspective of end users*. As noted by Recker and Mendling, establishing process management as behavioural science requires understanding "what people perceive and believe, what they do, and why they act as they do" (Recker & Mendling, 2016). Process stories contribute with that kind of knowledge. Furthermore, we have seen an increasing interest by the process community in tackling social aspects of process management, in particular culture (Grau & Moormann, 2014) and context (Vom Brocke et al., 2016). The proposed method provides a foundation for addressing these dimensions of the process paradigm.

Our contribution and research questions are as follows:

1. What kind of process knowledge is elicited by the process storytelling method?
2. How does this offer an opportunity for modellers to identify the various sources of knowledge supporting process execution?

The paper is organised as follows. In the next section, we discuss our conceptual framework for the research. Section 3 discusses the elicitation method in more detail. Section 4 provides a detailed account of the research design and procedures used in this study. Section 5 describes the two cases studies and provides results from the empirical research. Section 6 reflects on the obtained results. Finally, Section 7 provides some concluding remarks.

2. Conceptual Framework

We regard the business process as a combination of three major components consisting of people, process and information technology (Ryan & Ko., 2009). In Figure 1, we present our conceptual framework, where we decompose the people, process and information technology components. The framework is original, but is extensively informed by previous studies. "People" includes end users, which participate in processes, and modellers, which analyse, model, design, and implement processes (Silva & Rosemann, 2012). The "information technology" component supports the process lifecycle with appropriate notations, models, tools, and systems.

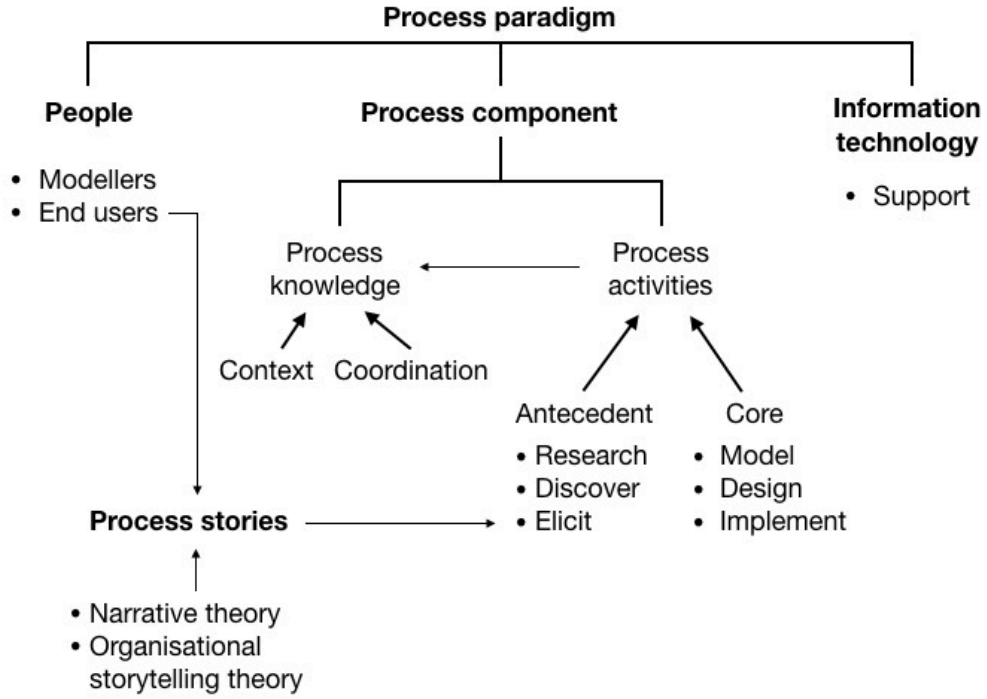

Figure 1 – Conceptual framework

The "process" component can be divided between process knowledge and process activities contributing to accumulate process knowledge. Process knowledge can then be further detailed into two fundamental categories: *coordination knowledge*, explaining how activities enfold along time; and *contextual knowledge*, explaining how coordination depends on other contingency factors (Vom Brocke et al., 2016). Regarding the former, it consists of a set of knowledge elements explaining activities, events, control flow, resources, actors, data, and timing (Van der Aalst, 2013). These elements are the core of process thinking. They define what a process is from an ontological viewpoint (Pedrinaci et al., 2008), and how we can use it, from a standardization viewpoint (Tregear, 2015). Contextual knowledge is essentially an open collection of knowledge elements that help bridging the business and process logics (M. Wang & Wang, 2006). That includes, for instance, information about specific cases and circumstances, variations, informal rules, strategies, and interactions between business and process. Context is about sensitivity to situation and contingency (Vom Brocke et al., 2016). The concern with context is relatively recent in the process community (Anastassiu et al., 2016; Janiesch & Kuhlenkamp, 2018; Kannengiesser et al., 2014; Rosemann & Recker, 2006; Rosemann et al., 2006; Vom Brocke et al., 2016; Wieland et al., 2011).

Process activities encompass two categories, which we designate as antecedent and core. The core activities include *modelling* (how to represent processes), *design* (how to solve organisational needs through process thinking) and *implementation* (how to make processes work in organisations) (Leyh et al., 2017). It should be no surprise that a significant body of research has been devoted to process modelling. A central concern has been the development of specialised notations such as BPMN, BPML, BPEL and S-BPM (Bonnet et al., 2014; Fleischmann et al., 2012; Geiger et al., 2017; OMG, 2011). Other fundamental theoretical

advancements consider structural issues, including coordination theory (Jarzabkowski et al., 2012), design patterns (Brambilla et al., 2012; Van der Aalst et al., 2003), and ontological basis (Burton-Jones et al., 2017b; Rosemann & Green, 2002). Finally, many researchers have been extending process models to accommodate various requirements such as flexibility, agility (Bruno et al., 2011; Kolar & Pitner, 2013; Reichert & Weber, 2012a), quality (Cortes-Cornax et al., 2016; De Oca et al., 2015; Malinova et al., 2014), and adoption (Malinova & Mendling, 2013), just to mention a few.

Regarding the antecedent activities, we identify three types of engagement with the sources of knowledge, which can be applied together and in a complementary way: research, discovery and elicitation. *Research* relies on manual analysis of business data without direct engagement with end users (Biazzo, 2000). It involves analysing genres of communication such as specifications, invoices, contracts, spreadsheets, memos, and other types of business communication (Passera et al., 2017). *Discovery* relies on automated or semi-automated processing of system data such as event logs (Augusto et al., 2016; Van der Aalst, 2011). These approaches use algorithms to find activities and control-flow rules, which may be combined or not with human analysis to predict the end users' behaviour. Finally, *elicitation* involves direct contact with people: end users are engaged in the process of identifying, clarifying and selecting the essential elements of business behaviour. This category includes for instance interviews, focus groups, talk-aloud-protocols, workshops, and ethnography (Clerke & Hopwood, 2014; Hoppenbrouwers et al., 2018). This third activity, elicitation, is our focus.

When compared to research and discovery, elicitation has the advantage of bidirectional interaction with the end users. It also offers the possibility to engage with the data in more dynamic ways, e.g. through collaboration (Hoppenbrouwers et al., 2018), simulation (Jeyaraj, 2010), storyboards (Aysolmaz et al., 2016), and role-playing (Harman et al., 2015). Furthermore, prior research suggests that process elicitation increases the success of process implementation (De Waal & Batenburg, 2014). Therefore, our study concentrates on improving process elicitation.

2.1 Prior research on process knowledge elicitation

The available body of knowledge regarding process knowledge elicitation is scarce. To start with, the phenomenon of interest is still missing from major process frameworks. For instance, it has not been included in Van der Aalst's comprehensive reflections about the process paradigm (Van der Aalst, 2013; Van der Aalst et al., 2016). Other frameworks, like the ones proposed by Aguilar-Saven (2004), Malinova and Mendling (2013), and Recker and Mendling (2016) also do not include process elicitation. The recent taxonomy proposed by Vom Brocke and Mendling (2018) also does not mention elicitation. However, the concept of process identification, which is defined by the authors as "[it] produces detailed descriptions of a business process in its current state" covers elicitation, although not in an explicit way (Vom Brocke & Mendling, 2018). The taxonomy also provides seven published cases on process discovery. A more detailed analysis of these seven cases shows that two of them

actually have done process elicitation, one using workshops (Cereja et al., 2017) and another using semi-structured interviews (Becker et al., 2018).

Such lack of interest may be related to allotting process elicitation into a broader category encompassing the elicitation of user requirements in information systems development (Davey & Cope, 2008; Dieste & Juristo, 2011; Hickey & Davis, 2004). However, we argue that process elicitation should be focussed on specific rather than general requirements, considering in particular coordination and contextual knowledge requirements. This specificity facilitates the externalisation of requirements by the end users in terms of coordination loops (Leyh et al., 2017) and workarounds (Cabitza & Simone, 2013) within an organisational reality (Riemer et al., 2013).

A complementary reason for the lack of interest in process elicitation may be an emphasis on modelling over other aspects of process management. Modelling is arguably the defining characteristic of process management (Alotaibi & Liu, 2017). For instance, Renger et al. (2008) review the challenges of collaborative modelling which focusses on building, structuring and communicating knowledge, but not on elicitation. Poppe et al. (2017) and Nolte et al. (2015) developed and evaluated collaborative environments for process modelling which again emphasise modelling over elicitation.

In Table 1 we overview a set of process elicitation methods and tools using our conceptual framework. The exercise supports the observation that research has been mainly centred on process modelling. Only two cases are specifically centred on elicitation, one concerning the development of a process storytelling tool (Antunes et al., 2013; Simões et al., 2018; Simões et al., 2016), and another concerning the development of a virtual environment for process role-playing (Brown et al., 2014; Harman et al., 2015; Harman et al., 2016). In both cases, the evaluations were centred on testing the usability of the developed prototypes. Rather than focussing on tool usability, this paper seeks to develop a better understanding of process elicitation by focussing on the phenomenon of process elicitation and in particular the outputs of process elicitation using process stories.

Table 1 – methods and tools addressing process elicitation

References	**Framework elements**				**Evaluation**
	People	**Process knowledge**	**Process activities**	**Information technology**	
(Silva & Rosemann, 2012)	Collaboration between end users and experts	Formal knowledge provided by experts. End users provide informal knowledge about process deviations	Combines elicitation, modelling and execution. Elicitation is done with execution	Proposed wiki-style environment. Combines process modelling with social media	Hypothetical case study illustration

(Antunes et al., 2013; Simões et al., 2018; Simões et al., 2016)	End users individually develop process stories	Combines coordination with a diversity of contextual elements	Elicitation	Web-based authoring environment	Prototype evaluation in experiments
(Brown et al., 2014; Harman et al., 2015; Harman et al., 2016)	Single-user approach. Users role-play processes	Combines coordination and context. Context is implicitly provided by role-playing	Elicitation	Immersive virtual environment. Users explore processes as if interacting in a physical enviroment	Prototype evaluation in experiments
(Oppl & Stary, 2014)	Collaboration between end users	Coordination	Modelling	Collaborative tangible interface for creating models	Tool evaluation
(Oppl, 2015)	End users must coordinate individual contributions	Coordination	Modelling	Method using card sorting. Has individual and collaborative stages	Results from several workshops highlighting model violations
(Oppl, 2016)	End users	Coordination (messages, actors and business objects)	Modelling	Collaborative tangible user-interface	Case study reporting tool use
(Oppl & Alexopoulou, 2016)	Collaboration between end users	Coordination	Modelling	Collaborative method combining modelling tools and web-based dialogue forms	Concept validation using an illustrative case study
(Front et al., 2017)	Collaboration between end users	Coordination (informational, interactional and organisational perspectives	Modelling	Collaborative role-playing sessions focussed on model development	Tool testing by restricted circle of users
(Hoppenbrouwers et al., 2018)	Collaboration between end users. Adopts role-playing	Coordination and context. Context refers to bottlenecks	Centred on modelling. Elicitation used	Collaborative workshops focussed on modelling	Results from workshop sessions

			to identify bottlenecks		

3. Process Stories

3.1 Theoretical background

Our approach to the process stories method for process elicitation is informed by two kernel theories: organizational storytelling theory (Denning, 2006; Morgan & Dennehy, 1997), and visual narrative theory (Cohn, 2013; Cohn et al., 2012).

Organizational storytelling theory is about the social construction of reality, which means that knowledge is communicated, shared and institutionalized by the members of the organization in the pursuit of integration (Boyce, 1996). Organizational stories (from now on stories, for simplicity) are the vehicle for socializing, engaging and institutionalizing organizational practice. They are both a process and an artefact. As a process, they support collective sensemaking (Boyce, 1996; Fisher, 1984): people tell stories in certain ways to communicate practices, to be persuasive, to institutionalize important aspects of the organization, to foster acceptance and conformity, and to integrate newcomers in the group. As an artefact, stories have a particular structure, which makes them recognizable to non-specialists, and actionable. The important aspect is that they are recognizable. Unlike other approaches, which develop recognition though specialized process notations and models (Van der Aalst et al., 2016), stories accomplish the same purpose through patterned language structures. As noted by Marzec (2007), they tell "who we are" and "where we are heading". A story has a plot, dramatic tension, character development, and pacing (Marzec, 2007). These elements exhibit strong relationships with actors, activities, events, and flows traditionally considered by the process paradigm. However, stories evoke easy and widespread recognition compared to the use of codified signs (e.g., distinguishing between activities, conditions and flows).

Following this line of reasoning, we suggest that stories have the ability to integrate coordination and contextual knowledge. The usual representation of activities, conditions and flows can be complemented with contextually richer and diversified information about what happens. That may include, for instance, explanations about atypical situations in the work routine, expected and unexpected events that may have occurred in the past, considerations and decisions often made, and aspects of organisational culture, rituals and practices affecting coordination.

The second theory influencing our "process stories" method is visual narrative theory (Cohn, 2013; Cohn et al., 2012). Visual narrative uses our cognitive abilities to interpret visual information. It seems consensual that humans are very good at interpreting the natural world surrounding them. As we have developed more virtual worlds supported by technology, we also have developed capabilities to interpret other types of visual information, in particular visual narrative. To be recognizable, visual narrative must follow appropriate structures. For instance, movies have prologues and epilogues, climaxes and twists (Cutting, 2016). These

structures also apply to other media types such as comic strips, graphic novels and manga (Cohn et al., 2012).

We are particularly interested in the use of comic strips as a way of eliciting process knowledge (Antunes et al., 2013; Simões et al., 2018; Simões et al., 2016). Comic strips provide structure to narrative and allow us to identify fundamental elements of coordination knowledge such as activities, actors and temporal dependencies. However, such knowledge is put together using recognizable patterns instead of notations and rules. For instance, comic frames can be used to convey information about the passage of time without strictly adhering to a convention about the representation of time. As with organizational storytelling theory, visual narrative theory brings structure without rules. Structure is implicit, not explicit. And the elements of structure are inferred by readers using common knowledge, instead of enforced notations and rules.

3.2 Elements of process stories

As suggested by organizational storytelling and visual narrative theories, process stories have several similarities with process models. Both address the same goal: describing business behaviour. Both describe activities. Both include elements of time necessary to narrate how activities enfold over time. Both express interdependencies and coordination of activities. However, process stories and process models also exhibit a fundamental difference: while process models formalize the knowledge elements describing a process, process stories give more freedom to readers to interpret the knowledge elements using implicit narrative and visual patterns. While process models are usually defined to avoid ambiguity and increase precision, process stories are utilized to afford ambiguity, informality and contextualization. Why trading off formality with ambiguity? The fundamental reason is to afford richer accounts of events by integrating coordination knowledge with contextual knowledge. In the following we propose a conceptual model of process stories (Figure 2).

The first concept to consider is the story. A *story* is a collection of narrative elements tied together by a narrative arc, which gives coherence and structure (Cohn, 2013). Following the paradigm introduced by comic strips, the narrative arc has a set of *scenes*, which discretize the narrative.

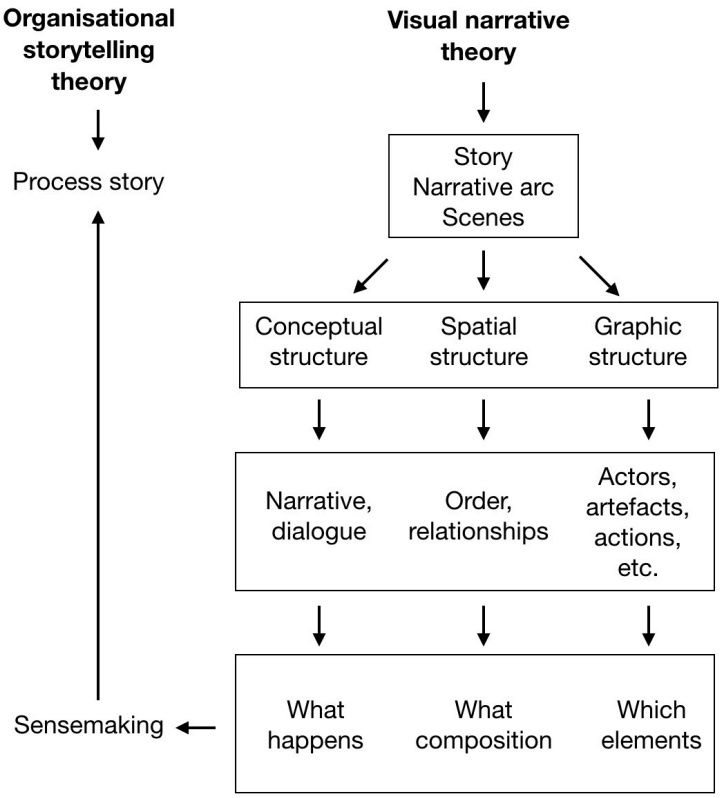

Figure 2 – Process stories

A scene contains three fundamental structures: conceptual, spatial and graphical. The conceptual structure attaches visual and textual elements appearing in a scene to semantic contents. For instance, a scene may depict a typical business situation, such as having a meeting, which may involve characters and objects, such as the meeting participants, a whiteboard, and the issues discussed in the meeting and presented on the whiteboard.

Two important textual elements we consider in the scene are narrative and dialogue. Narrative provides textual descriptions that contextualize and explain what happens in the scene, emphasising the semantic relevance of visual elements, providing non-visual cues, and explaining the meaning or the scene as a whole. Dialogue shows how the characters in a scene interact. For instance, a meeting participant may address the group to make a proposal, while another may raise an argument.

Spatial structure concerns the order and relationships between the elements in a scene. For instance, in the business meeting example, spatial structure elucidates that the meeting participants are discussing face-to-face, around a table and using a whiteboard.

Finally, the graphic structure provides cognitive cues about the elements in a scene: actors, artefacts and any other elements required to convey narrative, such as speaking, moving, time, etc. These cues are provided using lines and shapes. For instance, a typical graphical structure used in cartoons is the dialogue bubble, which shows who makes a communication and what is communicated. Many other visual cues can be used to convey, e.g., emotion and sound (Catricalà & Guidi, 2015).

All in all, we can say that conceptual structure explains what happens, spatial structure explains the narrative composition, and graphical structure shows which elements participate in the narrative. These three functions then tie with organizational storytelling through sensemaking (Cecez-Kecmanovic, 2005). Sensemaking is the process of making sense of the narrative elements by scanning, interpreting and reflecting about the story. Sensemaking is what allows readers to build a process story.

A *process story* is therefore a specific type of story that narrates a business process. Adhering to our separation of process knowledge into coordination knowledge and contextual knowledge, we posit that a process story has coordination elements, such as actors, events and activities, and contextual elements, such as decisions, places, interactions, and so forth. There is no limit to contextual knowledge: any element provided in a story that does not concern coordination knowledge, we define as contextual knowledge.

This conceptual model does not eliminate the traditional notion of process model: a process story *can* be used to describe activities, flows, decisions points, actors, and other elements traditionally described by process modelling notations. However, a process story is semi-structured: it blends together textual and visual elements, narrative and dialogue, it delivers ambiguity, and requires agency by the reader to make sense of a process. Therefore, process stories can also be used to describe other things beyond the process model, such as what was going on in the narrator's mind when a set of events unfolded. As already noted, all these knowledge elements that go beyond the notion of process model, we designate as process context. To many, this definition may seem flawed by the lack of precision: process context refers to other things, which are undetermined. However, we regard that characteristic as a strength: it brings about the capacity to say more about a process. However, more is not necessarily better. So, another goal of this research is to understand the value brought by process stories, when compared to process models.

3.3 Eliciting process stories

We need a method to build process stories. Our method was specifically developed for this study, although it is founded on prior research (Antunes et al., 2013; Simões et al., 2016). The method is tool-based, specifically targeted to end users, and does not require mediation by process or service experts.

The method invites end users to develop a slide presentation that describes a process story, which includes details about the process activities and any contextual information users may find relevant. The slide presentation can be created using most slide presentation tools like Apple's Keynote and Microsoft's Powerpoint. The slide genre of communication was selected because it has significant relationships to the notions of scene and narrative arc discussed in the previous section: a slide presentation tool can build scenes and a narrative arc by composing slides.

The development of the slide presentation is supported by a slide template, which has been configured with master slides depicting several business process scenarios (Figure 3). Each master slide provides specific spatial and graphic structures using a combination of:

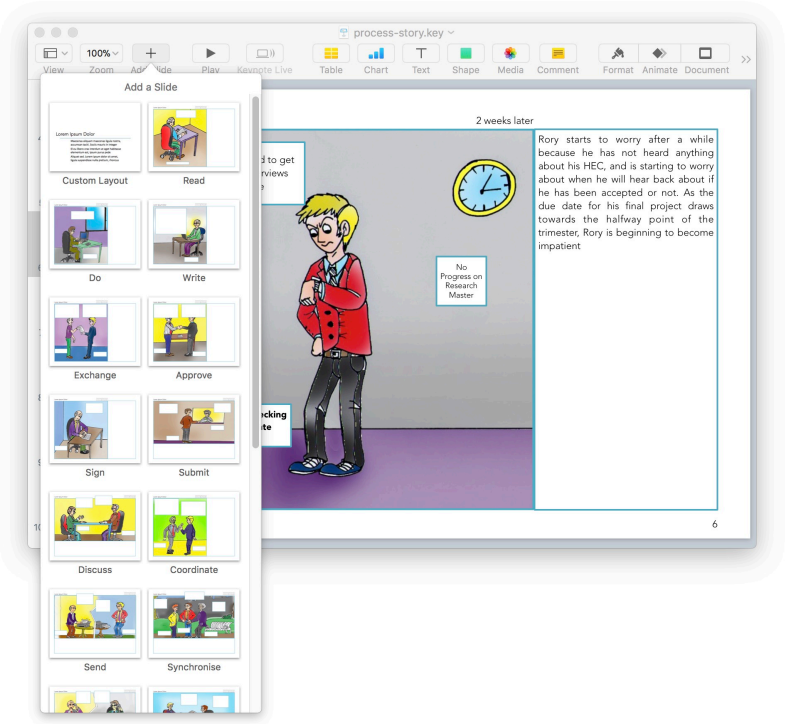

Figure 3 – Template for creating process stories. Several master slides are shown to the left with different business situations and characters. The selected slide depicts a situation where a person is waiting for an event. The narrative box in this slide is at the right.

1. A **cartoon**, which is used to depict a business situation such as having a meeting, making a phone call and talking to someone. Cartoons may display one character (e.g. writing a document), two characters (e.g. having a conversation), or a group (e.g. having a meeting). Cartoons may also include objects like documents, whiteboards and computers.
2. A big **narrative box**, which is shown either below or to the right of the cartoon. Narrative boxes give the narrator an opportunity to textually explain what happens, e.g. describing activities, events and contextual elements.
3. **Dialogue boxes**, which are shown close to the characters displayed in cartoons. These boxes allow users to put words in the mouth of characters, which in turn supports communication with other characters and with the reader.
4. **Labels**, which appear close to characters and objects portrayed in cartoons. These labels allow the narrator to name characters and things.
5. **Tags**, which are shown above the cartoon. These can be used by the narrator to name or summarize the scene. Some of the provided master slides use these tags to express sequence and time, e.g. “afterwards” and “10 minutes later”.

An important consideration was that the tool should capture user narratives without in any way leading the user. Considering Fisher’s arguments that “humans […] are reasoning animals” (Fisher, 1978, p. 376), we decided the tool should provide minimal instructions on how to develop a process story. Instead, it gives a very short example with seven slides. The

example describes the process of buying a pizza defined by the Object Management Group (OMG, 2010). When we trialled our minimal guidelines, we found they were clearly understandable by users and the results yielded the insights we were seeking.

In short, the process storytelling method takes end users to create process stories, which consist of slides with cartoons and accompanying textual elements. Process elicitation starts by emailing the slide presentation with the pizza example to selected end users. The end users then produce their stories by selecting master slides with cartoons and adding text to narrative and dialogue boxes, labels, and tags. Finally, end users send back their stories through email.

4. Research methodology

We adopt a descriptive approach to this research because: 1) we aim to describe a phenomenon, more specifically process elicitation using process stories, and 2) we intend to document characteristics of this phenomenon (B. Johnson, 2001). A cross-sectional type of study also seems appropriate to our goals, since time is not a factor to consider in process elicitation, and a longitudinal study would introduce the possibility of change in the target processes.

The method and its guidelines were pre-tested before data gathering commenced. A small group of participants, different from the one that participated in the data collection, was involved in telling stories about a process, and afterwards provided feedback about the clarity of the guidelines and difficulties using the template. Users involved in the pre-test found the method intuitive and easy to use. The obtained feedback helped clarifying the guidelines and lead to simplifications in the pizza example, which was originally too long.

Data collection uses process stories generated by end users. For data analysis, we combine quantitative and qualitative methods. This mix enriches the study as it contributes to obtain insights about process elicitation while increasing control and repeatability.

Since we are using multiple cases and combining quantitative and qualitative analysis, we have to use criteria and metrics that can be applied across different cases and organisations. We therefore use a procedure that compares process stories against a baseline, which we designate as *official process*.

An official process is a process model documented by an organisation, known to the members of the organisation, and endorsed by an entity with managerial responsibilities over the process, often known as process owner (Dumas et al., 2013). By organisation we mean a unit or collection of units with well-defined and repeatable goals, and a management structure. Official processes provide explanations about the different ways in which a case can be handled (Van der Aalst, 2013). Official processes may be used by organisations for process execution, which implies the case may be documented with significant precision and detail, or other uses such as communication and training, which implies the case may be described in broader terms. In both cases we assume that, even though official processes may not reflect true belief, they have instrumental value to organisations (Pritchard, 2009).

We only consider live official processes, i.e. processes reflecting current practices and repeatedly used by organisations. And finally, we only consider official processes formalised through documentation, including definitions, diagrams, rules and supplemental information, which are shared by the organisation.

In the two cases reported in this paper, we use pre-existing process models, which describe live official processes shared by many members of the organisation. The process models exist in official documentation, are considered current, and are recurrently used by the organisations.

In order to make a more precise comparative analysis between process stories and official processes, we convert both to BPMN. The conversions are done in a way that preserves the original descriptions. To ensure that the translations of official processes into BPMN are faithful to the sources, we requested approval from the process owners. Therefore, the baselines we use in our study have been reviewed, agreed and sanctioned by the process owners. Regarding the process stories, they are converted into BPMN by one researcher and then checked by another researcher.

The conversion procedure starts by scanning the original source and then creating the corresponding BPMN model. This is done by identifying typical process elements such as activities, events, gateways, and actors. The conversion is done in a single round to avoid the tendency to rationalise, abstract and improve the BPMN model. The conversion aims to reflect what is in the story – it neither seeks to abstract nor to rationalise the story. That is, the generated BPMN model provides a literal representation of the flows, activities, events, and gateways expressed in the source material, including any errors, omissions and ambiguities.

After generating all BPMN models, we then code the different model elements, considering activities, events, gateways and actors. Coding follows the principles of qualitative data analysis proposed by Miles et al. (2014). In particular, we use a predefined collection of codes with clear definitions to safeguard against random choices, keep the codes together with the source data to avoid ambiguity, and code in multiple round and using multiple coders to increase precision.

We do not use intercoder reliability as a measure of coding quality. Instead, we adopt a consensus approach to coding focussed on precision where coders independently code the stories, discuss any discrepancies, and then adjust the codes and code definitions to reflect the consensus views. We believe this approach is adequate to the nature of business processes, which have a high degree of standardisation (around activities, events, etc.), but it is also relevant to define a set of precise codes, which may be used by practitioners and researchers in the future.

We then proceed with a comparative analysis centred on coordination knowledge. First, the BPMN models are quantitatively analysed by quantifying the coded activities, events, gateways and actors. Second, we analyse differences in terms of actual contents, e.g. what specific elements in process stories appear or not in official processes. Finally, we complete

the analysis by checking the original sources to better understand the differences between process stories and official processes.

After a comparative analysis centred on coordination knowledge, we then analyse contextual knowledge. The assessment of contextual knowledge requires a different approach, since contextual elements are not documented in official processes. Therefore, the comparative analysis concerns differences and similarities between process stories.

The procedure starts by coding contextual knowledge following the principles of qualitative data analysis proposed by Miles et al. (2014). The codes are derived from the conceptual framework shown in Figure 1, referring to people, process components (knowledge and activities) and information technology (support).

Codes are assigned to specific elements in process stories that contextualise activities, events, gateways and actors participating in the process (the list of codes is provided below). Then we count the number of occurrences of each code to analyse the extent of contextual knowledge in process stories. Finally, ratios between the occurrence of contextual elements and coordination elements provide an indication of the richness of process stories. Special cases require checking the original sources to better understand differences in contextual knowledge reported in process stories.

This analytic procedure has been extensively pretested, and some minor adjustments were done until reliable results were obtained. The most critical problem we found during pretests was that official processes often include activities and events unknown to some end users. For instance, this happens when a process includes front-end and back-end activities, where the latter are only known to administrative staff. We took two measures related to this problem: 1) include all different types of stakeholders in the study, so that every activity in the official process can be reported by at least a stakeholder; and 2) make all measurements against exactly the same baseline, independently of the extent of the knowledge of narrators. This procedure ensures a consistent comparison between process stories and official processes, even though it may inflate certain metrics, e.g. similarity between processes, which can be very low in cases where several narrators do not know certain parts of the process.

4.1 Codes and criteria related to coordination knowledge

In this category, we code the following elements appearing in process stories and official processes: activities, gateways, events, and actors. We only code elements that can be enumerated and clearly identified. For instance, if a story has a meeting with two identified participants, we code two actors. However, if it has a group meeting, we code just one actor, taking the whole group as a single entity.

We also consider a metric corresponding to the total number of coordination elements, which is the sum of activities, gateways, events, and actors found in a story. This gives a simple metric of complexity: a story with more elements is more complex than another with fewer elements.

Still within this category, we also define measures of similarity between stories and official processes. To support a detailed analysis of similarity, we use a second set of codes, which can be applied either to the process story or the official process. In the following list of codes, an element can be an activity, gateway, event, or actor. Furthermore, a single element in a story is always compared against another single element appearing in the official process. The set of codes includes:

- Generalisation: When an element in a story provides less detail (in a hierarchical perspective) than another it is compared to in the official process.
- Refinement: When an element in a story provides more detail (in a hierarchical perspective) than another it is compared to in the official process.
- Extension: When an element in a story provides new knowledge, which extends the perimeter of the official process.
- Similarity: When an element in a story is equivalent or similar to another appearing in the official process. Similarity is not considered at the syntax but at the semantic level.
- Contradiction: When an element in a story provides knowledge that conflicts with the knowledge appearing in the official process, e.g. using a different rule or constraint.
- Omission: When an element in the official process provides knowledge that is missing from a story. Unlike the other criteria, which compare a story against the official process, this criterion compares the official process against a story.

4.2 Codes and criteria related to contextual knowledge

As noted earlier, this analysis does not support a direct comparison between process stories and official processes. Instead, it provides interesting measures that can be used to compare process stories. We consider the following codes related to contextual knowledge:

- People: A reference to people in a story, excluding people and groups that already participate in a story as actors, executing activities.
- Emotional element: An emotion is a description that reflects a state of mind such as stress, disbelief and satisfaction. We do not consider prompts used to sustain interaction.
- Setting: An element referring to the work setting, in particular reporting the use of specific systems, applications and tools.
- Interactional element: An element in a story referring to the interaction and collaboration between people, such as making a phone call, participating in a meeting, sending an electronic message, or having a face to face conversation.
- Decisional element: A contextual element in a story reporting how a decision is made, or affected by context, e.g. a special circumstance or request.
- Environmental element: An event or constraint that is beyond the actor's control. Such element comes from outside the story but affects its evolution.
- Location element: A reference in a story to a specific physical location.
- Time element: A reference to the passage of time or a deadline.
- Method element: A references to the way of doing. It provides abstract knowledge, which reflects organizational practice. But this knowledge is beyond the activities

already reported in the story and contains some form of self-reflection from the part of the narrator.

5. Cases

5.1 Organisations and processes

We selected two organisations for this study. Both are university departments, one located in Chile and another one in New Zealand. The selection was based on convenience.

In each organisation, we selected processes involving rich process knowledge, i.e. the processes are not mechanically executed but instead require people to analyse what has to be done in context and to make decisions. Furthermore, the two processes use different levels of information technology support, one being mainly done online and the other being mainly done manual.

The selected processes are currently enacted in the target organisations, with many instances running every year. The processes are well-known and cover core activities regularly performed by the organisations. In one case, key end users (head of department and program director) suggested the process because of its relevance and complexity; they wanted to know more about the process. In the other case, the process was selected because every member of the organisation must go through it.

One process implements a university-wide policy regarding ethics in research data collection, and is known internally as the Human-Ethics Committee (application) process (HEC). Every research project undertaken by the university that involves human participants must conform to ethical standards and therefore must be evaluated by a human ethics committee, which assesses the research objectives, research design, data collection procedures, selection of participants, etc. The HEC process deals with research project applications and is fully implemented online.

The HEC process is well known within the organisation since researchers (including students and staff) often apply many times a year. It is known to generate many initial rejections, this was one of the reasons why there was some particular interest in selecting it for this study. Usually researchers need several rounds until they finally see an application for ethical clearance approved. On the one hand, very detailed information about the research is required, at a stage were projects are still preliminary. On the other hand, researchers often submit incomplete applications just to get feedback. These facts create a paradoxical situation where applications take too much time to complete because the committee has to deal with

Table 2 – Official processes

	Activities	Gateways	Events	Actors	Total
GP	18	6	0	3	27
HEC	8	4	0	5	17
AVG	13	5	0	4	22

Table 3 – Participants

HEC		**GP**	
Researchers	2 (1 female, 1 male)	Supervisors	5 (1 female, 4 male)
Students	5 (3 female, 2 male)	Students	5 (1 female, 4 male)
Post-doc	1 (male)	Administrators	1 (1 female)
Total	8	Total	11

Note: One GP participant generated two stories.

many resubmissions, and researchers complain they cannot start their research because the applications have not been approved (an example of the "tragedy of the commons").

The HEC process is well documented. Besides the university policy, several documents explain how applications flow between applicants, administrative staff, committee members, and head of HEC (process owner). One document in particular includes a process model (using flowcharts), which corresponds to the official process and that was used to develop the BPMN model.

The second process deals with the Graduation Project (GP), which is the final undertaking of an engineering degree. The process takes a year to complete, from project proposal to discussion in front of an examination committee, and involves every student enrolled in the final year of studies. The process does not have online support, even though it requires using some online systems, e.g. to upload the final manuscript into the library system. The engineering program director is the process owner.

We selected the GP process because of its extension, variety of people involved (students, supervisors, administrators), and mix of formal requirements (e.g. register project), institutional practices (e.g. supervisor should approve documents), and informal practices (e.g. finding a project and supervisor).

The GP process is described in slide presentations available to teachers and students. Two UML models are included in these slides that describe the GP process in two stages, the first one dealing with topic selection and the other dealing with project completion. These two models were converted into BPMN models. Table 2 summarizes the characteristics of official processes, providing averages for the elements that will be analysed later.

5.2 Participants

Starting with HEC, we recruited participants among researchers, students and post-doc researchers that had previously submitted a project with success. Having succeeded as an applicant was essential to make sure the participants knew well the process. The head of HEC also participated in the study to validate the official process. Face to face meetings were used to gather data from the head of HEC.

Moving on to GP, participants were selected among supervisors, students and administrators. In particular, we selected supervisors and students who have successfully completed graduation projects, and the administrator that is responsible for managing the whole process. The GP process owner participated in the study to validate the official process. Table 3 summarises the characteristics of the participants in this study.

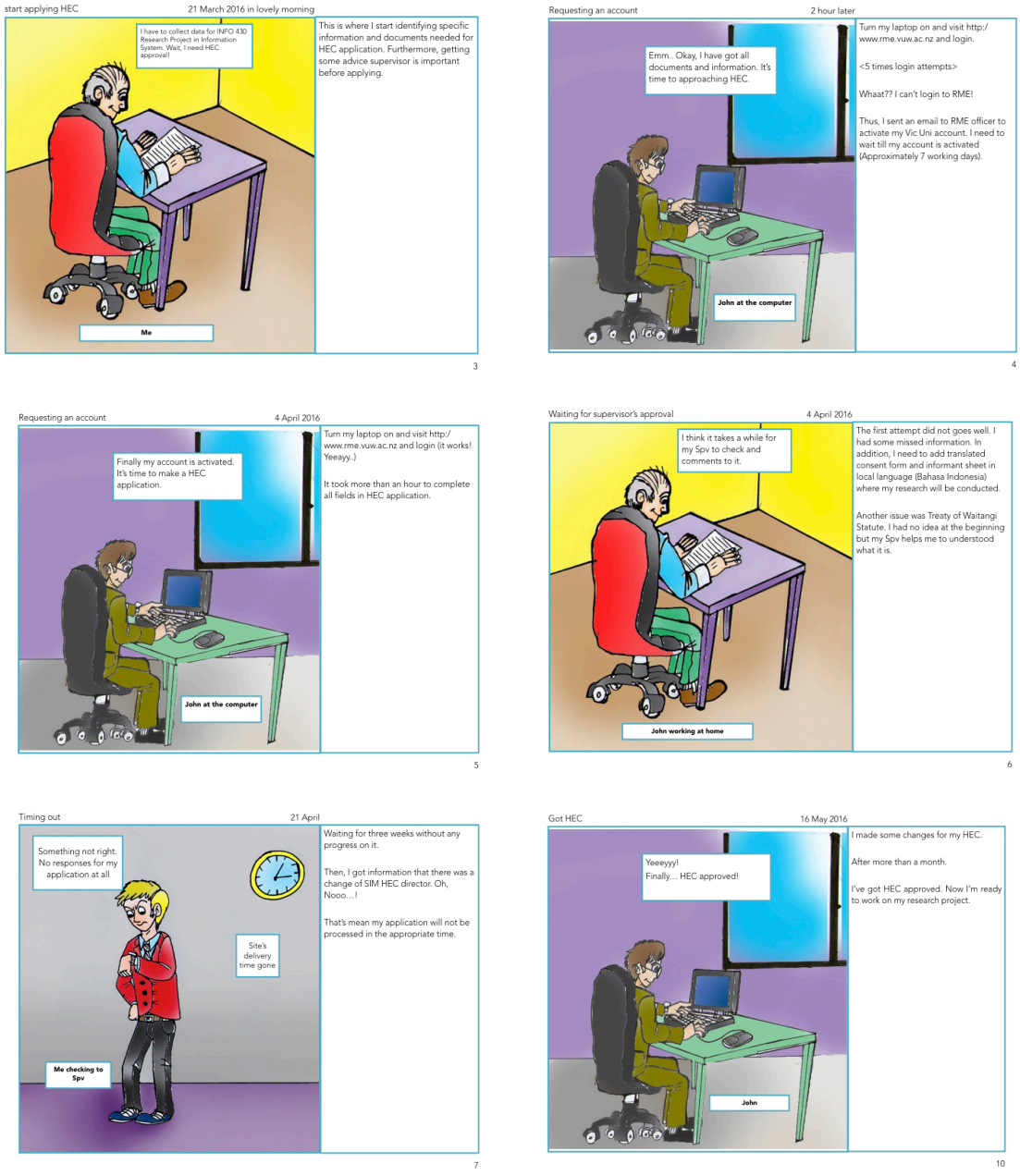

Figure 4 – Process story example (text not intended to be read)

5.3 Data collection and transformation

An overview of the data collection procedure has already been given in Section 3. Here we provide some additional details necessary to explain how it was applied in practice. First, it should be emphasised that, to have a levelled playfield, every participant in the study received exactly the same instructions, which were contained in a slide template emailed to the participants. Some participants inquired how they should tell their story, but the answer was invariably that they were free to tell the story the way they liked. As discussed later in detail, the participants adopted various strategies for telling their stories, and in all cases, they succeeded. Figure 4 shows a process story generated in this study.

The official processes were converted into BPMN by the authors. This approach may introduce some biases since the same knowledge can be expressed and structured in multiple ways. To avoid some analytic biases, the authors decided to truthfully reflect what was in the original models, avoiding optimisations, rearrangements and stylistic preferences. Furthermore, as already noted in Section 2, the BPMN models were approved by the process owners.

The process stories were also converted into BPMN models. The authors did again this task. The main challenge here was disentangling the coordination knowledge from narratives that use language in sophisticated ways. A decision was made to avoid over-analysing or rationalising the stories too much. We related activities to verbs and events to plot changes. The use of "or" and "if" was related to gateways. Split and join gateways were included whenever the end users expressed the execution of concurrent activities in the same slide, while activities in different slides were modelled as sequences. Repeating activities were modelled with loop gateways. We also note that when counting gateways, we counted divergent but not convergent gateways, as convergent gateways are a modelling scheme that does not exist in people's minds (people usually say "we do this and that", not "we converge after doing this and that").

5.4 Results

The results are divided in three main categories: 1) results related to coordination knowledge elements (Table 4); 2) results related to similarity between stories and official processes (Table 5); and results related to contextual knowledge (Table 6). Next, we discuss the results in detail.

Coordination knowledge

We observe that the average numbers of gateways in stories is lower than in official processes (1.50 versus 5). In particular, only one HEC story reported a gateway, when the official process has four; and two GP stories had zero gateways, when the official process has six. On the other hand, stories had more events (3.20 versus 0). The average number of activities in stories was proximate to official processes (14.65 versus 13). This suggests the overall complexity of stories is similar to official processes.

We may argue that looking at standard deviations tells more about the stories than looking at averages. In particular, we note that the activities reported in stories have big swings: the most detailed GP story has 37 activities and the least detailed has 7, while the official process has actually 18. HEC shows similar results, with a swing between 5 and 23 activities. And when considering the total number of elements, the standard deviation is 10.54, for an average total of 22.

Based on these results, we suggest the primary value of process stories may lie in how they report deviations and variations in coordination knowledge, that is, the capacity for some end users to describe processes differently. Of course, in some cases we can anticipate that stories

Table 4 – Coordination knowledge elements

	Activities	Gateways	Events	Actors	Total
GP1	17	3	0	3	23
GP2	13	2	1	3	19
GP3	10	4	0	3	17
GP4	27	7	2	4	40
GP5	23	2	5	5	35
GP6	7	2	2	3	14
GP7	25	2	2	5	34
GP8	8	1	3	3	15
GP9	11	3	1	3	18
GP10	11	0	3	3	17
GP11	9	0	1	2	12
GP12	37	3	3	7	50
AV	16.50	2.42	1.92	3.67	24.50
SD	9.43	1.88	1.44	1.37	12.19
SD/AV	0.57	0.78	0.75	0.37	0.50
	Activities	**Gateways**	**Events**	**Actors**	**Total**
HEC1	9	0	4	3	16
HEC2	23	0	3	4	30
HEC3	7	0	5	3	15
HEC4	23	1	5	6	35
HEC5	5	0	6	3	14
HEC6	7	0	11	6	24
HEC7	12	0	3	3	18
HEC8	9	0	4	4	17
AV	11.88	0.13	5.13	4.00	21.13
SD	7.16	0.35	2.59	1.31	7.75
SD/AV	0.60	2.83	0.50	0.33	0.37
AV	14.65	1.50	3.20	3.80	23.15
SD	8.71	1.85	2.50	1.32	10.54
SD/AV	0.59	1.23	0.78	0.35	0.46

do not add much. HEC5 is a good example, with just 14 elements, when the official process has 17. But on the other hand, four HEC stories out of 8 had more elements that the official process.

If we analyse the data related to actors, we observe that stories identify on average the same number of actors (3.80 for stories versus 4 for official processes). But again, looking at deviations is very revealing. In GP, two participants identified two actors not appearing in the official process; and GP12 even identified 4 missing actors. In HEC, two participants were able to identify one missing actor. Again, these results suggest that a good number of process stories uncover significant coordination knowledge missing in official processes.

Similarity in coordination knowledge

Table 5 – Analysis of similarity

	Generalisation	Refinement	Extension	Similarity	Contradiction	Omission	Existing	New
GP1	0	3	8	12	0	8	12	11
GP2	0	4	5	10	0	11	10	9
GP3	0	5	4	8	0	15	8	9
GP4	0	15	11	13	1	9	13	27
GP5	1	8	20	6	0	13	7	28
GP6	0	1	10	3	0	23	3	11
GP7	0	10	16	8	0	11	8	26
GP8	2	2	8	3	0	21	5	10
GP9	0	5	5	8	0	15	8	10
GP10	1	4	5	7	0	18	8	9
GP11	0	1	2	9	0	17	9	3
GP12	1	12	10	26	1	3	27	23
AV	0.42	5.83	8.67	9.42	0.17	13.67	9.83	14.67
SD	0.67	4.49	5.21	6.04	0.39	5.69	6.04	8.69
SD/AV	1.60	0.77	0.60	0.64	2.34	0.42	0.61	0.59
	Generalisation	**Refinement**	**Extension**	**Similarity**	**Contradiction**	**Omission**	**Existing**	**New**
HEC1	0	2	8	6	0	8	6	10
HEC2	0	7	10	13	0	8	13	17
HEC3	0	1	7	7	0	9	7	8
HEC4	0	6	20	6	3	9	6	29
HEC5	0	2	7	4	1	9	4	10
HEC6	0	8	4	11	1	8	11	13
HEC7	0	5	2	11	0	8	11	7
HEC8	0	2	10	4	1	8	4	13
AV	0.00	4.13	8.50	7.75	0.75	8.38	7.75	13.38
SD	0.00	2.70	5.40	3.45	1.04	0.52	3.45	7.07
SD/AV		0.65	0.64	0.45	1.38	0.06	0.45	0.53
AV	0.25	5.15	8.60	8.75	0.40	11.55	9.00	14.15
SD	0.55	3.88	5.14	5.12	0.75	5.09	5.16	7.91
SD/AV	2.20	0.75	0.60	0.58	1.88	0.44	0.57	0.56

The analysis of similarity provides a more detailed comparison between stories and official processes. The first result to note is that stories, in general, do not provide generalisations. This suggests that process stories are not the best approach to rationalize business processes.

It is also interesting to note that stories reveal, on the average, few contradictions. Nevertheless, two participants in the GP process and four participants in the HEC process were able to identify contradicting activities. One participant in HEC was even able to identify 3 contradictions. Contradictions are interesting because they show how official processes may constrain flexibility.

The number of omissions in both GP and HEC are very high. The main reason is that, as noted before, we look at every story per se and not every end user has a complete view of the official process. In particular, some elements of official processes may only be relevant to back-office staff. This situation can be observed by contrasting the number of omissions in GP12 and in the other GP stories. GP12 is the story reported by the process administrator,

which seems very aligned with the official process, with just 3 omissions, while the other stories have between 8 and 23 omissions. Of course, one can argue both in favour of revealing administrative details in official processes (so that people would know them), and against it (because people actually do not know them, or do not care). In any case, this type of analysis raises the discussion on what aspects of a process to reveal or not to reveal to fine tune an official process.

The number of refinements and extensions revealed by process stories are both high: the average story has 5.15 refinements and 8.60 extensions. This data suggests that official processes provide very generalised accounts of a business, and that reality is richer and more complex.

Another analysis that can be made is to compare the number of new and existing elements. We count new elements as the sum of refinements, extensions and contradictions, and existing elements as the sum of generalisations and similarities. The results show that the average story reports 9.00 existing elements and 14.5 new elements. We therefore suggest that process stories can be an effective way to uncover new coordination knowledge.

From the gathered data, we can also identify some interesting ratios. The ratio between new and existing elements in the average process story is 1.57. The ratio between new elements in stories and total elements in official processes is 0.64. The ratio between existing elements in process stories and total elements in official processes is 0.41. This data suggests that even a small number of stories has the capacity to uncover a significant number of missing coordination elements in process stories.

For completeness of analysis, we also note the following ratios:

Similarity/total = 37.80%

Extensions/total = 37.15%

Refinements/total = 22.25%

Contradiction/total = 1.73%

Generalisation/total = 1.08%

Contextual knowledge

The results show that the highest number of contextual elements in stories is related to time; and the next one is related to people. Per average story, we find 9.82 time-related elements and 8.12 people-related elements. The lowest number of reported elements is related to environmental factors, which suggests both processes are not significantly affected by outside events.

A measure that we find interesting is the number of emotions in process stories. The gathered data shows that end users generate 3.24 emotions per story. Again, this data reinforces the capacity of process stories to uncover contextual knowledge.

Table 6 – Contextual knowledge

	People	Emotional	Setting	Interactional	Decisional	Environment	Location	Time	Method	Total
GP1	9	2	0	4	7	0	0	9	1	32
GP2	5	1	0	4	6	0	0	5	14	35
GP3	3	0	0	2	6	0	0	1	5	17
GP4	16	0	1	13	14	4	0	11	9	68
GP5	7	2	2	8	6	13	3	13	3	57
GP6	9	8	0	5	19	4	0	7	2	54
GP7	10	5	2	13	12	1	0	21	5	69
GP8	4	9	0	5	6	2	0	8	2	36
GP9	8	1	0	4	3	0	0	1	8	25
GP10	4	5	0	3	12	1	0	14	2	41
GP11	9	2	2	5	4	4	0	8	2	36
GP12	33	3	9	25	5	0	2	21	29	127
AV	9.75	3.17	1.33	7.58	8.33	2.42	0.42	9.92	6.83	49.75
SD	8.13	2.98	2.57	6.56	4.81	3.73	1.00	6.56	7.96	29.25
SD/AV	0.83	0.94	1.93	0.86	0.58	1.54	2.39	0.66	1.17	0.59
	People	**Emotional**	**Setting**	**Interactional**	**Decisional**	**Environment**	**Location**	**Time**	**Method**	**Total**
HEC1	5	1	9	1	5	3	2	16	2	44
HEC2	16	7	11	7	6	3	1	22	6	79
HEC3	5	5	2	2	3	3	1	12	2	35
HEC4	14	2	5	6	9	9	0	4	5	54
HEC5	7	2	2	4	3	1	0	8	1	28
HEC6	8	7	5	4	4	4	0	19	5	56
HEC7	5	1	3	0	5	1	2	7	8	32
HEC8	7	2	3	4	6	1	1	3	2	29
AV	8.38	3.38	5.00	3.50	5.13	3.13	0.88	11.38	3.88	44.63
SD	4.27	2.56	3.34	2.39	1.96	2.64	0.83	7.05	2.47	17.61
SD/AV	0.51	0.76	0.67	0.68	0.38	0.85	0.95	0.62	0.64	0.39
AV	8.12	3.24	2.65	5.06	7.06	2.88	0.59	9.82	4.71	44.12
SD	3.95	2.95	3.24	3.60	4.28	3.46	0.94	6.59	3.50	17.72
SD/AV	0.49	0.91	1.22	0.71	0.61	1.20	1.60	0.67	0.74	0.40

An interesting comparison is between decisional and method elements. Applying the t-test to the two data sets reveals they are significantly different, which supports the idea that end users report differently on decisions and methods, showing more preference for decisions (average of 7.06 versus 4.71). The t-test has been considered adequate to work with this sample size (De Winter, 2013).

If we analyse the total number of contextual elements generated by an average story (44.12) and compare to the average size of an official process (22), we realise that the ratio between contextual knowledge in stories and coordination knowledge in official processes is 2.01, which suggests that process stories are a good method to generate contextual knowledge.

When analysing the percentages of contextual elements per category, we obtain the following results: time 23%, people 18%, decision 16%, interaction 11%, method 10%, and emotion 8%.

Qualitative analysis

In the qualitative analysis, we start from the quantitative results and analyse further the major deviations in individual stories. Such detailed analysis provides explanations that help better understand the end users' behaviours and states of mind. We already noted that the end users identified many missing actors, so it makes sense to analyse which actors they are referring

to. In both HEC and GP, the missing actors are related to activities extending beyond the "happy path", with workarounds and special requests. For instance, some HEC stories describe applicants anxious because they were not getting timely feedback about their applications, and thus contacting various people able to informally tell them what was going on. HEC4 is such a case, identifying five actors unknown to the official process. A post-doc researcher told this particular process story and what happened was that the online system was not prepared for dealing with this type of applicant. Therefore, the interaction with the online system was very awkward and required help from various people such as co-researchers and administrative staff, which were engaged in finding a way through the online system. The story describes a set of painful, repeated attempts to move the process forward.

In GP, missing actors were related to scope and feedback. Regarding the former, in general the end users saw the process in a bigger scope than the official process. For instance, searching for a supervisor was described in various ways by the participants and involved various people including colleagues and candidate supervisors, rather than a crude "select supervisor". Considering feedback, the GP case highlights that many missing actors are related with lack of awareness about the process status, leading people to seek help from others with privileged access to the process.

Four process stories identified contradictions with official processes. GP4 showed that in some cases candidates must follow a formality missing from the official process, which involved registering certain types of supervisors. GP12 noted in the story that students could actually fail the graduation, which is a possibility not considered in the official process, possibly to avoid stressing the candidates. HEC4 identified three contradictions in the HEC process. As already noted, this particular story described a case that was not considered by the official process: having an external, temporary researcher applying for ethical clearance to gather research data but going through a process that was defined for internal researchers. The contradictions identified by HEC4 illustrate how the external researcher had to deceive the system by using a surrogate person to submit the application on her behalf. Finally, the contradiction reported by HEC8 emphasises an unexpected event related to the online system used to submit applications. In the end, these contradictions do not seem to expose flaws in the official processes, but instead expose important differences between the intents of end users and process modellers.

The analysis of emotions highlights a dominance of negative sentiments related to difficulties moving a process forward. We noticed an emphasis on time issues, in particular incertitude and often despair caused by lack of timely feedback about the process evolution.

The majority of refinements concern low-level actions necessary to move the process forward, often revealing practical decisions made by the end users, minor administrative steps and interactions with systems. As an example, several GP stories report hidden steps necessary to negotiate a date for an examination. In HEC, most refinements were related to low-level interactions with the online system. Even though it could be argued that such low-level activities may be irrelevant to understand a business processes, the fact is these low-

level activities were vivid in the end users' minds. We therefore suggest that official processes should be more transparent to report the actual details necessary to fulfil their goals.

The analysis of extensions is also quite enriching, as it reveals that official processes often put too many fences around what belongs and does not belong to the process. The end users seem to have systematically extended the official processes with additional activities. For instance, some GP stories include preparatory meetings with potential supervisors.

Finally, the high number of omissions shows a dichotomy between the official process and what end users think about the process. The GP case is enlightening. GP12, who is the process administrator, was capable to describe the process with very few omissions, just 3 elements. However, the number of omissions related to the other end users ranged from 8 to 23. A detailed analysis of these stories shows that the end users either summarised briefly the process (and thus the high number of omissions) or detailed the process but in different ways from the official process. All in all, this suggests that process stories uncover many different ways to understand official processes.

6. Discussion

We have developed and tested an original process story telling method for requirements elicitation that is theoretically grounded, effective, and easy to use for both researchers and the participant "story-tellers". We now turn to our research questions, which we recall were: what kind of knowledge is elicited; wow does this offer an opportunity for modellers to identify the various sources of knowledge supporting process execution.

Considering the type of knowledge elicited, our method has a number of interesting features. We noted earlier that elicitation is under-represented in research on process modelling, and has the advantage of being bi-directional. The end result of process modelling, which is frequently referred to as the "process" is a generalized model. However, a process can also be considered as an instance (Van der Aalst, 2013). Clearly, process stories initially capture the characteristics of process instances rather than generalized process models. They can therefore be considered a form of rich, contextual "bottom-up" knowledge elicitation and representation, which can be used as an antecedent to process modelling.

Considering the gap between generalized procedures and end-users, we note that every interaction between user and process is in some way unique. Nevertheless, most organizations achieve levels of efficiency and economy by generalizing and standardizing their service delivery in various ways, including standardized processes (procedures), where the processes are a form of generalized representation of the interaction. However, it is possible to get these badly wrong from the end user perspective, so they are not experienced as a positive service experience by the majority of users. They can be too generalized, too specific, omit important elements, and so on. This gap can be difficult to spot, as it does not necessarily result in observable service failures. This is especially the case in mandatory or semi-mandatory use situations.

The variations between process stories and official processes also point to the existence of significant but undocumented reserves of knowledge within the organisation and its

stakeholder community supporting successful process execution. In our two cases, it was absolutely necessary for the end users to successfully complete the processes in order to achieve some essential milestone, and therefore, the vast majority of people entering the processes did eventually complete them (so they appeared to be "fit for purpose"). However, in order to fulfil that goal, they needed to draw on many "unofficial" resources in addition to the "official" ones. Process stories offer an opportunity for modellers to identify the various sources of knowledge supporting process execution, which would improve the "service quality" of the process from the end user's perspective.

On the other hand, we suggest that a *collection* of process stories *considered together* is capable to express a range of different ways in which a case can be handled. We therefore suggest that although process stories maintain the raw characteristics of each individual case, the *collection* of process stories, analysed using the method described in this research, can yield an understanding of a generalised case. We do not claim that a collection of process stories is equivalent to a process model. Process stories do not abstract the coordination elements in the same way as process models but instead identify patterns of use. Each process story may have a different beginning and ending, emphasising specific parts of the whole process (as suggested by extensions in our analysis of similarity), and considering different scenarios. Furthermore, each process story may regard the process at different levels of granularity (as suggested by generalisations and refinements in our analysis of similarity).

Process stories capture both coordination and contextual knowledge. With coordination knowledge, the data we gathered shows that on the average, process stories reveal a diverse picture of official processes, often with less detail, as it would be expected, but many other times with much more detail than official processes. In particular, they identify more activities, events and actors, but fewer gateways.

A more detailed analysis indicates that the end users recalled very fine-grained coordination knowledge, and at the same time extended the scope of official processes with more activities. Somehow the end users felt compelled to take official processes beyond their original perimeters when telling their stories. Based on these results, we argue that process stories significantly enrich coordination knowledge. We also suggest that process stories enable modellers with a better understanding of the work reality surrounding a business process. Areas of ambiguity, decisions requiring clarification, "friction" points where processes "get stuck", can also be identified. All of these require investments of time and cognitive and emotional energy from end users. Diagnosing and correcting them can provide organizational benefits.

Several end users could identify actors missing in official processes. Once again this suggests that end users may have broader views than what is reported by official processes. Since most of the missing actors were related to roadblocks, such as not knowing the process status and needing help to move forward, we suggest that modellers could be more inclusive when developing official processes. In particular, they should consider increasing the number of events, which can provide feedback and increase awareness.

Another aspect to consider regarding process stories is their contextual richness. Our analysis suggests that process stories convey about two units of contextual knowledge per element in the official process. This type of information is not usually reported in official processes. However, our study suggests various benefits from contextual knowledge, in particular regarding time-related issues, interactions with people, and decision-making elements. On the other hand, end users seemed less compelled to strategize about the processes, by providing fewer contextual elements about methods. We suggest that modellers should enrich official processes with more pathways dealing with work variations, privileging diversity and detail over abstraction.

From a theoretical perspective, we integrate process and story elements. This enables the method to bridge an important gap between the sort of free-form narrative that might be captured in a user interview, and the structured representation produced by a modeller. The method is intuitive to the user and follows widely understood story-telling structures, but is also "mutually interpretable" with the conventions of process modelling. This is to our knowledge, the first method that offers the possibility of a fully transparent audit trail linking multiple user views and a final generalized model.

From a practical perspective, in addition to the insights offered above, it was interesting to find out that a small number of process stories were enough to enrich process knowledge. In this, our findings align with research in the Human-Computer Interaction discipline, which similarly has found that relatively small numbers of evaluators can identify the vast majority of usability issues in an interface (Nielsen, 1999). In our two cases, we collected a small to medium number of stories. The results suggest that even a smaller number could be useful. Further research involving varying numbers of end users should be conducted to identify the optimal numbers. If, as our results suggest, small numbers of stories can prove effective, then this method offers a powerful, but lightweight addition to process thinking.

One way of looking at process stories is they could be considered as the "service view" of the process experience; they describe how the end user enacts the process in context and how they feel about it at a detailed, granular, step-by-step level. This is under-researched in both process and service literature. Collections of process stories can therefore be used to derive new processes and to carry out fine-grained diagnosis of problems with the user experience of existing processes.

6.1 Future research directions

The current study centres the analysis of process stories on differences against the baseline provided by official processes, because of its focus on demonstrating the utility of the proposed method. Future research may instead focus on incremental value, in particular analysing the cumulative value brought by each story and identifying at what point the elicitation of new stories reaches a saturation point where no significant new elements add up to process knowledge.

Future research may also consider investigating other types of end user participation, e.g. combining individual storytelling with collaborative analysis of process stories (Hoppenbrouwers et al., 2018), as well as combining elicitation with modelling.

As text mining and natural language processing become more sophisticated, a fascinating future opportunity would be to use text mining in conjunction with our process storytelling method to automate process elicitation.

A more in-depth study of the relationship between specific characteristics of processes and corresponding knowledge contents also seems very relevant. In particular, it seems relevant to further research differences between more structured and less structured processes.

Finally, considering the differences between process stories and process models, future research should analyse if/how process stories may lead process modellers to generate different types of models. Aspects to consider are generalisation versus refinement, and possible adoption of contradictions and omissions in process models.

6.2 Limitations

This study has four identified limitations. The first is related to the elicitation tool. The study uses a specific tool but does not provide data about its efficiency or effectiveness. Based on exploratory evidence, we suggest the tool can be useful for eliciting process knowledge, but we did not gather the users' opinions and neither measured their performance. Future research should assess the tool's efficiency and effectiveness.

The second limitation concerns the specific characteristics of the researched processes. The two selected processes have significant differences, concern different organisations, and even concern different cultures. However, they have specific characteristics. In particular, HEC is mainly executed using online support, while GP is mainly people-centred. Both processes concern few events and do not depend on location. Therefore, this sample does not account for the whole range of process characteristics related to process knowledge. The assessment results from this research should take into consideration that certain elements supporting the discussion, in particular the profile of process stories and ratios between process stories and official processes, are used to motivate the discussion about process knowledge instead of generalising the characteristics of process stories.

The third limitation is the lack of large-scale statistical analysis. The reason is not only the small number of samples but also the exploratory nature of the research. Future work should move towards a more confirmatory research framework with statistical hypothesis tests and more samples. Nevertheless, we believe this study provides crucial elements necessary to frame that research in the future, in particular regarding what metrics could be used, how to operationalize them and what to expect from them.

The dependency on the researchers to convert process stories into BPMN models can also be considered a limitation. In the future, we could have an independent party doing such conversions. Though we see the problem as similar to data coding in qualitative analysis, where coding is usually done by the researchers.

7. Conclusions

This paper brings insights into process elicitation, an activity that precedes process modelling and design, which seems currently overlooked in the literature. Through quantitative/qualitative analysis of two cases we show how process elicitation may enrich knowledge about business processes, illustrating what type of knowledge can be collected and how it relates to official processes. This study adopts process stories, a method that combines storytelling theory and visual narrative theory to express coordination knowledge and contextual knowledge about business processes.

We performed a comparative analysis between process stories and official processes that are well established, documented and communicated by organisations. The analysis is grounded on a comprehensive set of measures. These measures highlight differences in complexity, diversity and agreement between process stories and official processes.

The study results support the idea that process stories are useful to elicit process knowledge. The end users reported high averages of coordination and contextual elements related to knowledge. The most surprising results were related to deviations: how some end users excelled in identifying a large number of elements missing from official processes. These results suggest process stories can uncover a rich body of coordination and contextual knowledge about business processes.

Our analysis also suggests that end users regard business processes as larger in scope and more detailed than official processes. Overall, this study suggests that 1) process stories provide diverse and contextually rich coordination knowledge, bringing in more activities, events and actors to the process boundary; 2) process stories convey many low-level activities and contradictions often missed in official processes; and 3) process stories also bring in many contextual elements necessary to understand how the process evolves towards conclusion, in particular related to time, people and decisions.

These results add significantly to the existing body of knowledge on process elicitation. In particular, we note that previous research has mainly focussed more on prototype evaluation than the actual knowledge generated by end users during the elicitation stage. As such, this research provides an important contribution to develop the concepts of process knowledge and end user process elicitation. Furthermore, the adoption of narrative theory and organisational storytelling theory in the support to process elicitation should also be emphasised as an important theoretical contribution of this research. As profusely illustrated in the two case studies reported in this paper, these theories significantly contribute to understand the nature and process of generating process knowledge during the process elicitation phase.

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