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Modelling Sensible Business Processes

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Abstract. In this paper we develop the concept of sensible business process, which appears in opposition to the more traditional concept of mechanistic business process that is currently supported by most business process modelling languages and tools. A sensible business process is founded on a rich model and affords predominant human control. Having developed a modelling tool supporting this concept, in this paper we report on a set of experiments with the tool. The obtained results show that sensible business processes 1) capture richer information about business processes; 2) contribute to knowledge sharing in organisations; and 3) support better process models.

Keywords: Sensible Processes; Process Stories; Business Process Modelling; Business Process Management.

1 Introduction

Business Process Management (BPM) has evolved towards a mature discipline concerned with the transformation of business goals, rules, processes, and practices into electronic services. Built on top of a variety of enterprise software and infrastructural components such as workflow engines, enterprise resource planning, service-oriented architectures and information repositories, BPM has provided broad facilities to manage business processes, which potentially increase productivity and reduce cost [1]. The typical BPM lifecycle includes eliciting and analysing process-related information, designing process models using specialised tools and languages, enacting process rules in enterprise systems, and executing/maintaining the services [2].

According to this lifecycle, the success of a BPM initiative starts with good elicitation, analysis and design, so that when reaching the enactment stage, the electronic services will effectively deliver the envisaged business goals. Of course, ensuring success is relatively easy in the case of *purely automated systems*, since their scope is well delimited, workflows are known, and procedures are always applicable. In these systems, systematic and preventive verifications of the relationships between process models and actual data processing usually ensure that services can be continuously provided within the required service-level agreements. Furthermore, exceptions in purely automated organisations tend to be expected exceptions, which can also be handled by pre-programmed instructions [3,4].

Though the situation becomes much more challenging in areas where service provision involves a mix between humans and machines. Example areas include healthcare and customer relationship management, where human discretion is often necessary to resolve unique business cases [5]. In these areas, BPM needs to coordinate human decisions and automatic processes, which challenges the concept of purely automated system. Underlying these challenges, we find the different capabilities and constraints of humans and machines, e.g., machines can process more symbolic information in parallel and humans have more capacity for processing perceptual information [6]. Furthermore, humans have more capacity for recognising and interpreting context, making decisions with information gaps, and accommodating and improvising [7,8].

Additionally, the BPM discipline must consider a business reality characterised by ever changing business contexts and goals, diverse clients' needs, unexpected events, and emergent human behaviour. In such scenario, BPM experts may have to carefully consider the risks and consequences of mismatched process models and enacted operations, a problem that has been generally coined the "model reality divide" [9,10], which is ultimately related with other problems predating BPM technology like the "lack of realism" (when rules do not exactly apply to the situation), "lack of details" (when precise rules about the situation are missing), and "lost in translation" (when rules have been erroneously converted to machine language) [11]. All these problems underline how difficult it is to integrate human and automated behaviour.

The BPM discipline has its roots in software engineering and computer science. Formal theory and methods such as Petri Nets, Pi-Calculus, and the Entity-Relationship and Relational models have been widely used to model data and processes [1]. Standards such as BPMN [12], UML [13], IDEF0 [14], BPEL [15], XPDL [16], and BPQL [17], just to mention few, have been developed to help specifying business processes and process-related data in consistent and valid ways. Besides, an extensive body of research literature has been published concerning the requirements and constraints imposed by process enactment and execution. The concerned topics include avoiding deadlocks and live-locks, allowing model/language transformations, and avoiding inconsistent system states, system failures, unreachable states, racing conditions, non-determinism, data integrity failures, etc. [18,3].

We argue that these concerns reflect a mechanistic view of the BPM approach. While the success of current BPM technology is beyond any doubt, there has been some recent concern on several shortcomings, biases, omissions, and problems this approach has. Among these concerns we find, for instance, the lack of implicitness [10], struggle for flexibility [19,20], and lack of consideration for tacit knowledge [21]. Overall, these problems suggest that perhaps a more sensible viewpoint of this technology is needed. A sensible perspective privileges the integration of human knowledge, context-awareness, diversity, creativity, ambiguity, and many other properties pertaining to human behaviour in BPM systems [22]. This viewpoint leads to *sensible business processes*, which balance the level of control between machine and human within the BPM systems.

In the next section we elaborate our definition of sensible business process. Section 3 discusses results from three experiments assessing the elicitation and design of sensible business process models. In Section 4 we discuss the results and provide some implications for research.

2 Sensible Versus Mechanistic BPM

In the introduction we argued that the BPM lifecycle considering eliciting, analysing, modelling, and enacting business processes in organisations has been significantly constrained by the final stage and in particular the translation of process models into machine-readable instructions. The focus on a more sensible perspective, where the BPM practice may be less constrained by technology, suggests we should consider the issue of control in technology support.

In Fig. 1 we illustrate that the level of control over a human-machine system is a combination of two variables: human and machine control. The type of supporting technology determines such combination. Technology may either enforce strict rules and procedures over human activities or support open-ended, unrestricted human activities. In between, we find what has been designated as joint-cognitive systems, where control is a co-agency between humans and machines [6]. According to the joint-cognitive perspective, details of the real world may determine a swift change of control between the two parties, either because the machine may try to compensate for human error, or the other way around. For BPM in general and process enactment in particular, this means that enterprise systems should be designed for different levels of flexibility required by the work environment [20].

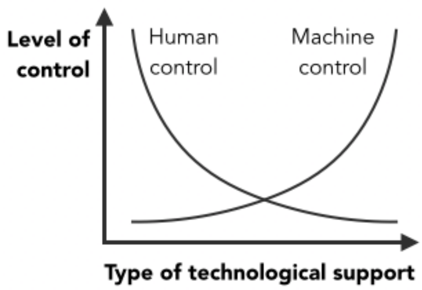

Fig. 1. Level of control (adapted from [23])

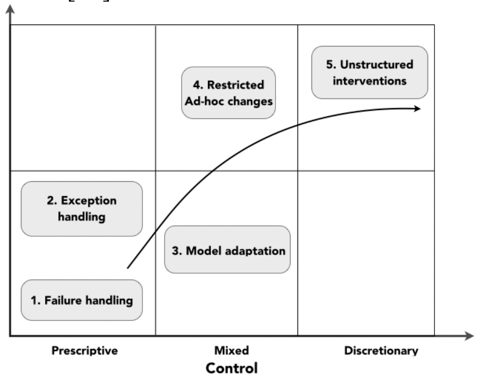

Fig. 2. Exception handling strategies (adapted from [3])

The joint support to human and machine control has significant implications for enterprise systems, especially regarding the implementation of exception handling mechanisms. In prior research we identified five types of exception handling mechanisms, which can be conceptualised in two dimensions considering the type of control and type of response [3,24].

We defined three types of control (Fig. 2): prescriptive, where machines apply predefined handling procedures and therefore human intervention is highly constrained;

discretionary, where humans take control and decide what to do next; and mixed, considering situations where control has to be negotiated between humans and machines. We defined two types of response, which may be either planned or unplanned. In the planned case, humans and machines have predefined exception-handling procedures, which can therefore be applied to resolve an exception, while in the unplanned case, no procedure is available and the handling procedure has to rely on other strategies, usually involving human ingenuity.

Using these two dimensions, we can now characterise the five exception-handling strategies. They may range from low-level, automated failure handling (e.g. wait for the network to recover from failure), to high-level, programmed exception handling (e.g. rollback a transaction in case of message failure), model adaptation (e.g. change the flow and conditions, if they do not impact other processes), restricted ad-hoc changes (e.g. add an activity between two consecutive activities), and unrestricted interventions (e.g. add or delete activities without consideration for model consistency).

Besides the problem of control, we should also discuss the differences between process models and business reality. By definition, any business process model is always an incomplete representation of the business reality [25]. However, we argue that here again we may consider that the level of modelling is a combination of two variables: contextualisation and normalisation. In Fig. 3, we use the concept of level of modelling to characterise how a process model may reflect the work reality by either leaning towards the normalisation or towards the contextualisation of work. On the one hand, normalisation seeks to find a single process model describing the regular/consensual sequence of activities, eventually with a great level of detail. On the other hand, contextualisation considers the large number of possible variations in process execution. Of course once again these two different approaches to modelling may require different types of support from enterprise systems.

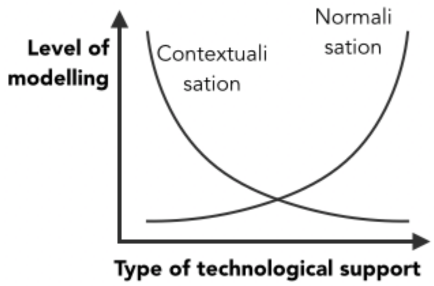

Fig. 3. Level of modelling

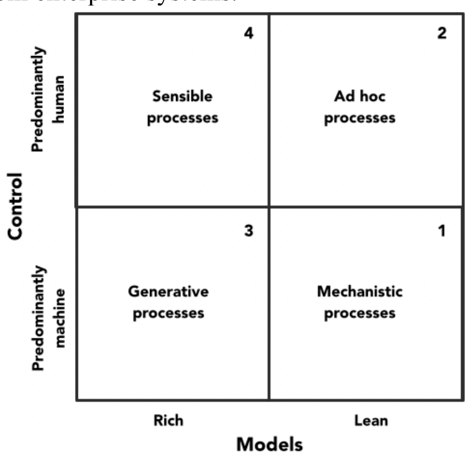

Fig. 4. Classification of processes

With these two dimensions of the problem, considering level of control and level of modelling, we may now discuss with more detail what types of processes fall in each category (Fig. 4). We first note that quadrant 1, favouring the normalisation of work with predominant machine control, is the domain of mechanistic BPM processes. They favour behavioural clarity and predictability. They avoid disturbances and human decision-making. With these characteristics, the processes are strongly suitable to mechanisation and computerisation [6].

Quadrant 2 suggests the support to ad hoc processes, where the dynamic flow of events, including unexpected events, determines the process evolution [24]. Health care treatments are typical examples of ad hoc processes, which usually deal with exceptional or unanticipated situations [26]. This kind of processes is characterised by significant human intervention in sensemaking the situation and decision-making. Here, an important role attributed to machines is to support the decision makers e.g. with visualisation tools, query and filtering mechanisms, etc. [24].

The combination of predominant machine control with rich models fosters the machines' capacity to generate and handle an infinite number of alternatives (quadrant 3). Research in generative design highlights how technology may inspire alternative solutions through evolution, breeding and adaptation [27]. According to this perspective, variety is not only possible but also desirable and exceptions, instead of representing a setback when analysing, modelling and managing business processes, may actually become an opportunity to improve a business process.

The combination of predominant human control and rich process modelling concerns sensible processes (quadrant 4). Here, human sensemaking and decision-making capabilities combine with rich information necessary to adapt the process to the changing environment both through human decision-making and through computational support [28,29]. Management and governance literature has provided several instances of sensible processes. For example, Pries-Heje and Richard [30], while examining the process of organisational change, identified many ways to enact organisational changes, all based on sound competing theories. This situation strongly requires human capabilities to analyse rich organisational information and to make sensible choices, which can be supported by computational tools.

The current paper focuses exactly on this quadrant. We characterise sensible business processes as *processes that leverage both the human capacities for decision-making and the information processing capacities for supporting the sensemaking process*. Thus sensible business processes appear in opposition to mechanistic processes, where modelling and control predominantly rely upon and utilise the machines' capacities. In the next section we describe research addressing the elicitation and modelling of sensible business processes.

3 Eliciting and Modelling Process Stories

The rich-lean perspective suggests that business process models may capture richer information on how work is done in organisations. This led us to develop an exploratory research agenda centred on the following research questions.

- What process knowledge would be captured?
- What methods and tools would be needed to capture such knowledge?
- What would be the effectiveness of these tools and methods?

In [10,31] we discussed the first two questions. Building on prior research [32], we suggested modelling “process stories”. A process story is a diverse collection of structured and unstructured information about a business process, which may integrate different perspectives and various narrative elements. Its conceptual foundation lies in Organisational Storytelling theory [33]. According to Denning [33], stories communicate complex ideas and spring people into action using narrative mechanisms. Furthermore, stories bring detailed explanations, contextual information, values, and what-if considerations to knowledge sharing.

Based on the storytelling theoretical foundations, we developed an information model for process stories [10]. A process story has a beginning and ending, descriptive attributes, triggers, and a sequence of scenes. The critical element to structure a process story is the scene. It combines visual with textual information to describe a work setting, presenting the actors, suggesting the social atmosphere, and explaining what happens in terms of events and action. A scene contains an abstract picture, which could also be described as a cartoon, of a business situation such has checking a form, contacting a client, having a meeting, and signing a document. By associating pictures to scenes we allow business people to analyse a process story by recognition and familiarity with the depicted situations.

Besides the abstract picture, a scene contains semi-structured information about actors, artefacts, events, and actions, which may be involved in the depicted work situation. Dialogue lines may also be associated to actors appearing in a picture, which follows a well-known narrative paradigm used by graphic novels. These dialogue lines may be used to convey additional information on how actors interact with artefacts and collaborate with other actors. Finally, textual attributes may be aggregated to scenes in the form of annotations and comments.

One particular characteristic of process stories is that, even though they can model traditional business processes with activities, flows and conditions, they can use scenes to convey other types of process-related information. For instance, scenes can be used to explain sensemaking and decision-making when performing activities. They can be used to add contextual details about the work setting, not only identifying the actors and artefacts involved but also other attributes and constraints like exchanged ideas or special requests. Scenes can also be used to express nuance, equivocality and conflict, reflecting past experiences, unusual scenarios, cautionary tales, which are typical of storytelling.

If we contrast this definition of process story with the traditional definitions of process models, e.g. the ones based on the dominant BPMN, we may easily notice the distinctions between their rich and lean imprints. Process stories are richer and open-ended while traditional models are leaner and formal. Very often, traditional process models describe the predominant flows but not the variations and exceptions, either because it is too expensive to model them, the language does not offer simple means to do it, or because models get too cluttered up to a point where they become useless. Modelling exceptions tends to be a difficult endeavour, since it may be difficult to consider all different types of events and specific points in a model where they may occur. Furthermore, some complex aspects of work are difficult to model with traditional languages. Examples include flexibility (in assigning resources or shifting responsibilities), fuzzy connections between activities, performing continuous activities, jumping between activities, sharing information, and dealing with optional and ephemeral information [34]. Process stories avoid these problems by adopting a more open-ended approach.

We have also developed an innovative BPM modelling tool supporting the elicitation, analysis and design of process stories [31]. As noted above, the tool uses cartoons for eliciting and representing process stories. Users can select and configure cartoons from a database. The database provides a large collection of cartoons illustrating common business scenarios such as handing over a document, having a meeting, requesting/providing data and assigning a task. These cartoons can then be configured to express a specific business situation, e.g. indicating who participates in a meeting and what is decided there.

Furthermore, the tool supports a collaborative approach to process modelling. Even though individual scenes cannot be concurrently edited, teams can share process stories and modify the process-related information. This allows, for instance, expressing alternative flows, filling up gaps and enriching information with individual experiences. This tool can be contrasted with the more traditional business process modelling tools [35]. One striking difference is that while traditional tools mainly focus on activities, our tool concerns the open-ended environment surrounding them. Furthermore, while traditional tools emphasise formal conditions and flows, our tool emphasises informal sequences of events, which can be interpreted by readers using anthropomorphic information, thus affording implicitness and contextualisation.

Contemplating again the three research questions brought forward in the beginning of this section, we note the critical is the third one, what is the effectiveness of the tool and method. So far we have accomplished three rounds of experiments with the tool. In the following, we provide some insights from these experiments and present the obtained results.

3.1 First round (tool usage)

The first round of experiments was primarily focussed on gathering formative insights about the tool usage. As previously discussed, the tool combines storytelling with cartoons, which breaks the traditional process modelling paradigm centred on activities, conditions and flows. The risk of users rejecting the tool because of a paradigm change was high and empirical tests were necessary to understand if the users would be able to develop process stories using the tool.

A set of individual modelling sessions were setup in a real-world organisation. The selected organization was seeking to integrate process management into an existing information system. However, they had not yet developed a clear process-oriented view and neither had started designing the process models. We approached the organization with two goals in mind, helping to select and design the processes and at the same time observing and analysing how some of its members would elaborate process stories using the tool. The empirical tests were organized according to the following steps: meeting with leadership to identify and select processes; modelling sessions with key members using the tool; and analysing the outputs and obtaining informal feedback about the tool.

The modelling sessions were done in a period of four weeks. Different types of stakeholders where engaged in using the tool, including three managers. The form of engagement was different according to responsibilities. The three managers were engaged in individual modelling sessions, while the remaining 24 participants were divided in two groups and were assigned to joint sessions.

The results from these empirical tests were encouraging but also raised several major concerns about the tool and the modelling method [10]. One critical problem that was raised was the effort required for modelling process stories. One participant even referred to it as "mechanically slow". The tool required picking scenes from the database, adding contextual information to each scene, and then organising scenes in a meaningful sequence. The participants complained the whole method required too many interactions and took excessive time. Further evidence suggested that this was a real constraint because most produced process stories were very short and lacked detail.

Two other concerns were also raised during the experiments. First, the participants revealed preoccupation with the correctness of their stories, i.e. how far they might diverge from the processes formalized by the organization. This suggested that organizational culture might also be a problem to consider when eliciting process stories.

Second, the participants were not always able to portray some situations as they wanted. Some of them tried to depict precise working contexts (e.g., a casual meeting taking place in a formal work area), while the tool offered a limited set of abstract scenes (e.g., casual meetings taking place in open spaces and formal meetings taking place in meeting rooms). As an exhaustive coverage of possible situations and contexts is hardly achievable, this suggested the participants should have been more exposed to storytelling strategies.

Overall, these tests indicated the concept of process story was appropriated by the participants but more training and repeated usage would be required to generate them; and also some positive reinforcements about the benefits of describing processes from alternative points of view would be necessary. Though the critical problem was the excessive effort required to tell a story. This led us to make structural changes in the tool to increase ease of use. The second and third rounds of experiments were done with the upgraded tool.

3.2 Second round (small team, desired process)

The second round of experiments was targeted to a smaller organisation. It involved a small team of six persons, including the team leader. The team was responsible for providing a complex service related to information technology infrastructure management and the leader had arrived to the conclusion that service provision was affected by too many exceptions, ad hoc decisions and lack of knowledge management. In this particular case, the adoption of a process view was stimulated by the objectives of improving consistency, efficiency, transparency, accountability, and learning. In this context, the leader decided to use the tool to design an improved business process model and the whole team was invited to participate.

The second round of experiments was designed in a more structured way. To start with, we defined a set of goals, questions and measurements, which is shown in Table 1. We considered three goals related to meaningfulness, contextualisation and sharing. Regarding meaningfulness, the intention was to assess if the generated process stories were sufficiently detailed and could be translated into purposeful activities. Asking if emotions, unexpected situations and contextual knowledge were present in process stories assessed contextualisation.

Table 1. Goals and measurements

Goal	Questions	Metric	Type	Data Categories
Evaluate meaning-fulness	Stories are detailed? Processes could be derived from stories?	Number of scenes	Quantitative	Numerical
		Use of narrative	Qualitative	Low, Medium, High
		Use of dialogue	Qualitative	Low, Medium, High
		Structural complexity	Qualitative	Low, Medium, High
		Conveys activities, condi-tions and flows	Qualitative	Yes, No
Evaluate contextu-alization	Stories por-tray emotion? Stories depict unexpected situations? Stories pro-vide contextu-al knowledge?	Presence of emotional elements	Qualitative	Yes, No
		Presence of unexpected situations	Qualitative	Yes, No
		Presence of contextual reasoning	Qualitative	Low, Medium, High
Evaluate sharing	Stories helped the team better under-stand the process? Individual stories en-riched the organisational practice?	Word count in story seg-ments	Quantitative	Numerical
		Activity count in story segments	Quantitative	Numerical
		For each story segment, ratio of activities appear-ing in individual and converged stories	Quantitative	Numerical
		For all segments, ratio of activities appearing in individual and converged stories	Quantitative	Numerical

Concerning sharing, we looked for evidence of knowledge articulation and integration. This required dividing the process stories in different segments and analysing the respective levels of detail to find evidence of positive/negative changes.

The experiment was organised in three stages: training the participants on the tool usage; production of individual processes stories using the tool; and collaboration to reach a converged process story. The first phase lasted one week. The team received basic training on the tool usage and began using it for telling process stories. At this stage, there was frequent interaction between the team and the researchers to clarify the tool usage and to identify potential problems in developing process stories. This involved explaining the importance of scenes and how they could be configured to convey contextual information.

The second phase lasted about two weeks. The team members were invited to individually use the tool to elaborate their process stories. There was no interaction between the team and the researchers at this phase. Finally, in the final phase, participants were asked to collaboratively produce a converged process story. Since the tool allows viewing and changing each other's stories but does not support any explicit convergence process, the team would have to improvise a way for reaching a common, agreed upon story. This involved the team leader in gathering stories from all participants and suggesting a converged process to the team. The converged process would then be discussed and agreed by the team in a face-to-face meeting. Actually, because of the unanticipated complexity of some individual stories, two meetings were necessary to complete the discussion. After these two meetings, the team leader used the tool to record the collective process story.

The results from this experiment provided fine-grained information about our humanistic approach to process modelling [35]. Details about the individual process stories generated in phase two are shown in Tables 2-5.

Table 2. Details about meaningfulness

Story #	Number of scenes	Use of dialogue	Use of narrative	Structural complexity	Story conveys activities, conditions and flows
1	10	None	Medium	Medium	Yes
2	8	Low	Medium	Medium	Yes
3	37	None	Medium	Very high	Yes
4	14	Medium	Medium	High	Yes
5	13	Medium	Low	High	Yes
6	15	Low	Medium	High	Yes

In Table 2, we summarise the measurements related to meaningfulness. Since the participants were purposely trying to model a desired process, not a current one, most stories scored poorly on the use of dialogue and highly on structural complexity. Two stories did not use dialogue at all, and all of them used structure as the primary means of telling a story. Most team members used narrative to describe what happened in a scene and for connecting scenes. Interestingly, every story could be converted into a traditional process model with activities, conditions and flows.

Table 3. Details about contextualisation

Story #	Presence of emotional elements	Presence of unexpected situations	Presence of contextual reasoning
1	No	No	Low
2	No	No	Low
3	No	No	Low
4	Yes	No	Low
5	Yes	No	Low
6	No	No	Low

Table 3 summarises the obtained results regarding contextualisation. We note that few stories conveyed emotional elements such as uncertainty, frustration and disbelief. No story conveyed unexpected situations.

Table 4. Details about sharing: word count (WC) and activity count (AC)

Story #	Segment 1		Segment 2		Segment 3		Segment 4	
	WC	AC	WC	AC	WC	AC	WC	AC
1	0	0	39	4	35	5	6	1
2	0	0	26	3	31	3	11	2
3	169	21	0	0	93	17	0	0
4	0	0	63	5	77	8	19	2
5	0	0	35	6	29	5	16	3
6	29	4	43	6	30	4	23	4

Table 5. Details about sharing: Ratios of activities appearing in individual and converged stories, shown by segment and overall. Stories not addressing a given segment are marked with "-".

Story #	Segment 1	Segment 2	Segment 3	Segment 4	Overall
1	-	75%	20%	20%	50%
2	-	100%	33%	50%	63%
3	38%	-	41%	-	39%
4	-	100%	0%	50%	40%
5	-	83%	0%	67%	50%
6	25%	67%	100%	25%	56%

Tables 4 and 5 summarise how the process stories contributed to the final story through knowledge sharing. We note the participants tended to focus on particular areas of expertise. For instance, story 3 concerned segments 1 and 3 but not 2 and 4; story 6 fully described story segment 3, but did not contribute much to the other segments. Perhaps more importantly, we also note that the converged story was assembled from diverse contributions of all stories in a rather balanced way: story 3 provided the lowest contribution but yet 39% of the modelled activities were present in the converged story.

All in all, the second phase of experiments indicated the method and tool provided an effective approach for business process elicitation and modelling, but the generated process stories lacked contextualisation. On hindsight, the main explanation for the lack of contextualisation was related with the participants' goals. They were explicitly aiming at developing a new business process and therefore it is just natural that a new, idealised process does not convey much contextual information about a non-existing reality. In the third round of experiments we addressed that limitation.

3.3 Third round (large team, existing process)

For the third round of experiments we selected a larger organisation. We have also chosen a complex business process involving multiple divisions; and involved more participants in telling process stories. The experimental design had to be adapted to accommodate the additional complexity. The goals and questions described in Table 1 were reused by this experiment; and a similar experimental design in three stages was followed. For the second stage, various modelling sessions were scheduled and the participants were invited to come up to one or more sessions for generating process stories. The participants would still work individually in these sessions. At the beginning of each session, the participants were informed about the process they should work on, but they were given freedom to model whatever they would consider relevant or interesting.

The third stage was also adapted, replacing the convergence meetings with a different approach, since converging a large, heterogeneous group is substantially more difficult that converging a small, homogeneous team. Instead, in the third stage we converted each individual process story into a traditional process model and then compared those stories with a reference process model previously approved by the organisations' management.

Table 6. Details about meaningfulness

# Story	Number of scenes	Use of dialogue	Use of narrative	Structural complexity	Story conveys activities, conditions and flows
1	2	55	2	Low	Yes
2	5	90	28	Medium	Yes
3	6	68	160	Medium	Yes
4	3	204	3	Medium	Yes
5	7	274	319	Medium	Yes
6	12	158	80	High	Yes
7	8	112	55	High	Yes
8	7	83	25	High	Yes
9	7	144	133	Medium	Yes
10	1	160	112	Medium	Yes
11	4	81	94	Low	Yes
12	7	118	74	Medium	Yes
13	3	105	78	Low	Yes
14	3	29	45	Low	Yes
15	2	7	8	Low	Yes
16	7	105	126	High	Yes
17	8	164	102	High	Yes
18	12	141	241	High	Yes
19	4	126	16	High	Yes
20	5	141	52	Medium	Yes

As reported in Table 6, we collected 20 stories in this experiment. We note the participants used narrative and dialogue as the primary means of telling their process stories, which is supported by the high word count regarding both narrative and dialogue. Most stories contained a relatively small number of scenes, which seems well aligned with the organisations' multi-divisional structure.

Some stories, even though having a low number of scenes, featured high structural complexity. As with the previous experiment, this suggests the participants externalised significant knowledge about the business process. Interestingly, stories 1, 11 and 13-15 provide low structural complexity but yet have significant use of dialogue and narrative. This suggests these scenes were used for storytelling. Even more interesting, story 10 is entirely contained in one scene with medium structural complexity, an indication of narrative sophistications.

Table 7. Details about contextualisation

Story #	Depiction of unexpected situations	Presence of emotional elements	Presence of contextual reasoning
1	No	No	Low
2	Yes	No	High
3	No	No	Medium
4	Yes	Yes	High
5	No	No	High
6	Yes	No	High
7	Yes	No	High
8	Yes	No	High
9	Yes	Yes	High
10	Yes	Yes	High
11	No	Yes	High
12	No	No	Low
13	Yes	Yes	High
14	Yes	Yes	High
15	Yes	Yes	High
16	Yes	No	High
17	Yes	No	High
18	Yes	Yes	High
19	Yes	No	High
20	Yes	No	High

Regarding contextualisation, we found a large number of stories depicting unexpected situations and emotional elements, which indicates the participants' interest in describing processes beyond the traditional activities, conditions and flows. We also observed a predominance of applied contextual reasoning in the vast majority of the collected stories, including contextualised explanations supporting staff decisions over concrete circumstances, and detailed descriptions outlining unique scenarios that triggered custom behaviour/responses according to context. We argue that this combination, i.e. the depiction of unexpected situations together with emotional elements and contextually rich explanations (often foreign to the "happy path" normally depicted in mechanistic models), is an indicator of the externalization of participants' tacit knowledge in the form of process stories.

Table 8 provides a detailed summary of the process stories that were elaborated and their contributions to knowledge sharing. When comparing the activities described by the participants with the reference model (last line in Table 8), we can conclude that there is no direct mapping. Several stories provide significantly more knowledge, e.g. stories 3 and 4 more than double the number of activities. Again, this suggests that process stories enrich process knowledge with detailed insights about how work is actually done in the context of a business process.

In Table 8, we show two columns indicating if a story contributed to the reference model or not. As in the previous experiment, this provides another indication of how individual participants contributed to shared process knowledge. Once again, the results support the view that process knowledge is a collective construction. The results also show if stories contradicted the reference process or not. We found out that five stories expressed knowledge contradicting the reference process sanctioned by the managers. This reinforces the idea that process stories can be richer than traditional business processes by expressing different and often contradicting views about a process.

Table 8. Details about sharing (the last line provides details about the reference process model. Stories 4, 15, and 20 were omitted because they modelled a different process)

Story #	Number of activities per segment				Adds to reference	Contradicts reference
	Segment 2	Segment 2	Segment 3	Total		
1	0	0	7	7	yes	no
2	6	5	0	11	yes	no
3	7	8	0	15	yes	no
5	5	9	0	14	yes	no
6	0	0	27	27	yes	no
7	0	0	25	25	yes	yes
8	0	0	17	17	yes	no
9	13	0	0	13	yes	no
10	11	0	0	11	yes	yes
11	0	7	0	7	yes	no
12	2	0	15	17	yes	yes
13	5	0	0	5	yes	no
14	0	6	0	6	yes	no
16	14	0	0	14	yes	yes
17	13	2	9	24	yes	yes
18	25	2	0	27	yes	yes
19	13	0	0	13	yes	no
Reference	13	3	22	38	-	-

4 Discussion

In this paper we suggest a classification of business processes in four categories: mechanistic, ad hoc, generative, and sensible. Sensible processes are founded on rich models and support predominant human control. We argue that such a combination leverages the capacity of humans and machines in BPM, which contributes to address the requirements of enriching knowledge [21] and flexibility in BPM [19,20]. On the one hand, rich models afford information systems to reach beyond regular behaviour. For instance, rich models may provide details about process variations, exceptions, past occurrences, and contextual elements influencing the trajectory of a process instance. On the other hand, the predominance of human control in the interaction between humans and information systems affords more flexibility regarding process execution, which may be supported with richer process models. Of course these possibilities depend on the capacity to design rich process models.

Having previously developed a process modelling tool supporting the design of rich process models, which we designate by process stories, in this paper we focus on a set of experiments that were set up to assess the capacity to design process stories and their potential value to organisations.

The several rounds of experiments demonstrated the validity of a set of assumptions behind process stories and the concept of sensible process. An important one is that process stories can be designed by end-users, i.e. business people that do not have expertise in process modelling. We argue that bringing process modelling to end-users increases process contextualisation. Traditional modelling tools usually require grasping specialised languages such as BPMN and UML. However, these languages tend to be formal, very complex and impose significant constraints, which are mainly related to their mechanistic lineage. The end result is that traditional modelling tools tend to be primarily used by modelling experts. Naturally, modelling experts have their own biases and goals when modelling business processes, which may conflict with the goals of the target organisations. The related literature refers to this phenomenon as silo views [36] and social distance [37]. Furthermore, existing process modelling languages and tools make it difficult to represent business rules [38,39], collaborative aspects of business [40], and non-routine work [41]. The concept and information model underlying process stories addresses these concerns by adopting a process modelling language that is informal, open-ended and closer to the business context. The results from the experiments support this argument, showing that end-users were able to develop process stories and the stories were relevant to discuss and elaborate process models.

Another important assumption behind process stories that was validated by the experiments is that they can bring about rich, contextualised information about the environment where they are enacted. Several stories developed in the experiments contained emotional elements, unexpected situations and contextual reasons. Furthermore, several stories also contained contradictory information, when compared with the reference process sanctioned by the management. However, we also noted that contextualisation may depend on the organisational goals. In the second experiment, where the participants where seeking to develop a desired process, the produced process stories did not contain contextual details. However, in the third experiment, where the participants were engaged in describing an existing process, the generated stories contained significant contextual information.

Finally, another relevant question about process stories is if they contribute or not to generate better process models. This question addresses matters of quality in general and effectiveness in particular. Ascertaining the quality of a business process is a complex endeavour, as it involves a large set of criteria like understandability, utility, efficiency, completeness, and correctness [42,43], to name a few. In the specific context of modelling sensible processes, we argue that quality assessment should primarily concern matters related to model richness and human control. This suggests that aspects such as understandability and utility should prevail over more technical characteristics such as correctness and efficiency. Regarding the results from our experiments from this point of view, we note that in the second experiment, process stories helped teams agreeing on a process model that was more balanced than the individual stories. In the third experiment, the produced process stories simultaneously added to and contradicted the reference story, which suggests that process stories contributed to both comprehensibility and utility.

The concept of sensible business process opens up interesting avenues for future research. One interesting possibility is the transformation of process stories in traditional process models and subsequent integration in enterprise systems. In particular, process stories provide contextual information that may be relevant during process execution, for instance when handling exceptions. Another possibility, which is related to generative design, is the automated generation of a large number of alternative process models from a single process story, so that process participants and eventually enterprise systems could select a particular model depending on the specific conditions at hand. This would certainly contribute to increase the flexibility of enterprise systems.

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