A non-linear business process management maturity framework to apprehend future challenges

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A B S T R A C T

In a context where enterprises and organizations aim to optimise their behaviour, obtain certifications and labels, and benefit from the smart use of information systems and technology, two considerations drive this research: (1) the weak maturity level of worldwide Business Process Management (BPM), which exposes the need to reconcile academic theories with industrial contexts, and (2) the need for upcoming software functionalities that prioritize removing the barriers frequently encountered by industrialists when trying to implement the method. To reach such goals, this research work has developed a conceptual framework to represent the BPM implementation state. It is built along three axes: the BPM Cycle (Design, Enact, Maintain), the Field (Culture, Business, IT) and the Abstraction Level (Data, Jobs, Behaviour). An organization's overall BPM maturity can thus be evaluated by positioning its capabilities along the framework's axes. It is also suggested that the framework be used to track the implementation of new procedures in an organisation. The framework is presented and detailed before being applied to a complete case study.

Keywords:
Business process management
Maturity framework
Non-linear framework
3D maturity framework
Organization
Continuous improvement
Maturity evaluation

1. Introduction

Businesses structure their operations to satisfy objectives and goals. These particular ways of working constitute their own business processes (Vernadat, 1999). Since the 1980s, myriads of methodologies (van der Aalst, 2013) have emerged to manage and improve business processes. The term Business Process Management (BPM) was first used in 2002 and suggests a lifecycle method to continuously improve and manage processes (vom Brocke & Rosemann, 2015). According to ter Hofstede and Weske (2003), and as shown in Fig. 1, BPM is a set of methods, techniques and software to (i) design and configure, (ii) execute, (iii) control and (iv) diagnose processes. In other words, BPM is made of multiple cycles which consist in (i) formalizing the way operations are conducted in the business (Design and Configuration), (ii) playing out processes as they were designed (Execution), (iii) collecting data and monitoring KPIs (Control) and (iv) deducing process weaknesses, which are then compensated for in the next cycle of the approach (Diagnosis).

BPM methodologies have been conceived by academics for industrialists. Since the 1980s, methodologies to manage business processes have been taught in universities as strategies to improve many aspects (van der Aalst, 2013) such as agility, productivity, or risk & compliance management. The method has shown satisfying results for large organizations like Ford Motor Co. and Wal-Mart (Al-Mashari & Zairi, 1999). But still, the weak worldwide level of BPM maturity in 2016 (Harmon & Wolf, 2016) is evidence that BPM still does not constitute a suitable strategy for the majority of companies that are of smaller size. Imanipour, Talebi, and Rezazadeh, (2012) revealed that between 60% and 80% of attempts to implement BPM failed in 2012, revealing the need to reconcile theoretical approaches with industrial implementation methods (Indulska, Recker, Rosemann, & Green, 2009). New academic strategies should be based on industrial capabilities and should consider the reality of enterprise ecosystems.

BPM methods have existed since the end of the last century, a time when Information Systems (IS) were neither equipped nor thought to support the orchestration of processes in organizations (IS were mainly dedicated to managing databases and, at best, to connecting a heterogeneous set of software tools). In this context, modelling approaches were not designed to integrate computer systems, data sources and software tools that nowadays could (and maybe should) be involved in the facilitation and fluidity of the organization's behaviour. Approaches to modelling business processes and, more generally, the behaviour of organizations must incorporate this shift from a mode where the processes were modelled to be operationally managed by the human actors of the company to a mode where they are supported by modern IS. BPM methodologies should integrate this new aspect to prevent the expected

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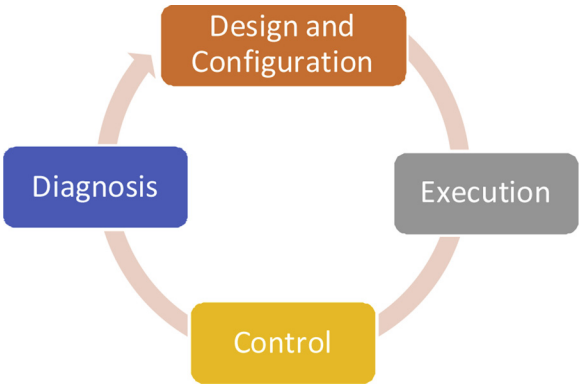

Fig. 1. Business Process Management (BPM) according to van der Aalst, Netjes, and Reijers (2007).

decline in enthusiasm for them (Harmon, 2018).

BPM methodologies need to be more successful more often, and it is becoming urgent to conduct a thorough investigation of practical BPM implementations so as to identify the main difficulties faced by industrialists and to help them in bridging these gaps. On a societal level, this research generally aims to provide guidance in the design of new BPM implementation methods to ensure industrial success (the *Social Challenge*).

Maturity is defined as "the state of being complete, perfect, or ready" and the "fullness or perfection of growth or development" (Oxford University Press, 2012). In terms of evaluating BPM Maturity, two different aspects of an organization's maturity are important: Enterprise Maturity (a company's BPM capabilities) and Process Maturity (the condition of processes in general or distinct process types). For both aspects, BPM Maturity models are conceptual models provided to evaluate maturity through several desired or logical stages - the maturity levels - from an initial state to a more mature state (Gottschalk, 2009). To conceive better implementation methods (the *Social Challenge*), we should first be able to confront existing methods with frequent industrial failures and classify them. To reach such a goal, we should be able to characterize an enterprise's BPM maturity depending on what has already been implemented by the organization, meaning that we first need to identify what criteria can characterize BPM maturity (*Scientific Question 1*). Such a framework should be able to characterize an organization's overall maturity in terms of BPM implementation and should indicate the achievements required to reach a higher maturity level (*Scientific Question 2*).

The next section builds a literature review that primarily describes the research supporting and answering the questions raised and described above (the *Social Challenge* and *Scientific Questions 1* and *2*). Section 3 gives the big picture of the framework and is mostly based on the results of the literature review. Section 4 details each position in the framework in term of achievements. Section 5 presents a case study to demonstrate how the framework can be used in an industrial context where the goal is to obtain ISO certification. Section 6 gives evaluations and discusses the limitations of the framework while Section 7 raises perspectives for its usability.

2. Literature review

This literature review is divided into four subsections. Subsection 2.1 gives some more detailed arguments supporting the need to reconcile academics and industrialists regarding the topic of BPM implementation. Subsection 2.2 defines BPM maturity and describes a sample of BPM maturity frameworks. Subsection 2.3 identifies important Business domains that our BPM Maturity framework should consider. Finally, subsection 2.4 explains why we chose ISO 9001:2015 (ISO, 2015) as a reference in terms of BPM maturity for our case study.

2.1. A gap between academic theories and industrial practices

An organization's success depends on its ability to remain competitive. Business Process Management (BPM) were quickly recognised as a common practice by both academics and industrials to increase one's Return On Investment (ROI) by optimising its internal operations (Frolick & Ariyachandra, 2006). The BPM lifecycle approach aims at managing business processes from their design to their analysis and improvement. With the growing number of companies having a full BPM strategy since the 1990's, process designing naturally became a core research subject for academics. Industrial applications evolved accordingly with the emergence of Business Process Management Suites (BPMS). BPMS are software systems driven by process designs to enact and manage operational business processes. BPMS developed rapidly during the 2000's to meet the demands of industrialists looking for a way to computerize the method (Ko, Lee, & Wah Lee, 2009). Among others, these suites include Appian, AuraPortal, Bizagi, Bonitasoft, Flokzu, Iterop, Kissflow, Process Street, ProcessMaker, Signavio and WorkflowGen. More and more organizations are adopting these BPMS, also known as Process-Aware Information Systems (PAIS), to manage and execute their processes (Yongsiriwit, 2017).

Progress made in Information technologies (IT) during the past few years has led to some new concepts with positive impacts on BPMS (Ahmad, Francis, & Zairi, 2007; Almajali & Dahalin, 2011; Benaben, 2012), such as process deduction (Bidoux, 2016; Montarnal, 2015) or cognitive BPM (Hull & Nezhad, 2016), also known as Machine Learning and Artificial Intelligence applied to BPM. But, 15 years later, some theorical concepts are still not integrated to BPMS. For instance, (Meidan, García-García, Escalona, & Ramos, 2017) Key Performance Indicators (KPI) still cannot be integrated into process models, neither can they be linked to services, and BPMS still do not commonly provide process documentation generation features, despite this being a requirement to obtain certifications (SEI, 2002). Academical theories are progressively outpacing industrial implementation.

According to Klun, Mendling, and Trkman (2016), the lack of success of BPM programmes is not due to insufficient human skill or deficiencies in methodologies, but rather to the lack of a theoretical underpinning of each step of the BPM implementation cycle, from achievements to rewards. Moreover, according to Benaben (2012), the lack of actual assimilation of BPMS by enterprises is mainly due to the time shift between the emergence of BPM (during the 1990's) and the emergence of BPMS (during the 2010's): deploying an entire business process cartography was just too complicated and too intricate to succeed without the support of BPMS. Enterprises learned that it was not possible; and that belief was deeply rooted by the time BPMS started to reach the maturity level that would make them the solution. Enterprises need to move beyond this belief and BPMS must demonstrate their value. Therefore, companies desperately need progress in bridging the gap separating operations from concepts (Møller, Maack, & Tan, 2007).

2.2. BPM maturity

More than a hundred maturity models have been developed in various domains. They can be classed as (i) descriptive *i.e.* for the assessment of an organization's current state, (ii) prescriptive, providing suggestions for improvement actions or (iii) comparative, to confront other organizations' level of maturity (De Bruin, Freeze, Kulkarni, & Rosemann, 2005). Very few maturity models are prescriptive, whereas descriptive and comparative models are much more commonly investigated (Pöppelbuß & Röglinger, 2011). For the last 15 years, numerous researchers have conducted surveys to identify success and failure factors for BPM implementation (Ahadi, 2004; Buh, Kovačič, & Indihar Štemberger, 2015; Chong, 2007; Škrinjar & Trkman, 2013), thus highlighting the numerous domains involved in the BPM method such as Management, Strategic alignment, Employees, Communication, IT, Culture or Governance. van Steenbergen, Bos, Brinkkemper, van de

Table 1
State of the Art of existing BPM Maturity Frameworks.

Framework Name	Reference	Criteria to measure advancement along BPM cycle	Other criteria to measure BPM Maturity
BPM Maturity Model (BPMMM)	Rosemann, De Bruin, and Power (2006), Rosemann and De Bruin (2005)	**Perspectives**: Align, Design, Execute, Control, Improve	**Factors**: IT/IS, Culture, Accountability, Methodology, Performance
Process Performance Index (PPI)	Fisher (2004)	**States of Maturity**: Siloed, Tactically Integrated, Process Driven, Optimized Enterprise, Intelligent Operating Network	**Five levers of change:** Strategy, Controls, Process, People, IT
Process and Enterprise Maturity Model (PEMM)	Power (2007)	**Enablers of Maturity**: Design (purpose, context, and documentation), Performers (knowledge, skills, and behaviour of people doing the work of the process), Owner (identity, activities, and authority), Infrastructure (information systems and human resources), Metrics (definition and uses).	**Enterprise capabilities**: Leadership (Awareness, Alignment, Behaviour, Style), Culture (Teamwork, Customer focus, Responsibility, Attitude toward change), Expertise (People, Methodology), Governance (Process Model, Accountability, Integration).
Process Management Maturity Assessment	Rohloff (2009)	**Program management**: Set goals, Analyse, Define, Realize, Review	**Categories**: Process Portfolio & Target Setting System, Process Documentation, Process Performance Controlling, Process Optimization, Methods & Tools, Process Management Organization, Program Management, Qualification, Communication, Data Management, IT-Architecture
Process Management Maturity Model	Cronemyr and Danielsson (2013)	**Maturity Level**: Awareness, Established, Improved, Adapted	**Categories**: Management of the Organisation, Documentation, Way of Working, Layout of the process, Management of the Process, Users of the Process, Measurements, Improvements
Model for Business Process Maturity Assessment	Moradi-Moghadam, Safari, and Maleki (2013)	**Index**: Initial, managed, defined, quantitatively managed, optimising	**Criteria**: Design (Purpose, content, Documentation), Performers (knowledge, Skills, Behaviour), Owner (Identity, Activities, Authority) Infrastructure (IS, HR), Measurement (Def, use)

Weerd, and Bekkers (2013) explain that most existing maturity models regrettably focus on only one dimension, even though business process performance not only relies on individual process characteristics but also on enterprise capabilities such as culture and expertise.

This paragraph aims to study the state of the art of existing BPM Maturity frameworks, with the results summarized in Table 1. To obtain a homogeneous and usable benchmark, we decided to focus on frameworks (1) that are not dedicated only to specific business domains (supply chain management, software development, etc.) and (2) taking multiple domains into account (business, knowledge, and information technology management). These frameworks are then compared to the proposed framework in Section 6. Identified frameworks are presented along with the domains they consider as relevant to assess BPM Maturity.

These frameworks all claim to evaluate the same characteristic: how advanced a company is in terms of BPM. Yet some frameworks base their evaluation on unique concepts that are not shared by other frameworks, such as Accountability, Performers or Governance for instance. To create our BPM Maturity framework, we need to identify the domains we consider as critical for BPM maturity measurement. In the next paragraph we select the relevant domains to build our own BPM Maturity assessment framework.

2.3. Critical domains involved in the evaluation of BPM Maturity

Despite their differences, the frameworks presented in Table 1 all share a common idea: the BPM Maturity of any company should at least be evaluated in the context of the step in the BPM Cycle that has been reached. This research already shares this idea by considering the **BPM cycle** as the first dimension of the framework, and the following paragraphs aim to define other critical domains.

2.3.1. Fields (Culture, Business, IT)

Buh et al. (2015) highlight the need to consider the different stages of BPM adoption independently of each other. BPM adoption is defined as the implementation in a structure of any BPM concepts, and it appears necessary to differentiate five states of BPM adoption, going from the initial concepts to full integration in the business: Awareness and understanding of BPM, Desire to adopt BPM, BPM projects, BPM program, and Productization of BPM. Previously cited authors (Table 1) have also concluded that BPM adoption covers at least two **Fields**: the organization's ***Culture*** and its ***Business.*** Alonso, Verdún, and Caro (2017) further insist on the need to bridge the gap that exists between these two fields.

Grau and Moormann (2014) point out that any process initiative is tightly bound up with the company's culture and that this psychological aspect has been widely neglected. With the development of technology, each business concept now has a digital counterpart, leading Rahimi, Møller, and Hvam (2016) to define a Business Process as the link between IT capabilities and business strategy. ***IT*** constitutes a critical **Field,** just as much as ***Culture*** (see Table 1 and Cutura, 2013; Sherwin, 2011) and ***Business***. Kruger and Johnson (2010) underline the necessity to distinguish communication technology from both information management and knowledge management, but also to define the border existing between these three fields.

Over the years, a multitude of scientists (Bai & Sarkis, 2013; Buh et al., 2015; Grau & Moormann, 2014; Santos, Alves, Santos, & Santana, 2015; Trkman, 2010) and industrialists (Burlton, 2011; Cutura, 2013; Dyer et al., 2012; PRIME BPM, 2017; Sherwin, 2011) have conducted surveys to build lists of success and failure factors for BPM implementation in industrial contexts. Table 2 summarizes them and associates them to previously identified **Fields**.

2.3.2. Abstraction level (data, jobs, behaviour)

On another level, Benaben and Vernadat (2017) define an organization as a set of functions providing capabilities, fed by information as inputs and organized according to processes describing the behaviour of the organization. These authors also discuss the counterparts of these concepts for the ***IT*** Level; Functions may be offered by software Applications, Information may be any piece of computerized Data used by the organization and Computerized Processes are called Workflows. They conceptualize three **Abstraction Levels** describing two **Fields** (***Business*** and ***IT)*** that interlock with each other. The three interlocking **Abstraction Levels** and the concepts resulting from their intersection with ***Business*** and ***IT*** levels are summarized in Fig. 2.

Hu, Chang, and Hsu (2017) explain how Information is the

Table 2
Critical Factors identified when implementing a BPM strategy.

Field	Critical Factors for BPM implementation
Social & Cultural	Communication Culture for organizational change Empowerment Organizational resistance People involvement Information withholding Rewards and motivation systems Leadership Championship and sponsorship Management of risks & Quality management system
Business Organization, Structure, Project planning & Management	Adequate job integration BPR effectiveness Job definitions and responsibilities allocation Teamwork and quality culture Aligning BPR strategy with corporate strategy Adequate financial support Goals and measures Unrealistic expectations Consulting Previous experiences
IT Infrastructure	Aligning IT infrastructure with corporate strategy SOA architecture, interoperability IT investment and sourcing decisions Modelling tools, data mining, BAM, detecting tools IS integration Lack of BPM knowledge

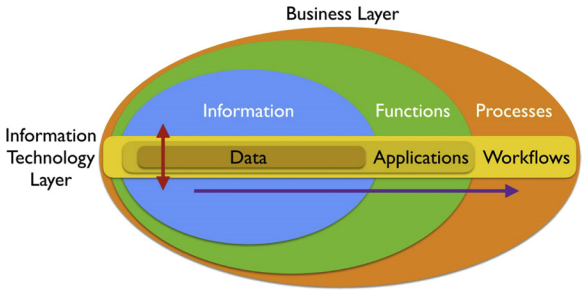

Fig. 2. Abstraction Levels across Business and IT Levels according to Benaben and Vernadat (2017).

foundation of the Business field. This is the idea depicted in Fig. 2, since each circle represents the core of a bigger circle: Information is at the core of Functions, and Functions are at the core of Processes, and together they describe the Business. In line with this representation, the IT field is depicted as a transversal field across the organization and is built using the same structure, so as to facilitate diffusion of Information through the Business Layer. Data, Applications and Workflows respectively are the IT equivalents of Information, Functions and Processes (Bénaben, Boissel-Dallier, Pingaud, & Lorre, 2013). These three abstraction levels of the IT field can be interwoven following the same logic: Data is the foundation of Applications, and Applications are the foundation of Workflows.

2.4. A reference base to assess reaching a higher maturity level

In order to validate our framework, we need to compare it with existing references in terms of BPM Maturity. As a reference we chose ISO 9001:2015 (ISO, 2015), which is a non-specific standard defining

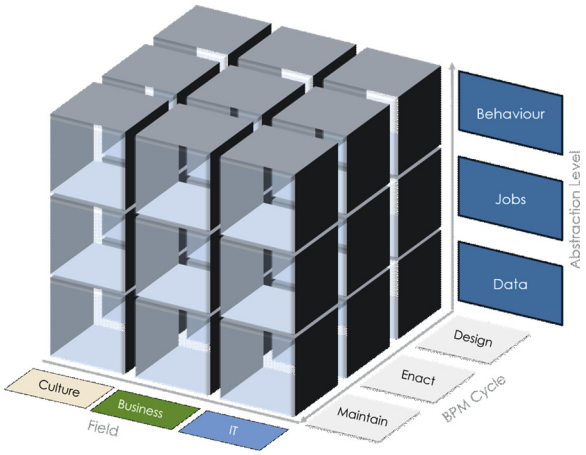

Fig. 3. Our BPM maturity framework structure: axis and levels.

the foundations of a quality management system. Created during the 90's, the requirements are recognised worldwide as enabling certified organizations to be more efficient and improve customer satisfaction. To obtain the certification, an organization must receive a third party into its physical structure to audit its practices against the requirements of the norm. ISO 9001:2015 is based on the principles of continuous improvement. Since it obliges organizations (1) to control internal development and growth, (2) to maintain processes in continuous accordance with client requirements, and (3) to preserve customer and employee satisfaction constantly, the ISO 9001:2015 certification is a guarantee of BPM maturity.

3. Our BPM maturity framework

The structure of the framework presented in this section is based on the conclusions of Paragraph 2. This section aims to set the fundamental definitions for the chosen axes and their labels. Fig. 3 depicts the resulting framework. As stated in the previous section, our framework is built along three axes of development; (1) the **BPM Cycle**, (2) the **Fields** and (3) the **Abstraction Level**.

If the (1) cycle of the BPM approach is considered as one dimension (see Fig. 1), it is possible to differentiate businesses progressing along the BPM lifecycle. By doing so, the framework would result in different maturity levels for businesses that have only created models compared to businesses that have designed and are also using models. However, it has been decided to group together the two steps of Control and Diagnosis under the name of Maintain, in order to keep similar granularity levels between steps. This axis, the **BPM level**, then consists of three labels: ***Design*** (building models), ***Enact*** (using models) and ***Maintain*** (diagnosing indicator results).

The consideration of (2) different *Fields* enables our model to reveal different maturity levels for organizations that have integrated concepts in their culture, compared to those that also apply them in their work, or those who have implemented them in their information system. The **Business Field** axis is made up of three labels: ***Culture*** (psychology and knowledge), ***Business*** (projects and programme within the business structure) and ***IT*** (computerized concepts). As stated in Section 2.1, we think that the emergence of new technologies, such as Artificial intelligence or process mining, could change the way BPM is implemented in organizations. Therefore, we particularly emphasise the need for our framework to represent the **Business Field** axis.

The last axis, (3) Abstraction Level allows the differentiation of organizations conducting improvements in their processes from those also improving their activities, and again from those doing this on the data they use. This last **Abstraction Level** axis is composed of three levels: ***Data*** (material used within Jobs), ***Jobs*** (Indivisible activity usually expected to produce outputs from inputs) and ***Behaviour***

(sequencing of Jobs). Our project likes to define an organization by how its data and skills interact with each other. This vision is fully in line with the way the **Abstraction Level** axis breaks down the **Culture, Business and IT Fields**. Therefore, we decided to use this axis in our framework, despite its originality and its novelty among the frameworks cited in Section 2.

In the next figures we will represent the framework as a cube composed of 27 positions. With a cube representation, we can see that each position has several neighbouring positions and that transitions from one position to another might represent a challenge. Using three axes to evaluate BPM Maturity prevents the framework from being linear, meaning that the positions are not ordered. However, it does not mean that reaching a particular position will not have any impact on the future positions obtainable. But before talking about difficulties and facilitators, we need to define the meaning of each position in the framework.

4. Detailed description of the BPM maturity framework

This section aims to define the 27 positions resulting from the framework presented in Section 3. Each position is the result of the intersection of three layers. To articulate the presentation, we have first chosen to detail, in Section 4.1, the intersection between **Field Layers** and **Abstraction Levels** by building a plane between these two axes. We then explain, in the three following paragraphs, the meaning of the 9 positions resulting from the intersection of each **BPM Cycle** layer with the plan previously detailed. The articulation of the paragraphs is illustrated in Fig. 4. We have chosen to present the framework positions along the **BPM Cycle** that has already been explained in Section 1, but the 27 positions are also presented along the two other axes in Appendix A. and Appendix B in Supplementary materials.

4.1. Intersection of abstraction levels and fields

In line with the results described in paragraph 2.3, concepts resulting from the intersection of the three **Abstraction Levels** with the **Fields *Business*** and ***IT*** have already been defined. As a reminder, a "***Business*** is set of *functions* providing capabilities, fed by *information* as inputs and organized according to *processes* describing the ***Behaviour*** of the organization". The implemented (***IT***) counterparts of these three concepts are respectively *Applications*, *Computerized Data* and *Workflows*. For the ***Culture*** level it makes sense to use the word *Knowledge* to represent ***Data*** and to use *Skill* for ***Jobs***. The last concept (Intersection of ***Culture*** with ***Behaviour***) represents the awareness of the existence of sequences between Jobs and the acceptance of the need to monitor them. For this concept we have chosen the word *Monitor*. A recap of concepts resulting from the intersection of **Abstraction Levels** and **Fields** is presented in Table 3.

The following three paragraphs define the concepts resulting from the intersection between the plane presented in Table 3 and each level of the **BPM Cycle** axis.

Table 3
Concepts resulting from the intersection of Axes Fields and Abstraction Level.

Monitor	Process	Workflow	Behaviour
Skill	Function	Application	Jobs
Knowledge	Information	Computerized Data	Data
Culture	Business	IT	

Table 4
9 Positions in the Model Layer.

Goals & resources identified	Process formalized	Workflow implemented	Behaviour
Functions identified	Function formalized	Applications implemented	Jobs
Data identified	Data formalized	Data implemented	Data
Culture	Business	IT	Design

4.2. Intersection of abstraction levels with fields within the design layer

The ***Design*** Layer corresponds to the *implementation* (for ***IT***), the *formalization* (for ***Business***) and the *identification* (for ***Culture***) of models within the organization. In the **Abstraction Level**, ***Data*** gathers every *material* used within the organization, ***Jobs*** are equivalent to *functions* and ***Behaviour*** respectively refers to a sequence of *goals and resources* (for ***Culture***), to a *process* (for ***Business***) and to a *Workflow* (for ***IT***). Table 4 sums up the different intersections of **Fields** and **Abstraction Levels** within the ***Design*** Level of the **BPM Cycle** axis.

4.3. Intersection of abstraction levels with fields within the enact layer

The ***Enact*** Layer corresponds to the act of using business concepts in an organization. Here, ***Culture*** stands for the *comprehension* of concepts, ***Business*** is for the main *work* of the organization and ***IT*** for the *use* of previous implementation. Following that definition, we can easily identify positions for expertise and experience; the knowledge (and so the ***culture***) of ***enactment*** would be the expertise, baptised here "*know-how*"; the ***business*** application of ***enactment*** would be the experience, here represented by "*do*". Table 5 summarizes the different intersections of **Fields** with **Abstraction Levels** within the ***Enact*** Level of the **BPM Cycle** axis.

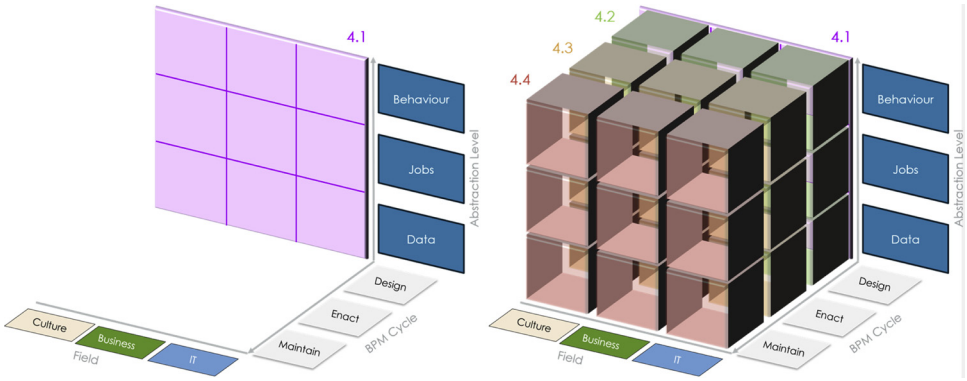

Fig. 4. Articulation of paragraphs in Section 4.

Table 5
9 Positions in the BPM Cycle Level: Enact.

Sequence of Jobs comprehended	Process followed	Workflow run	Behaviour
Know-how	Do	Applications used	Jobs
Use of Data comprehended	Data used	Data Manipulated (CRUD)	Data
Culture	Business	IT	Enact

4.4. Intersection of abstraction levels with fields within the maintain layer

The ***Maintain*** Layer is the combination of Control and Diagnosis. This Layer is mainly about *Key Performance Indicators* (KPIs), defined as measurable values (e.g. gathered using embedded sensors) representing how effectively a company is achieving key business objectives. They may reveal potential dysfunctions in the models and contribute to the appropriate management of organizations. In an industrial environment, Control is made possible thanks to the measurement of these KPIs and their comparison with target figures. Diagnosis corresponds to the analysis of malfunctions or of improvements to integrate into future models. KPIs can be *behavioural* (for ***Behaviour***) or *functional* (for ***Jobs***) and can also be set to evaluate the consistency, the lack of redundancy and the security of the *Dataset*. Table 6 sums up the different intersections of ***Fields*** and **Abstraction Levels** within the ***Maintain*** Level of the **BPM Cycle** axis.

4.5. Representation of the framework with its 27 achievements

Fig. 5 summarizes the 27 positions in our framework layer by layer, in terms of achievements. The next section develops the idea of constraints existing in the framework, and this concept is then further developed in the Perspectives section.

4.6. Structuring constraints existing in the framework

Now that resulting concepts have been precisely defined, we can validate the interlocking of the three **Abstraction levels** described in paragraph 2.3. It indeed does not make any sense to implement a workflow without having implemented applications or a database. We can therefore conclude that some prerequisite constraints might exist along the **Abstraction Level** axis, meaning that no positions of the ***Behaviour*** layer can be reached if the position directly below (***Jobs*** **Abstraction Level,** same **Field**, same **BPM Cycle** level) has not been reached yet.

We could argue that the same kind of prerequisite constraints exists along the BPM Cycle axis because it does not make any sense to ***maintain*** a concept we never ***enacted.*** But since it is possible to ***enact*** a concept that has not previously been ***designed***, we can only conclude that the ***maintain*** layer cannot exist without the ***enact*** layer, meaning that no positions of the ***Maintain*** layer can be reached if the position right behind it (***Enact*** **BPM Cycle Level,** same **Field**, same **Abstraction Level**) has not been reached yet. As regards the **Fields**, since all levels can exist independently, there cannot be any prerequisite constraints along that last axis. The prerequisite constraints are represented in Fig. 6.

Table 6
9 Positions in the BPM Cycle Level: Maintain.

Behavioural KPI identified	Behaviour diagnosed	Behavioural KPI implemented	Behaviour
Functional KPI identified	Functions diagnosed	Functional KPI implemented	Jobs
Dataset Evaluation rules identified	Dataset diagnosed	Dataset evaluation implemented	Data
Culture	Business	IT	Maintain

As a conclusion to this paragraph we would like to focus on the non-related levels, meaning those with no prerequisite constraints. Since the order to reach the non-related levels is not imposed by any structuring constraint, multiple paths can lead to higher maturity levels, and some paths might be more effective than others. This idea is more deeply developed in part 7 - Conclusion and Perspectives, where it is suggested that the framework may be improved through concepts of difficult and easy transitions from one position to another.

Defined in terms of achievements, our framework could be used to (i) assess overallorganization maturity but also to (ii) track the implementation of new processes, jobs and data in the company. The next section is dedicated to demonstrating these two different uses.

5. Case study

Iterop is an innovative French start-up in software editing. Its product, IteropSuite, is software for process modelling, enactment and monitoring. The company also uses its own product for its daily work. In 2015, Iterop undertook the process of obtaining ISO 9001:2015 (ISO, 2015) certification as a guarantee of quality for its customers, but also to demonstrate that process-oriented development is a fast and efficient method to achieve strategic goals. In 6 months, Iterop received the certification with more than 20 key points identified (Iterop, 2017).

As explained at the end of Section 4, this paper claims that the current framework could be used to assess the overall maturity of an organization, but also to track the implementation of new processes, jobs and data in the company. The two use-cases presented respectively in sub-sections 5.1 and 5.2 are dedicated to covering both these potential uses of the framework.

5.1. Iterop BPM Maturity before and after obtaining the ISO 9001:2015 certification

Since Iterop uses the workflow tool the company have developed on a daily basis, all behaviour, jobs and data is computerized. For this reason, every maturity level reached within the ***Business*** **Field** is also reached within the ***IT*** **Field**. The consequences in terms of maturity representation are that every position reached within the ***Business*** layer comes with the position at its right side (***IT***).

For the ***Model*** layer (Table 7), Iterop already had its *Data* and *Functions identified*, *formalized* and *implemented* before the certification. The company also had its processes formalized and implemented, whereas the identification of goals and resources was not systematic yet.

As concerns the ***Enact*** Layer (Table 8), Iterop is driven by the *processes* it follows. Thus, everything *done* by the company follows an implemented process (*Workflow)*. Within the Culture Field, since all the formalization has been conceived by its principal users (and not by an external designer), we can consider that they *know and comprehend* the ***data*** they use, the ***jobs*** they do and the ***sequence of jobs*** they follow. However, we keep in mind that this knowledge can be lost with time and especially if dictated by a BPM software over a long period of time.

Within the ***Maintain*** Layer (Table 9), *KPI* for ***jobs*** and ***data*** were already *identified* and *implemented* but their *measures* had not been systematically *analysed* yet.

This paragraph describes the positions reached (and in what order) by Iterop thanks to the ISO 9001:2015 certification. ISO 9001:2015 (ISO, 2015) requires two main points: (i) the formalization of all exchanges with employees and clients and (ii) the analysis and improvement of processes. As regards the 1st point, Iterop had to identify content for their missing model: Goals and resources (1). Regarding the

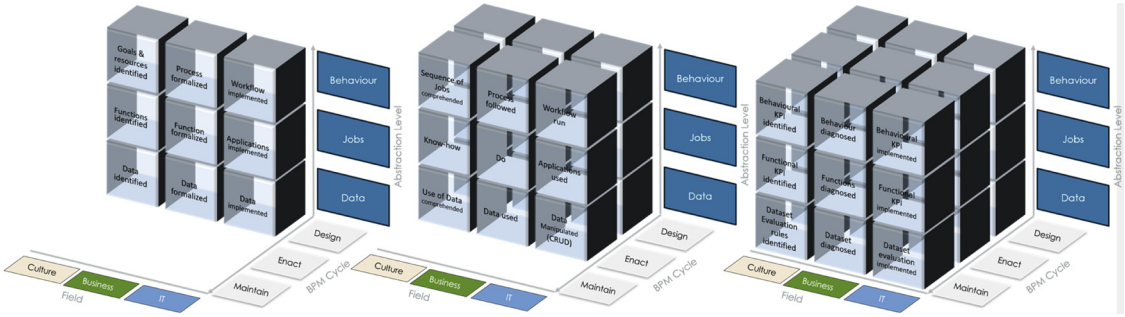

Fig. 5. Our BPM maturity Framework: meaning of positions in terms of achievements.

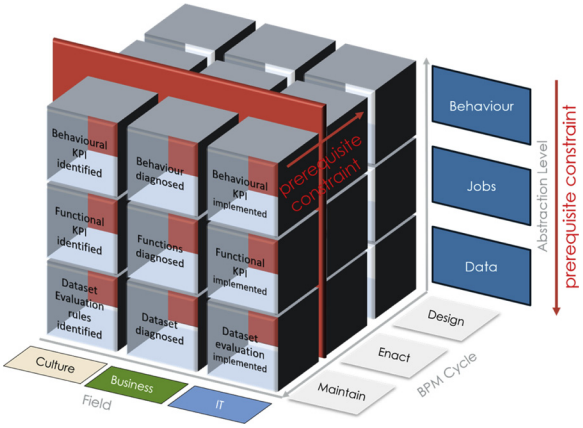

Fig. 6. Prerequisite constraints existing in the framework.

Table 7
Positions in the Model Layer reached by Iterop before obtaining the certification.

Goals & resources identified	Process formalized	Workflow implemented	Behaviour
Functions identified	Function formalized	Applications implemented	Jobs
Data identified	Data formalized	Data implemented	Data
Culture	Business	IT	Design

Table 8
Positions in the Enact Layer reached by Iterop before obtaining the certification.

Sequence of Jobs comprehended	Process followed	Workflow run	Behaviour
Know-how	Do	Applications used	Jobs
Use of Data comprehended	Data used	Data Manipulated (CRUD)	Data
Culture	Business	IT	Enact

2nd point, Iterop had to progressively identify and implement behavioural KPI for each of their processes (2) and started analysing KPIs that were already implemented but not used enough (3) (Table 10).

Iterop's BPM Maturities before (left) and after (right) are pictured in Fig. 7.

Table 9
Positions in the Maintain Layer reached by Iterop before obtaining the certification.

Behavioural KPI identified	Behaviour diagnosed	Behavioural KPI implemented	Behaviour
Functional KPI identified	Functions diagnosed	Functional KPI implemented	Jobs
Dataset Evaluation rules identified	Dataset diagnosed	Dataset evaluation implemented	Data
Culture	Business	IT	Maintain

5.2. Evolution of maturity during the implementation of new procedures required by the norm

The ISO 9001:2015 certification created the need for a new process for Iterop: that of auditing their internal processes and bringing corrections and improvements to models. The company had never conducted such audits before, and they chose to implement them using a process-oriented approach. The steps they followed are described in this paragraph and shown in Fig. 8.

The audit process, and the functions and data involved, were first formalized (1), as detailed in the norm. A new document for the new *process* contains a *formalization* of the process using a BPMN 2.0 diagram, where the *functions* involved are described and the data (needed and produced) is all detailed (types and description). The company quickly *implemented* the new *dataset*, set up mails and connections (*Applications*) to the calendar and resulting *workflow* (2) in their BPM software, Iterop, to (3) *run* them. The orchestration of workflows forced the employees to (4) follow the process as it was first formalized. Descriptions helped the actors (and not only the designer) to correctly do the jobs they were expected to do, and data was automatically used by the workflow. After several iterations of using the process, the actors (5) acquired essential knowledge about the data they used, the jobs themselves and their sequencing. It was only after having acquired such knowledge of enactment that they could (6) identify data, functions, goals and resources that were involved in the process, and complete the documentation. This new expertise enabled them to (7) identify KPIs for processes, functions and data that were (8) implemented, allowing processes to be frequently diagnosed (9).

6. Framework evaluation and limitations

6.1. Contributions to theory

Other frameworks from the literature review show that Abstraction Levels are hardly ever investigated by existing maturity frameworks. In contrast, our framework recognizes that conducting continuous improvement for data or jobs is indeed a progression towards achieving high BPM maturity levels, whereas other frameworks only recognize

Table 10
Positions in the Design and Maintain Layers reached by Iterop after obtaining the certification.

1. Goals & resources identified	Process formalized	Workflow implemented	Behaviour
Functions identified	Function formalized	Applications implemented	Jobs
Data identified	Data formalized	Data implemented	Data
Culture	Business	IT	Design

2. Behavioural KPI identified	3. Behaviour diagnosed	2. Behavioural KPI implemented	Behaviour
Functional KPI identified	Functions diagnosed	Functional KPI implemented	Jobs
Dataset Evaluation rules identified	Dataset diagnosed	Dataset evaluation implemented	Data
Culture	Business	IT	Maintain

processes. Even if this rare axis will cause our framework to be less comparable with others, our position is that this vision could be useful for maturity models aiming to guide BPM implementation, since it imposes a BPM approach not only on behaviour but also on functions and data.

As far as we know, this is the first time that the notion of prerequisite constraints in maturity models has been expressed. A prerequisite constraint can be seen as an axis along which a position cannot be reached without the previous one. For maturity models that are only based on one linear dimension, this notion already implicitly exists, but the absence of prerequisite constraint identification that helps guide the user in implementing their BPM approach is a shortcoming of other frameworks.

6.2. *Implications for practice*

An assessment of the framework is available in Appendix C in Supplementary materials. It follows the guidelines of Van Looy, Poels, and Snoeck (2017). This first evaluation reveals that the framework provides more in-depth descriptions but may be overly-dependent on the assessors' skills. There is specifically a limitation in the culture layer achievements of the proposed framework, where the evaluation sometimes relies on subjective techniques. However, we think it is important to measure the BPM culture of an organization to assess its overall BPM maturity level and so to keep this layer in the framework.

Tarhan, Turetken, and Reijers (2016) demonstrated that an increased maturity level, with respect to a maturity model, leads to an improved business performance, which is a goal coveted by every organization. Yet, since most BPMMs display descriptive rather than prescriptive characteristics (as raised in 2.2 - BPM Maturity), organization lacks guidelines to improve their maturity levels. The proposed framework describes positions in terms of achievements, thus helping organizations to see what they need to accomplish to reach new maturity levels.

The non-linear structure of the framework allows every organization to place their advancement in the structure, revealing that different strategies can exist to reach a high BPM maturity level. We plan on using that theory to investigate the role of IT in enabling the acquirement of new business capabilities. Nowadays, technologies have so much more capabilities than in the 80 s (Artificial Intelligence, Big Data, Cloud Computing) that it has become a common intuition to think that technology would shortly enable businesses to reach higher maturity levels in less time than they need today. An Adequate Alignment of IT Infrastructure and BPR Strategy has always been identified (Al-Mashari & Zairi, 1999; Indulska et al., 2009; Recker, Mendling, & Hahn, 2013) as a key success factor for implementing a BPM strategy. But despite the natural partnership that has always existed between BPM and information technology (Davenport & Short, 1990), industrial engineers have still not fully exploited the idea of taking better advantage of IT to implement a BPM strategy (Yongsiriwit, 2017). We think that the framework could be used to support that intuition.

Harmon (2018) points out that nowadays organizations do not implement BPM in the entire business, but rather focus on specific processes and "lurch from one process improvement effort to the next". To our knowledge, this is the first time a maturity model has been designed for use both in the evaluation of an organization's overallBPM maturity level and for the evaluation of a single procedure in the organization. Most maturity frameworks also contain achievements such as "processes need to be defined" or "data needs to be identified". We decided to consider the same achievements for single procedures. Thus, the framework can be used to follow the implementation of this new procedure until it reaches the same level as other existing procedures in the

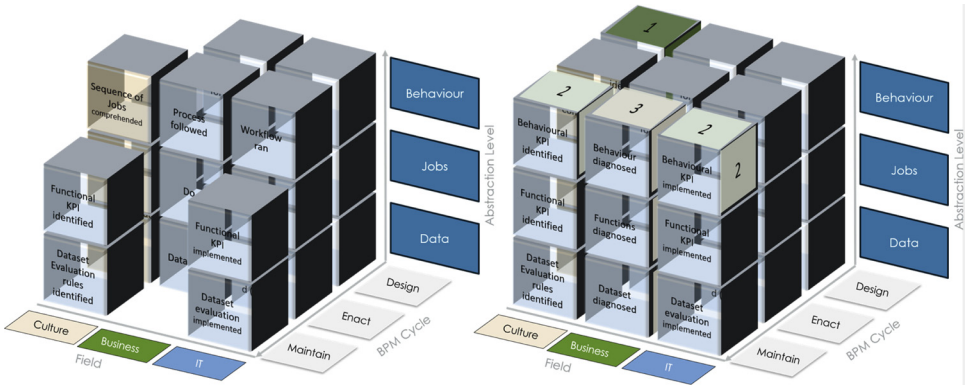

Fig. 7. Iterop's BPM Maturity according to our framework before (left) and after (right) obtaining the ISO 9001:2015.

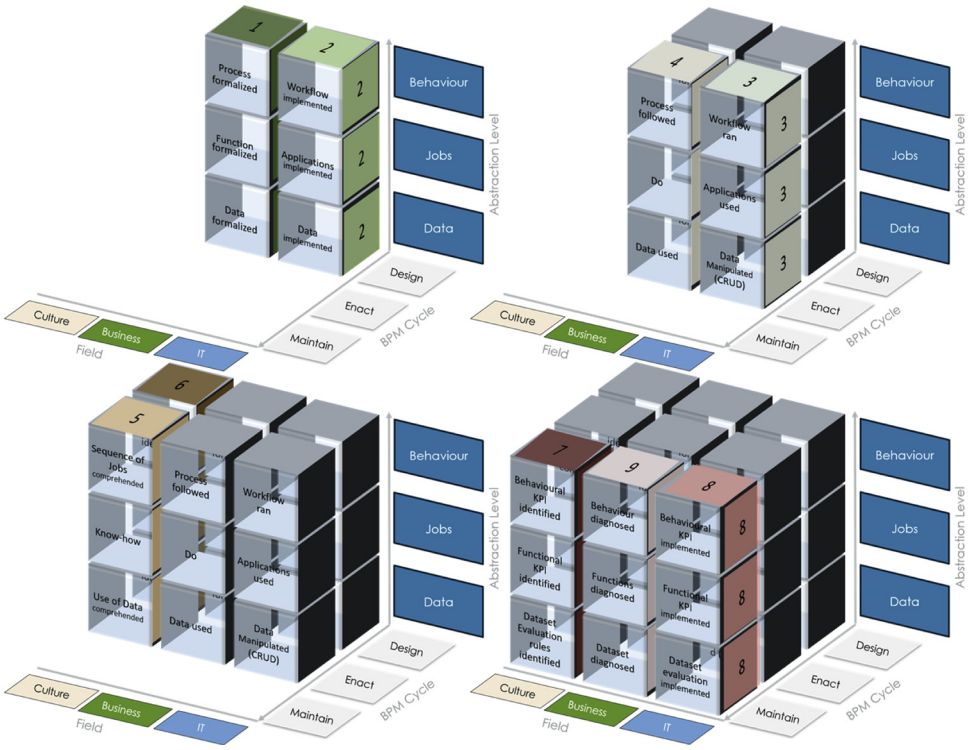

Fig. 8. 9 steps of the process-oriented implementation of Process Auditing.

company. The difference between these two case studies resides in the positions that have been reached when starting the guidance: when implementing new procedures, no position has yet been reached, whereas guiding an organization in its entire BPM implementation requires determining what positions have already been reached. Due to its non-linearity, we consider this initial need to position a company within the framework as the main limitation of our work.

6.3. Limitations and avenues for future research

A first version of the framework did not consider the two steps, Control and Diagnosis, of the BPM approach as being merged, but the *Diagnose* layer appeared to be empty (composed only of achievements such as: identify flaws). We decided to keep the framework with only three levels for the BPM Cycle axis to widen the perspective for the future use of the framework. However, although some organizations might have their own KPIs identified, implemented and measured, they may not possess the required reengineering knowledge or skills in KPI results interpretation to effectively upgrade their processes. This step of the BPM approach is rarely reached by organizations and our framework does not dedicate an entire layer to it.

Compared to other frameworks, our proposal does not include concepts such as Strategic Alignment, Methodology, Leadership and Communication. These missing concepts may help a new achievement, or indeed prevent it from completing, meaning that our framework could still be enriched by identifying frontiers between layers or positions. We suggest that this framework could be enriched by characterizing frontiers between two positions. We would like future research to investigate those frontiers more fully. A frontier can have prerequisite constraints (like the ones identified in Section 4.5) or perhaps only simple barriers (making it difficult, but not impossible, for organizations to reach a new position from a previous one). On the other hand, the opposite concept may apply: frontiers may facilitate flows (meaning it would be easy for organizations to reach a new position from a position already obtained). We would like our future research to investigate these concepts of barriers and flows so that the framework in its 2.0 version could then be used to demonstrate where future research should be focusing on (barriers that need to be raised or flows that can be taken advantage of) to better reconcile theories and industrial implementation.

In line with this idea of improving the structure with barriers and flows, the framework could be seen as a relief map where barriers would be mountains and flows would be rivers. Thus, targeting a precise maturity level, organizations would rather take the most lucrative path, meaning the shortest one, or the one with the fewest mountains and the most rivers. This perspective might finally prove that IT is a real enabler for the acquisition of new business capabilities, which constitutes our main perspective for the framework.

7. Conclusion

Our goal was to focus on how to improve industrial BPM implementation and we strongly believe that, despite the numerous features existing to partially guide companies, industries lack guidance to implement the overall method. In order to support organizations in implementing their entire BPM approach, our research attempts to conceive a new, comprehensive framework for BPM maturity assessment. With regard to our first *Scientific Question (What criteria can characterize BPM maturity?),* we identified three domains defining an organization's overall BPM maturity: BPM Cycle (Model, Enact, Maintain), Field (Culture, Business, IT) and Abstraction Level (Data, Jobs, Behaviour). We described the 27 positions resulting from the intersections between these domains in terms of prescriptive achievements. The proposed framework can be used to (i) assess an organization's BPM maturity or (ii) help implement new procedures in the structure by indicating those achievements that need to be completed in order to reach a higher maturity level. This second use of the framework answers our second *Scientific Question (What should an organization achieve to reach a higher maturity level?)*.

Depending on the organization, the order in which positions are reached can differ, meaning that our framework could reveal different strategies to reach a high maturity levels. Following this idea, we think

that our framework could be seen has a travelling map in which one should avoid difficulties and prefer following a path with facilitating flows. Hopefully, numerous theories also complementing the BPM domain and could thus constitute these flows: data and process mining features, flow optimization tools, optimization of warehouse organizations, simulation, (flow, workshop, production, product), Lean management, business activity monitoring tools... We wish to improve our framework with these existing features to reveal easiest strategies to reach a perfect maturity level. Moreover, we think it could suggest how IT could evolve to raise remaining barriers for BPM implementation and thus constitute a guide for future research subjects.

Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ijinfomgt.2019.05.013.

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