Ontology based framework for collaborative business process assessment

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***Abstract*— To remain competitive and agile, modern organizations invest several business and IT enablers in order to supervise their change management initiatives. In this perspective, research in enhancing business process management (BPM) capabilities (maturity, risk assessment, etc.) presents relevant guidelines in order to adapt IT solutions when business requirements evolve.**

In this context, this research proposes an ontology based framework for business processes assessment. The first objective of this research covers the definition of a functional category of ontological concepts related to the qualification of business process dimensions. Hence, we identify concepts related to processes lifecycle, process maturity, task related risk, etc. The second category covers the non-functional aspects related to the QoS, event management, etc.

The second objective targets the definition of assessment model based on the instantiation of the proposed ontology. The application of this approach aims to identify the stark nodes of business processes and to validate the alignment with evolutionary business processes requirements.

I. INTRODUCTION

In recent years, companies aim to setup flexible and adaptable information systems to support their strategies and business processes. They need to align their business strategy with IT to facilitate the adaptation of the organization to the requirements and the changes of the environment. Thus, Alignment Business/IT is becoming more and more important, especially when setting inter-enterprise collaborations. Therefore, many companies start internally to improve their business process continuously in different aspects to respond the changes in their environment. In this context, we propose an ontology based framework for business process assessment. The aim of this approach is to supervise the evolution of collaborative business processes and improve their quality and productivity.

This paper is organized as follows: Section 2 presents a review of business process alignment approaches and business process assessment. Section 3 is divided into two parts. In the first part, we define our process analytic model. The second concerns an ontology based process assessment model and its application rules. Section four concerns a conclusion and a presentation of future works.

II. RELATED WORKS

Before introducing our proposed assessment model, we highlight various issues related to the domain of Business Process. Many researchers have attempted to address these issues by incorporating various models.

A. Business Process

In this section, we present the abstraction levels and the importance of the analysis of the business process.

1) Business Process abstraction levels

Johansson [1] defined a business process as a set of related activities that transform an input to create an output with added values.

In order to provide different views on process models, business process model abstraction appeared.

Scheer [2] developed the method ARchitecture of Integrated Information Systems (ARIS) which identifies three levels of abstraction of business process:

• Requirements Definition: describe only the concepts and business logic, without using any technical realization.

• Design Specification: gives more details of the concepts, and an initial translation to a solution to the third level.

• Implementation Description: implements the proposed solution at the Design Specification level.

Weske [3] classified business process, based on the strategic level of the involved business processes. The first level represents the business strategy, which does not relate to business processes, but rather means strategies to which business processes should be modeled. At the second level, the business strategy transforms into goals. The third level depicts organizational business processes and presents interact with suppliers or customers. The fourth level refines the third level with more details specifying activities and their relationships. Finally, the fifth level concerns the implementation of business processes.

Silver [4] is interested in the Business Process Model and Notation (BPMN) and he suggested another classification of business process:

•Descriptive BPMN: shows the business people and structuring the business process.

•Analytical BPMN: details the descriptive business process model.

•Executable BPMN: adds all details in order to execute the business process (data, services, messages, human task assignment, etc).

Dhamen [5] considered that a business process is generally modeled into 4 views:

-The business level: defines a set of business existing in the company.

-The functional level: represents the formalization of the interactions between different functional participants in the process.

- The application level: defines the link between activities/participants modeled in the functional level, and the applications/services. Processes are assessed at this level.

- The technical level: is the IT infrastructure that supports the application.

2) Business Process Analysis (BPA)

Business Process Management (BPM) consists of managing end to end the business processes of the company to get a better view [6]. Indeed, it allows companies to analyze, model, execute, control, automate, measure and optimize their business activities.

Certainly, the objective of BPM is to support and to maintain the lifecycle of business process in the organizations. But, the most important in BPM lifecycle is the analysis of deployed processes. So, BPA can provide organizations with knowledge to understand how their processes are currently being performed in order to detect gaps between guidelines and actual practices [7]. In addition, BPA aims to assess processes and to determinate a track of improvement. In fact, the business processes analysis consists in defining, computing and analyzing of metrics concerning business activities to evaluate their performance and thereafter the flexibility of the whole company [8].

Many works emphasize the benefits and potential uses of ontologies in the field of analysis and assessment of business process. Theories of ontology are relevant to measure the performance of processes, because ontology provides a set of concepts for modeling process and reason about their characteristics.

Pedrinaci and Domingue [8] proposed the Metrics Ontology model. It's about a domain independent ontology that supports the seamless definition of business metrics, and the corresponding engine which can interpret and automatically compute these metrics over domain specific data. Pedrinaci et al [9] proposed Core Ontology for Business pRocess Analysis (COBRA) to analyze their business processes by offering a core terminology to business practitioners for mapping the domain specific knowledge. They considered that the BPA is typically structured around three views: the process view, the resource view, and the object view. Then, COBRA has been structured around these views in an attempt to enhance BPA.

To remain competitive and to be more reactive to changes imposed by the current market, modern organizations need also to align their business with the IT. In the next sub-section, we will explain the Alignment Business/IT.

B. Alignement Business/IT approches

The alignment can be defined as an internal coherence in the organization between the components of IT field (the computer system architecture) and the components of business field (competitive strategy and processes of the organization) [10]. In fact, IT is an operational enables the actors of the company to accomplish their activities that are often grouped in the process in order to achieve strategic objectives. Therefore, the need to align Business/IT became the top priority of the companies. They must adapt in internal to the external constraints to remain competitive, reactive and flexible. This alignment allows companies to increase their performance and to ensure their sustainability [11].

The problem of alignment appeared in the first time in the late 1970s and since then numerous researches and methods, several techniques and tools were proposed to emphasize the alignment concerns. Indeed, the business and IT performance are tightly coupled and they are considered an inseparable partner whose influence is mutual, and enterprises cannot be competitive if their business and IT strategies are not aligned [12]. Henderson and Venkatraman [13] proposed the Strategic Alignment Model (SAM). This model is divided into two areas: Business and Information Technology (IT). These two areas are subdivided also into two domains: external domain (strategy) and internal domain (structure). The first domain interests to the strategies reflecting the environment of the company. The second domain concerns the infrastructure IT and business process. The strategic fit describes the relation between the external domain and internal domain. The functional integration represents the horizontal relation between two elements of the same domain [11].

Many contributions emphasize the importance of strategic alignment Business-IT, such as [14], [15], [10] and [16].

Several researches suggested an extension of the model SAM. For example, the model of Javier [10] aims to support the specificities of the alignment with the strategy and with the environment. Other studies proposed new approaches. For instance, the method Alignment Correction and Evolution Method (ACEM) proposed by Etien [17] and the method INtentional STrategic ALignment INSTAL proposed by Thevenet et al [18].

Lemrabet et al [19] proposed a model named (Economic, Technological and Methodological) EMT to demonstrate that SOA and BPM are complementary disciplines that offer both a competitive advantage to organizations by allowing them to improve their agility. These two approaches play an important role in the continuous optimization of business processes, by allowing complete implementation of the alignment between business and IT. On the one hand, the BPM discipline provides the ability to implement business processes centered on customer and aligned with business requirements. On the other hand, SOA ensures efficient and capable infrastructure to respond quickly to changing business processes.

Walsh et al [20] proposed the Translated strategic Alignment Model (TSAM). It is a conceptual and non-functionalist model, which integrates several streams of literature. This model may drive toward a critical level of alignment that appears as necessary to clear the path toward competitive advantage.

In recent years, there have been several researches regarding business models based on ontologies for monitoring the alignment between business and IT.

Ghedini and Gostinski [21] proposed a methodological framework using ontologies to understand the effects generated between business and IT purposes and thereafter to ensure the alignment between Business and IT. Similarly, Brocke et al [22] created an Ontology for Linking Processes and IT infrastructure (OLPIT) to model the relationship between IT resources and business processes for the purpose of measuring the impacts of IT

infrastructure changes on business processes, and vice versa.

In the next sub- sect, we are going to discuss the aspects of Business Process assessment.

C. Business Process assessment

For evaluate a business process, many aspects can be identified, such as the maturity, the risk…

1) Maturity

Maturity Models describe the evolution of a specific entity over time [23]. They have been confirmed as an important tool for allowing a better understanding of the organization situation and help them to find the best way to change [23]. The goal of a maturity model is to improve the efficiency of the company by identifying, analyzing and making the process more efficient. The maturity models provide an assessment tool which compares the process performance to that of best practices established [24].

The Capability Maturity Model 'CMM' was developed at the Software Engineering Institute (SEI) at 1989. CMM introduced the concept of five maturity levels defined by cumulative requirements [25]. The aim of CMM is to present sets of recommended practices in a number of key process areas that have been given to enhance software development and maintenance capability. But, the Software CMM has been retired in favor of the CMMI ® (Capability Maturity Model ® Integration). CMMI is an integrated, extensible framework for improving process capability and quality across an organization. It has become a cornerstone in the implementation of continuous improvement for both industry and governments around the world [26]. One distinctive feature of CMMI is its use of levels to measure: the capability of an organization in individual process areas (from capability level 0 to capability level 5, with capability level 5 being best), and an overall organizational process maturity rating (from maturity level 1 to maturity level 5, with maturity level 5 being best). The CMMI model is organized in a hierarchic structure: process areas, Generic and specific objectives, and generic and specific practices.

To improve practices of the organization and to achieve the desired maturity, CMMI model offers two representations (staged and continuous). Staged representation defines successive levels of maturity, from 1 to 5, that are associated with process areas. The purpose of this representation is to provide to the organization a homogeneous roadmap for the implementation of improvements. The continuous representation is designed to give maximum flexibility to choose the process areas for improvement which will achieve the business objectives of the organization.

Many international standards have been created to treat the issues of the quality of management:

- ISO/IEC 15288 and ISO/IEC 12207: international standard on system life cycle processes.
- ISO/IEC 15504: an international standard that defines the requirements for performing process assessments.

Another model, which has been developed by Luftman [27], can provide the organization with a roadmap that identifies opportunities for improving the harmonious relationship between business and IT.

Santana Tapia introduced in [28] developed the ICoNOs MM model, which is based on CMMI, for assessing and improving the maturity of business/IT alignment in collaborative networked organizations.

Guédria et al [29] created the MMEI model which allows an enterprise to have an idea of the probability it has to support efficient interoperations and to detect precisely the weaknesses which can be sources of interoperability problems. The model MMEI defines five levels of interoperability maturity (Unprepared, defined, aligned, organized, adapted). Cuencaa et al [30] considered that MMEI is centered in the Interoperability barriers (conceptual, technological and organizational) and the enterprise concerns (business, process, service and data).

2) Risk assessment

According to the AS/NZS ISO 31000 standard, a business process risk is the chance of something happening that will have a negative impact on the process objectives, and is measured in terms of likelihood and consequence [31]. Understanding of the operations of the an organization operations is required to completely understand business risk that can reach the material misstatement, and business process level internal controls intended to address business risks and the risk of material misstatement [32].

Taylor et al [33] proposed a simulation environment based on the jBPM Process Definition Language (JPDL) workflow language. In this environment, a process model characterized by some risk information (key risk indicator KRI, key performance indicator KPI, and risk event) can be simulated to evaluate the effects of risk events on some pre-defined KPIs and KRIs.

Kaegi et al [34] simulated a process model modeled by the model BPMN through agent-based modelling technique to analyze business process-related risks.

Jallow et al [35] proposed an approach in order to analyze risks in business processes. So, this approach identifies a set risk events and their occurrence probabilities, in order to assess and quantify the impact/consequences of those risk events on each process and on the overall process.

III. CONTRIBUTION

In the perspective of defining an assessment model for business / IT alignment, we aim to propose an analytic process model as well as a metric model. The application of these models is expected to supervise the evolution of collaborative processes and decide about their quality. The evaluation doesn't cover the ROI objective.

A. Process analytic model

The analysis of any process lifecycle allows to identify the following steps:

- The specification: the stage where we answer to the strategic and business objectives
- The adaptation: the stage where we define what is possible to implement
- The use: the stage where process is used
- The optimization: the stage where the process is re-engineered

- The dissemination: the stage where the process doesn't answer to any business / or strategic objective and we should freeze it for revision.

The following figure (Figure 1) illustrates the connection between these stages and the possible evolution schemas.

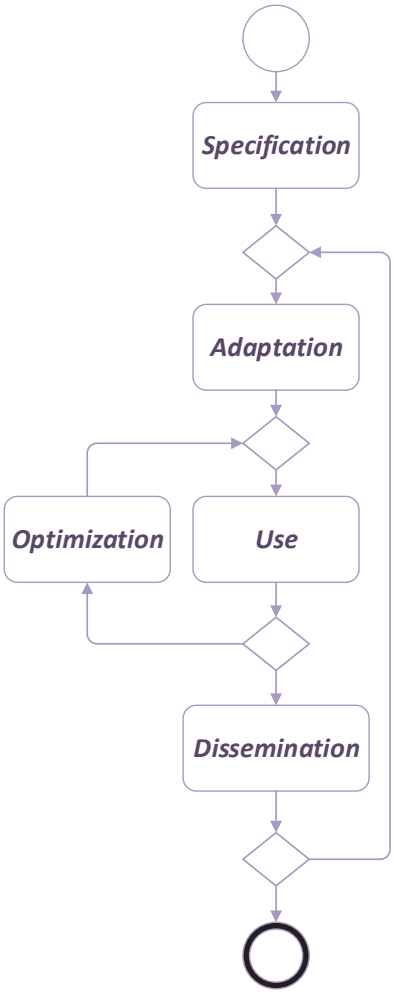

Figure 1: Process Lifecycle

From the other hand, the concepts of enterprise architecture provide several decompositions of viewpoints. We identify in our work:

- The business viewpoints: formalizes the validated vision of the collaboration objectives at the business level.
- The functional viewpoints: defines the necessary details in order to ensure the feasibility of the business process.
- The applicative viewpoints: concerns the implementation of the functional level.
- The technical viewpoints: concerns the definition of infrastructure facilities to support the applicative processes. This abstraction level is not covered at our research level. We consider only the execution environment from the geographic location (on promises / distributed or shared / in the cloud).

In the development of our processes, we are choosing BPMN as modeling language. The correspondence between process lifecycle stages and process abstraction level is resumed in the following table (Table 1). Only the most relevant projections between stages and level are considered.

TABLE I.
PROCESS STAGES AND VIEWPOINTS

	Specification	Adaptation	Use	Optimization	Dissemination
Business	X	X		X	X
Functional		X	X	X	
Applicative			X	X	

In the next sub-section, we propose an evaluation model at the applicative level (implementation) with aggregation mechanisms until business level assessment.

B. Process assessment model

At the applicative side, it is useful to measure and evaluate the quality of deployed processes. At this level, we characterize service tasks through two sets of concepts:

Functional concepts: related to the running environment of each service task. It's about quantitative indicators characterizing data input/output, assigned organization role, and the implementation type of the task (i.e. service task, user task, etc.).

Non-functional concepts: related to the appreciation of contextual and qualitative concepts like maturity, availability, risk level and use frequency.

Both, functional and non-functional indicators are defined from the instance tracking data provided from the server level. Several execution environments (i.e. Oracle BPM/SOA server suite, etc.) provide structured data in databases (not just log files) in order to facilitate the exploitation of process tracking data and related payloads.

In order to facilitate the exploitation of collected information, we propose a first level of aggregation mechanism allowing to define a common value for the assessment of each applicative task. We are building a notation model for each measurement concept. In fact, the definition of implementation type quotation level is more important when task is implemented as service task. From the non-functional side, the risk gravity is related to failure rate and task-use frequency.

For the aggregation at the applicative process level, we apply a serialization mechanism for process tasks in order to solve parallel branches by maximum value rule. After that, we assume the following composition rules:

- Each applicative task is a sub-class of a functional task
- Each functional task is a sub-class of a business task

We illustrate, by the following ontological model (figure 2), the connection between all proposed concepts.

In order to provide a relevant interpretation model at the business process level, we are developing a classification model through a supervised learning process.

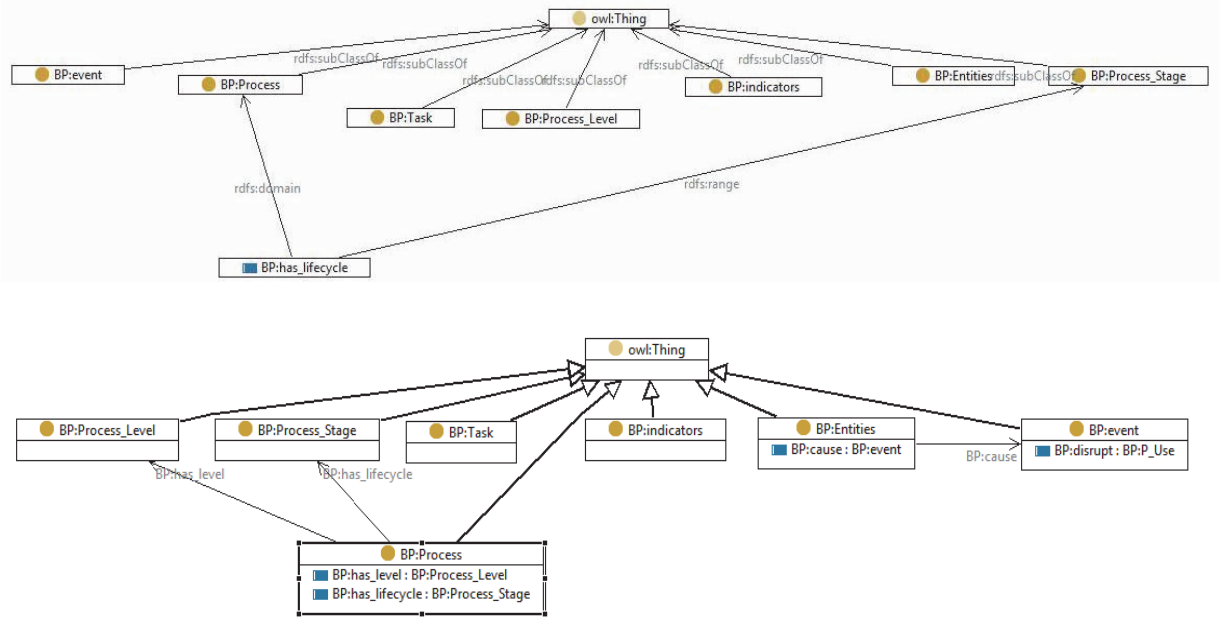

Figure 2: Ontological model for process assessment

Table 2: example of performance quotation

Periodicity: 1 month		Concept details	New values	Average of previous values	Performance
Nonfunctional	Maturity	CMMI	3	3	100%
	Availability	Number of successful calls / total numbers of calls	0,93	0,83	93%
	Use frequency	Number of calls (Instances)	30	36	83%
	Risk Level	Gravity: 1 to 16=> service failure event, connected error events, execution location (premises, distributes, cloud) Use frequency	8	12	50%
Functional	Implementation type	User or Manuel Interface: weight = 1 Service: weight = 3	3	3	100%
	T-input	Number of parameters	3	4	100%
	T-output	Number of parameters	1	1	100%
	Role	Internal: weight = 1 External: weight = 3	1	1	100%
				ATask	91%

The exploitation of proposed classification model aims to define the pathway of possible process reengineering actions. The Figure 1 provides the potential evolution steps starting form the process USE stage.

We propose in the table 2 an example of performance calculation results at an application task level. The most impacting concept in our assessment model is related to the risk aspect. The notation aspect is subject to revision until the maturity of the hall assessment process.

When the decision classification is based on learning process, the same metrics doesn't provide always the same decision. The appropriation of the results at the industrial side needs additional development efforts.

At the business level, the results generated from the proposed assessment model are compared with results from the evaluation of key business performance indicators. The sensibility of our approach allows to point directly the bottlenecks of collaborative business processes at the task level.

IV. CONSLUSIONS AND PERSPECTIVES

We proposed in this paper an ontology based for process assessment. The process analytic model identifies process lifecycle stages as well as common viewpoints. The metric model measure performance level at each applicative task. The business performance metric is aggregated at the business level in order to estimate the

quality of collaborative business processes. The validation of the proposed models is based on 6 collaborative business processes for customers and suppliers relationship management.

Our future work concerns the classification of metrics and their associations to processes' events. By more tracking data, we aim to refine further the learning and classification processes. As results, we expect to propose event impact models and define more evaluation nodes (functional and non-functional) and new concepts related to the temporal aspect in order to monitor the evolution of the business process. The improvement of the existing ones could enhance the stability of our decision system.

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