A model-based approach for operational Business-IT alignment

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Abstract. Large organizations are perpetually looking for created value and competitiveness and Information Technologies (IT) are a real catalyst if well-exploited. However, over time, changes occur and often lead to inconsistencies and misalignment between the business and its underlying information system (IS), becoming a great handicap for the durability and the responsiveness of the business. One of the key approaches to tackle these inconsistencies and keep the IS profitable for the organizations is Business-IT Alignment (BITA) which means making sure that business orientations, business capabilities and IT-based software system are correctly aligned and coherent. We focus on the operational BITA, namely the coherence of business services (functions) and their underlying software applications. My PhD project aims to propose a model-based semi-automated approach mainly to achieve and sustain the alignment between Business and IT artefacts. We aim to lean on Enterprise Architecture frameworks since they lean on standards (Togaf, Archimate) and to extend them. We propose in this paper a short overview of the existing approaches, a bunch of research questions related to the topic, in addition to the basis of the solution we are targeting.

Keywords: Business-IT Alignment · Enterprise Modelling · Enterprise Architecture.

1 Introduction

Information systems are more than ever considered as a catalyst for creating value in large organisations. The competitiveness wanted through information systems strongly relates on their ability to orchestrate processes - data - actors - software - hardware - in a coherent way. This coherence is expressed through the various types of « Alignment ». Among the multiple types of alignment, we are particularly interested in the Business-IT Alignment (BITA) problematic which addresses the necessity of making business processes and software systems coherent in order to keep the information system a profitable asset to its owner. BITA was mentioned for the first time in the literature in the late 90's when [7] presented it as a serious solution to deal with the inconvenience faced by information systems. This approach was based on the layered-architecture of information systems defined by enterprise architecture frameworks such as

Zachman [15] and Togaf [13]. These enterprise architecture frameworks define some principal layers of abstraction going from the operational levels related to the technical infrastructure to the strategic levels of the decision-making system. However, the number and also the composition of the IS layers varies in the literature depending on the adopted framework's background and also depending on the interest and orientations of the organization. Still, these are the common main layers :

- **Strategic layer** : Which shows the path to follow in terms of managerial goals and objectives to reach.
- **Business Layer** : Which is composed of business processes, business motivations, business actors, business capabilites, etc. . .
- **Application Layer** : Which is related to software system, mainly composed of software and applications components.
- **Technology Layer** : Which is composed of the infrastructure that supports the application components in terms of networks, servers, etc. . .

Information systems have never been associated to a unique definition [4], neither does BITA. When **BITA** is considered between the strategic and business layers, we talk about **strategic BITA** [7]. While the **operational BITA** is located between business and application layers. Note that some authors defined additional layers to fluidify the linkage between the principal layers described above. For instance, Longépé [9] defines a functional layer between the business and application layers in his work about urbanization of IS. This functional layer is made of a hierarchical description of business functions. We can also cite Bhattacharya [3] who defines a combination of Business Motivation Model (BMM) and Archimate to model the strategic alignment. The BMM is an OMG specification that provides a scheme or structure for developing, communicating, and managing business plans in an organized manner [10]. We can already notice the disparity of IS layers structuration as Longépé's **functional layer** and Bhattacharya's **BMM** are totally different.
As mentioned in [11], many BITA challenges are related to (core)-operational BITA which is at the border between business and IT concerns such as strong dependencies, high maintenance costs, high project failure rate, slow adaptation to changes (regulatory or strategic), etc. [8, 14]. An ambition through the thesis is to come up with some solutions to these issues related to the **operational BITA** and more specifically those that concern the synchronization of operational business processes and operational IT processes. The reasons why this kind of alignment becomes a real concern will be detailed through the state of art in section 2. In section 3, we will give an analysis following the state of art, while the research questions and first insights leading to our scientific contribution will be described in PhD contributions in section 4.

2 State of art

The contributions on operational alignment cover various subjects that are difficult to compare because they are addressed according to different concerns

(cartography, architecture, evolution of IS). In this section, give an overview of two systematic literature reviews about BITA which seem to be at the same time the most complete and recent [6, 1]. In addition, the contribution of Aversano al. [2] is cited to show an example of a process of alignment. We also clarify some interesting points about Pepin's thesis [12] due to the similarity of our topic and research concern. To sum up in a brief and accurate way the state of art, these 4 references are chosen among all the other references studied.

Aversano al. 2012 [1] was among the first papers I have read as an initiation to the topic. The authors clarify the impact of alignment on the performance of information systems but also the disparity of approaches regarding 90 both in terminology and models, in addition to their alignment, evaluation and evolution. They show that the operational side (also called functional) has rarely been explored, formalized and finally rarely automated. Later, they propose in (Aversano al. 2016) [2] a three-step method (modelling, evaluation, evolution). The assessment is based on a set of metrics (coverage/adequacy) to calculate a degree of alignment. The major contribution lies in user assistance through : (i) the use of reverse engineering to generate UML models (when not available) from the source code ; (ii) the semantic analysis to propose traceability links allowing the calculation of metrics, logging of versions to observe the evolution. The SLR of Habba & al. [6] the alignment is considered between: (i) business needs; (ii) business processes; (iii) software system. The questions asked are related to the definition of alignment, its measurement and its practical application. The authors identified 63 papers on the subject and highlighted the variety of approaches. The alignment of business requirements and business processes (29 papers mentioned) is done according to fairly natural correspondence rules. Meanwhile, the alignment of business processes and applications is less natural and relies primarily on rule-based model transformations to link both models (or generate application models from business processes). The authors globally highlight the lack of methodology, alignment assessment and tooling, as well as the wide variety of existing languages for modelling (e.g., UML, BPMN, SoaML, i*, MAP) and thus lack of formalization and homogeneity of the alignment. While the choice of BPMN seems to be a consensus for business processes, there is no emerging reference standard for the application layer. UML is the most used but in a heterogeneous way (usecase diagram, activity diagrams, component diagrams. . .).

Pepin's thesis [12] contribution is interesting because it takes a concrete point of view on BITA. New meta-models are constructed to describe the layers of abstraction. Application models are generated from the source code using reverse engineering methods. An evaluation of the alignments is also considered. A pragmatic approach is thus proposed for an operational alignment of the business process layer (BPM) and the abstract application layer from the code. In practice, the alignment is achieved through non-intrusive facet weaving techniques on the models concerned. Finally, the validation of the approach is done on real cases. Meanwhile, the construction of models, when not produced by the

architects, is not automated. Models feeding and alignment measurement are to be improved.

3 Analysis

The state of art shows a clear disparity between the approaches that dealt with the topic. We decided then to deepen the systematic literature review(SLR) initiated by Habba al. [6] in order to get a better and up-to-date vision on the operational BITA. Indeed, the paper selection process of the SLR are selected through a convenient process, but we consider only the papers that dealt with alignment between "business processes" and "software system". This is an additional filter to reach the operational BITA. In addition, some new papers have appeared since 2017 have to be taken into account. The additional motivation behind the idea is to analyse these approaches better. We aim to proof that the multiple challenges (cited before) that are encountered by IS deserve more contributions. To complete our study, we focus at the moment on 5 research axis:

- **Axis 1 - Models** : This axis considers the multiple model-based representations of Business Process and Software System.
- **Axis 2 - Alignment Links** : This axis focuses on the analysis of **links** between entities of Business Process and underlying Software System. The analysis targets types - directions - semantic notations.
- **Axis 3 - Evaluation means** : This axis enables a comparison of alignment measure methods. This feature needs a serious contribution because very few papers proposed a clear method to evaluate the alignment.
- **Axis 4 - Tools** : This axis concerns exploring **"Tools"**. By "tools" we mean either those used to implement technical solutions, or those developed/constructed from scratch.
- **Axis 5 - Case Studies** : This axis is useful to know on which **"Case studies"** the efficiency of solutions are validated.

We are actually working on this and the paper will be submitted later.

4 PhD contributions

The state of art and the work of our current survey show us the concerns to be addressed to implement an operational alignment. Among them we find the choice of languages to express the models of the different layers of abstraction and alignment relations, the (semi)automated construction of these models, the evaluation of alignment relationships (metrics, visualization), monitoring and control of IS evolution through alignment as the main ones that we have identified for now.
We structure these concerns into 4 *research questions* :

- **RQ1**: On which reference model or combination of reference models should we rely to represent the cartography of the IS, especially the layers we consider for the alignment ? Modelling standards allow to abstract reality into a generic and understandable notation and to avoid ad-hoc modelling.
  This **RQ** is related to **Axis 1**.
- **RQ2**: What taxonomy of relations exist between the Business Layer and Application Layer ? By this question we intent to know what kind of relations exist between the entities to align, and to try to classify them. We look for possible answers to this **RQ** through the **Axis 2**.
- **RQ3**: How to evaluate and/or validate the alignment between the business and application entities considered ? This **RQ** is related mainly to **Axis 3** and partially to **Axis 5** because we need to set an method evaluation method first and experiment it on real case studies later.
- **RQ4**: How to sustain acceptable alignment with the continuous changes that happen over time inside organizations? Do we consider a continuous alignment process or an asynchronous maintenance process ? These questions suppose that we have already achieved a good alignement.
  This **RQ** is related to **Axis 4** in addition to the automation feature.

Our particular context : As part of our work, we only consider the alignment of business layer (structuring of the organization's operational processes) and application layer (abstraction of software architectures from code source). From **Business layer** we consider mainly business functions, that are somehow similar to the tasks of business processes. And from **Application Layer**, we keep the application services provided by software components and abstracted from source code. We can then talk of **sub-layers** as they are not considered as principal ones in the literature (see Figure 1).

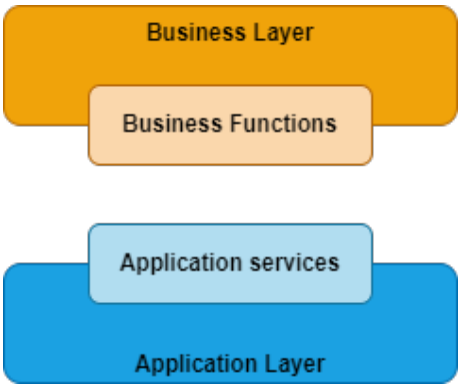

Fig. 1. Layers and sub-layers of operational BITA

From our perspective, we can define a good alignment as a one that tends on the one hand to avoid inappropriate and unwanted couplings and dependencies,

and on the other hand, to ensure the existence of the necessary connecting links between the two layers considered. Strong undesired dependencies are avoidable because it makes the system rigid and the integration complicated, especially those links between application components themselves that are not (or not fluently) connected to the adequate business process elements. Business logic information are then described at the application layer that is frequently changing due to software maintenance and development rather than being described at the business layer. We have also to make sure that all business functions and application services are well-connected (this is actually a feature difficult to formalize). Otherwise, either some business functions are not implemented as needed or some applications are useless and over-costing.

Accomplishments: These first months of thesis were mainly devoted to: (i) the study of the domain (enterprise architecture, urbanization, alignment, domain standards such as Strategic Alignment Model(SAM), Cigref, Togaf, Archimate) through around 50 articles, 4 books , and a thesis; (ii) the study of software engineering and reverse engineering techniques that enables code abstraction into application services for the future development of prototypes promoting alignment, its measurement and its evolution. (iii) experiments carried out on enterprise modelling tools.

Planned actions : Regarding our proposal, the first step is to give accurate and unambiguous definitions of the concepts involved. Then, we plan to formalize meta-models of the two layers to align in addition to a meta-model of alignment links. These meta-models will then be used to build a quantitative (first) then qualitative (later) analysis of the alignment based on indicators (metrics, data aggregation, etc.) making it possible to detect favorable or unfavorable situation as a kind of alignment patterns/anti-patterns [5]. The second step concerns the effective construction of alignment links by integrating different techniques mentioned in the state of the art (model transformations, reverse engineering, facet). As a third step, it is planned to analyze the evolution of the alignment on different versions of a computerized information system and to propose ways of improvement to the software architects. In terms of implementation, we aim to extend the de facto standard Archimate - an Enterprise Architecture modelling language -. This choice to extend Archimate in particular is justified by the fact that it is extensible and properly integrated into modelling tools.

5 Conclusion

Through this paper, we wanted to introduce and show the importance of the thesis' topic which is related to operational Business-IT Alignment, that aims to mind the gap between business and IT artefacts. We also talked about the need to realize a continuous alignment between different components of an information system inside an organization, and especially the operational business-IT alignment.
The PhD started in October 2021. These first months of the thesis were mainly devoted to initiating and getting familiar with the topic, to conducting a detailed

bibliography research, and to setting the research orientations we want to follow and the research questions RQ1, RQ2, RQ3, RQ4 we will try to deal with. Meanwhile, the second year will be devoted to establishing IS layers meta-models, to design bridges between them eventually through a linking meta-model, and to setting calculated metrics in order to get alignment evaluation rate. We also aim to be able to validate the approach on concrete case-studies.

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