Return on Experience of the Implementation of a Business-IT Alignment Approach: Theory and Practice

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Abstract. Approaches for business-IT alignment assessment developed in the research community represent an increasing interest for practitioners as they offer an in-depth analysis of the business and IT systems in the organisations. In order to be used by practitioners as a regular tool, these approaches have to be validated. Our experience shows that the perception of validity in academia - "in vitro" - and in the industrial environment - "in vivo" – may differ substantially. In this paper, we discuss the theoretical and empirical (or practical) validity of alignment assessment approaches based on metrics. We propose an empirical validation of a fitness measurement approach for business-IT alignment. First we identify a set of practical validity criteria for this approach and then we generalise our example proposing a set of practical guidelines for operationalisation of approaches based on alignment measurements. Our study reveals a significant gap between our understanding of validity and the perception of our industrial partners about this validity. The contribution of this work is a set of empirical criteria of validity and a set of practical guidelines that can significantly improve the usability – by organisations – of research approaches for business-IT alignment assessment.

Keywords: business-IT alignment, criteria of validity, measurements, theoretical validation, empirical validation.

1. Introduction

Assessment of business-IT alignment is a subject of continuous interest in research and industrial communities. For practitioners, validation of business-IT alignment is an important part of the organisation government; for researchers, approaches to accurate alignment measurement pave the way to new theories in the field [1]. Many approaches to business-IT alignment assessment are addressed in the literature. These approaches can be divided into three groups: questionnaire-based approaches [2], [3], [4], framework-based approaches [5], [6] and approaches based on alignment measurements [7], [8]. For many organisations the metrics-based alignment assessment is beneficial: it provides quantitative results that allow managers to measure the business value of the existing IT, and to increase this value. Our work is concentrated on the last type of business-IT alignment assessment approaches– the metrics -based ones. Validation of business-IT alignment approaches based on metrics is addressed in the research literature [9], [10], [11]. We agree with the author in [12] that in order to be valid these approaches should be grounded on a solid theory: *"it is questionable whether it is worth showing that a measure is measuring a particular attribute if that attribute is not part of a theory"*.

Briand [12] argues that most of the proposed metrics and the way to measure them have not undergone an empirical validation. Schneidewind [10] advocates an empirical validation process in which a metric is associated with a measure of interest. This process is specified for the software metrics but remains valid for metrics in any other discipline - particularly in Enterprise Architecture. Our experience shows that practical validation criteria of a metrics-based approach can be quite different from the theoretical ones. We follow the author of [16] who argues that *"a measure can be correct from a measurement theory perspective but be of no practical relevance to the problem at hand. On the other hand, a measure can be not entirely satisfactory from a theoretical perspective but can be a good enough approximation and work fine in practice"*.

In this paper, we discuss the theoretical and empirical (or practical) validity of metrics-based approaches to alignment assessment. We propose an empirical validation of the fitness[1] measurement approach for business-IT alignment developed in [17]. First, we identify a set of practical validity criteria for this approach and illustrate these criteria on the example. Then we generalise our criteria and propose the guidelines for operationalisation of approaches based on alignment measurements.

Research protocol: In the literature, five classes of empirical research are identified [18]: controlled experiments, case studies, survey research, ethnographies and action research. In our work, we have selected "case studies" as a research method type. This method offers a deep understanding of a given phenomenon and explains how and why this phenomenon occurs.

In this work, we use the ABC-Supermarket case for our study.We justify this case as a critical case to test the fitness measurement approach [17]. We proceed with the case study as follows: first, we identify the criteria of theoretical validity for the fitness measurement approach [17]. To justify our criteria, we make an analysis of related works and show that these criteria are considered important in many approaches [7], [9], [10], [12], [13], [16]. Then we implement this approach in the industrial project of Information Systems (IS) evolution in ABC-Supermarket. While implementing, we (i) observe whether the theoretical criteria of validity are met; (ii) check that the theoretical criteriaare recognised as "important" by practitioners (iii) identify other validity criteria, which are important for practitioners but are omitted in the identified theoretical criteria list (we call these criteria "empirical vriteria of validity").

Our study shows that some of the theoretical criteria are refuted and other factors related to fitness metrics validity are elicited.

[1] The fitness relationship definition used in [17] is ''the degree to which the needs, demands, goals, objectives and/or structure of one component are consistent with the needs, demands, goals, objectives and/or structure of another component''.

This paper is organised as follows. In Section 2 we introduce the Fitness Measurement Approach and define the theoretical and the empirical criteria of validity for this approach. In section 3, we present the case study, by introducing the industrial project and the scope of our research; we describe how the fitness measurement approach was implemented, and we report the measurements' results. In section 4, we summarise the lessons learned and discuss the gap between our understanding of the measurements validity and the perception of our industrial partners about it. In Section 5, we present the conclusions and future work.

2. Validation of Fitness Measurement Approach

In this section we present the Fitness Measurement Approach developed in [17]. We define a list of theoretical criteria that should be respected by the ***valid*** fitness metrics These criteria correspond to the perception of the Fitness Metrics Approach validity from the researchers' point of view.

2.1. Introduction of Fitness Measurement Approach

In [17], authors propose an approach to evaluate the fitness relationship between the business and the system supporting it. The fitness relationship is established between components of business and system models. The approach proposes a fitness measurement according to four points of view (called "factors"): *intentional, informational, functional and dynamic*. This approach also identifies the ten fitness *criteria* associated with these factors and defines a specific metric for each of them. For example, the g*oal satisfaction* criterion characterises the intentional alignment factor. It describes how the business goals specified within an organisation are supported by the IT systems existing in this organisation. The metric defined for this criterion is a *goal count*. Goal count can be *measured* by calculating the ratio between the business goals explicitly represented by the corresponding *states* of the IT systems and the total amount of business goals (see [17] for more details). The measurement result $0 <$ goal count ≤ 1 can be then analysed: if goal count $= 1$, then all goals are taken into account. Please note that the approach does not address the cost, human and social factors. It is rather concentrated on evaluating the information which is supposed to be included in the IS.

Table 1. Fitness measurement framework

Alignment factor	Fitness criterion	Fitness Metric
Intentional alignment	1. Support ratio	Activity count
	2. Goal satisfaction	Goal count
	3. Actor presence	Actor count
	4. Resource presence	Resource count
Informa-tional alignment	5. Information completeness	Business object/System class mapping count
	6. Informational accuracy	Business /System state mapping count
Functional alignment	7. Activity completeness	Business object/System class mapping count
	8. Activity accuracy	Business/System state mapping count
Dynamic alignment	9. System reliability	Law-mapping count
	10. Dynamic realism	Path mapping count

The Fitness Measurement Approach is based on a set of concepts important for the alignment assessment. *Business goal* [19] is a set of stable states of business objects we seek to achieve. *Business object* (BO) is an object that represents the entities in the business domain. *Business state* (or BO state) is a state of a BO at a time t, defined by the values of all attributes of this BO. *Business actor* is defined as someone or something that interacts with the business or IT system using an interface; it participates in a business process and triggers external events that result in a state transition of a BO. *Business resource* [19] is a BO, which neither initiates actions nor causes a state change. In our case, a product specification is an example of a business resource. *System class* (or system object) is an object that represents the entities in the IT system (by analogy with a business object). *System event* [19] is associated with a system state change. By analogy with business activities that are changing business objects' states, we consider system events changing states of system objects. *System goals* describe purposes of the system [17]**.** We say that a system goal maps a business goal if the states of business objects associated with this business goal are represented by the states of the corresponding system objects. *System state* (or system object state) is a state of a system object (class instance) at a time t. It is defined by the values of all attributes of this object. *Paths* are sequences of business (or system) states. *Business laws* represent legal rules and principles adopted by business organisations.

The Fitness Measurement Approach addresses the problem of business-IT alignment in the organisations and strongly relies on the detailed information about the organisation processes, data models, etc. In case this information is not available, one can build it up as it was discussed in [20].

2.2. The evaluation hypothesis

In this section we define evaluation hypotheses of the Fitness Measurement Approach. The hypotheses consist of a set of theoretical criteria of validity for the fitness measurements. Based on our research experience and on the related literature analysis we retain the following validity criteria:

1. The ***measurements should be based on verifiable observations*** (models, specifications, interviews, etc).
2. The ***measurements' results should be non-ambiguous*** – they should have only one interpretation.
3. The ***measurements should be effective***: they should correspond to the problem complexity and help practitioners to decide on the course of improvement actions.
4. The ***measurements' results should be accurate***: they should precisely localise the misalignment in the organisation.

Many works on metrics-based approaches validity confirm our validity criteria.

Verifiable observations: research works [12], [22] argue that a metric is valid if it measures what it purports to measure. To do so, we need to clarify what attribute we are measuring and how we proceed to measure it. The precision of the underlined data to be measured is thus important to have a valid measurement.

Non-ambiguity: in [9], authors discuss the validity of a metric structure. In order to be valid, the metric requires the validity of the attributes it measures, the unit it uses, the instrument it underlies and the measurement protocol it defines. They argue that the *non-ambiguity* of these elements guarantees the metric validity.

Effectiveness: Fenton [11] discusses the metric validity view based on the identification of the usefulness of a metric for a stakeholder's purpose. In [21], [16], [7] the authors argue that metrics constitute a crucial source of information for decision-making. Indeed, they (metrics) should localise where malfunctions hold and where resources are needed and give accurate information to managers in order to help them make decisions.

Accuracy: Bodhuin [7] emphasises that the purpose of metrics is to check the alignment and to detect misalignment between business processes and the information system supporting them. He defines two metrics: "technological coverage" indicating the percentage of activities supported by the system. If an activity *i* is supported by the system, the second metric: "technological adequacy" brings more precise information and measures how adequately is the support of a set of system components for the activity *i*.

3. The Practical Test of the Evaluation Hypotheses

In order to be widely accepted, each research method or approach, , should prove its usefulness in practice [12]. In the previous section we defined the theoretical criteria of validity for the fitness measurement approach. In the following, we test if these criteria remain valid in practice. We argue that proving the empirical validity of a research approach guarantees its entire validity.

Practical validity addresses the ability of the research approach to meet the practitioners' needs: it tells the practitioners how they can benefit from this approach and what will be the added value. To validate the Fitness Measurement Approach, we should answer the question: « when do the results of this approach can be considered by the users as satisfactory? ».

To do so, we apply the Fitness Measurement Approach [17] in a real project. The appreciation of the results by practitioners informs us about the "practical validity" of this approach.

3.1 The Case study: alignment validation in ABC-Supermarket

ABC-Supermarket is a mass retail company - one of the leaders on the French market. ABC-Supermarket groups approximately 3000 independent operators, and thousands outlets in France and internationally. This company specialises in different sectors of retail business and is well known in both food and non-food retail markets.

The initial specialisation of the ABC-Supermarket is food and household products. Seven years ago ABC-Supermarket integrated a new product category – textile – in its portfolio and defined a new trade name - ABC-Fashion. To provide the IT support for purchase (upstream) and retail (downstream) activities for textile products, the company decided to use the existing information system – the one which is used to support the business activities for food products.

Initially, the reuse of the existing IS for ABC-Fashion seemed justified as retail business defines similar *processes* for food and textile products. *Master data* for both food and textile products also have a lot in common: all these products are characterised by their type, price, etc. However, over the years, the textile trade name turnover decreases and the survival of the trade name was threatened. The existing IS showed its limits in managing the textile business. As a solution, numerous manual fixes and workarounds have been developed over years. As a result, the existing IS got overloaded with patches and became not efficient.

The company decided to make evolve its information systems. The challenge becomes the trade name survival. The main objective of this evolution is to precisely define where the existing IS fails in supporting the textile business requirements, and what improvement can be made to correct the misalignment.

To answer these questions we apply the Fitness Measurement Approach. While the fitness measurements results in a set of values, the process of acquiring these values leads to a deep understanding of the gap between the existing IS and the textile business requirements.

3.2 Scope of the fitness approach application

The *upstream activities* of ABC-Fashion include marketing, products referencing, providers referencing, outlets billing, etc. These activities are supported by the existing upstream information system (or UIS) of the company. The *downstream activities* of ABC-Fashion address the product management in the outlet stores, e.g. stock replenishment. These activities are supported by the existing downstream information system (or DIS).

The cited UIS and DIS were affected by the evolution requirements. Among listed above, product referencing is one of the most critical tasks as it maintains the link between the upstream and the downstream information systems: the outlets use DIS to order products available in UIS (see fig.1). If a product is not referenced in UIS, it is not available for ordering. That is why the IT support for the product referencing represents the main concern for the ABC-Fashion management. Mismanaging the product referencing activity affects the whole business process: the stock management (in the upstream and at the outlet level), the ordering process, marketing campaigns... For this reason, we concentrate in this study on the textile product referencing activity and how the existing IS (the food one) supports it.

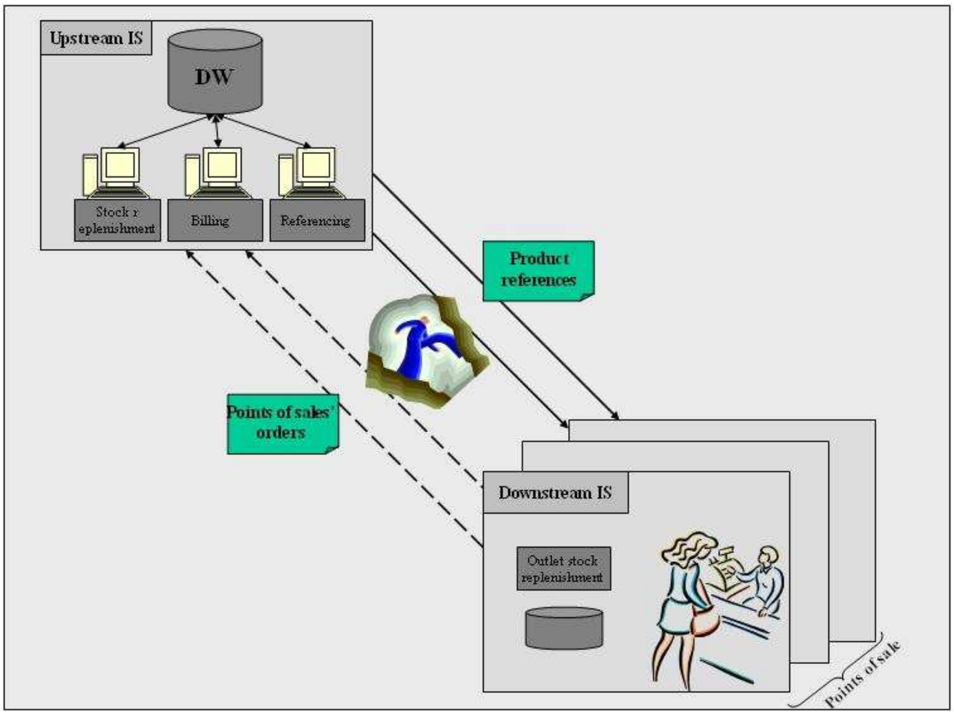


Fig.1. Product referencing application: the link between UIS and DIS

3.3 Constraints of the research work

Researcher: One researcher, working partial time, during 9 months in the ABC-Supermarket, applied the fitness measurement approach.

Experimental objects availability: Less than 20% of business and system models are available in the organisation. Indeed, over ten metrics, two were applied without building the corresponding “input” models.

The unavailable artefacts have to be built. Otherwise, fitness measurements cannot be applied.

3.4 Implementation of the Fitness Measurement Approach

As cited above, Fitness Measurement Approach relies on business and IS models. As the most of these models do not exist in the organisation, we built them up based on the available information sources. As a result, we were able to implement nine fitness metrics out of ten.

a) Data collection

To construct the missing business models, we collected data that describe the business view of ABC-Fashion on the textile product referencing. We interviewed the following business actors: (i) the head of department of the textile trade name: in order to understand the textile business requirements, (ii) the responsible of the product referencing department: in order to apprehend the product referencing problem, (iii) IS users: in order to understand the IS functioning and how it is used. The available business process landscape and process specifications were also analysed.

To construct the required IT artefacts, we collected data that describe the IT support of textile product referencing provided by the existing information systems (UIS and DIS). In order to apprehend the detail of the system architecture and functioning, interviews have been conducted with the following IT actors: (i) the referencing system administrator, (ii) the referencing system designers, (iii) the referencing system developers.

The following documentations were also analysed: (i) the user manuals of the product referencing system, (ii) short descriptions of application functionalities available on the Intranet, (iii) software applications’ data dictionaries, containing the information about product master data, and (iv) screenshots.

We also studied the product referencing system testing it on some “toy” examples. After conducting interviews with the mentioned specialists and the examination of the existing documentation, two problems have been highlighted: (i) compared to food products, who’s assortment can be either permanent (always on the shelf) or non-permanent (a subject of a commercial operation), textile products are subdivided into three planning categories: permanent products, collection products (e.g. summer/ winter), and short-cycle products (e.g. fashionable articles, brand promotions, etc); (ii) apart from the master data, operations on textile products also require textile-specific data (e.g. *colour range* and *size range*).

Business and system artefacts reflecting these two problems should be built in order to localise precisely the problem sources and identify accordingly potential solutions.

b) Consolidation of collected data

We are interesting in highlighting how the existing IS has been adapted to support the business requirements and to what extent it fits them. To conduct our study, we use:

- the MAP formalism [23] to build the business and IS goal models describing respectively the referencing process as it is seen by ABC-Fashion and as it is supported by the referencing application.
- UML modelling to build the business and the system class diagrams

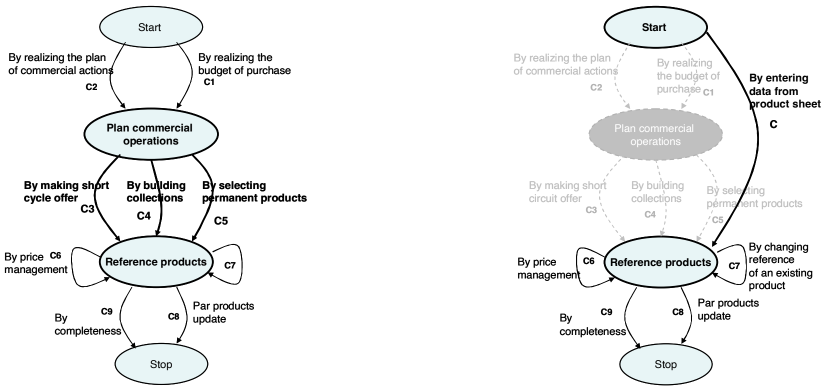
specifying respectively the data model for the product referencing as it is seen (or required) by ABC-Fashion and its implementation by the existing information system.

These artefacts (business goal models and business and IS data models) can highlight enough the problems cited above. For lack of space, these models are not presented in the paper.

Problem detected by MAP modelling:

A *map* is a process model in which a non-deterministic ordering of *intentions* and *strategies* is defined. *Intentions* are the goals to achieve. S*trategies* represent the ways to achieve these goals. A *map* diagram is a labelled directed graph with *intentions* as nodes and *strategies* as edges between intentions. A *section* in a *map* is the triplet <I_i, I_j, S_{ij}> where I_i is the *source intention*, I_j is the *target intention* and S_{ij} is the *strategy* connecting the source and target intentions. A *section* can be, in turn, refined by a *map*.

The comparison between business and IS maps shows that there are some business goals (at different level of abstraction) which do not correspond any IS goal. Some business strategies are also not supported by the product referencing application. In fact, as shown in Fig. 2, the business goal "*Plan commercial operations*" is not supported by the Product Referencing application (shown by dashed and grey arrows in Fig. 2(b)). The system implements only one strategy for achieving the goal Reference products. It does it from scratch by entering data from the product sheet directly. This means that the system does not distinguish Collection, Permanent, and Short cycle products and thus processes all product types in the same way. This explains a partial satisfaction of the business goal "*Reference products*".



(a) (b)

Fig. 2. (a) Business map for product referencing process (b) UIS map for product referencing application

Sections C3, C4 and C5 are refined in sub maps with sub goals and strategies (11 business goals in total). An important part of these sub goals are not supported by the product referencing application. For lack of space, the sub maps are not presented in the paper.

***Problem detected by the UML modeling*:**

To reference food products, only the business object Logistic Unit is required. A logistic unit for the product of a type T specifies *a container, a pack, or a box* with X items of the given product inside. It represents a minimal amount of the product of type T that can be ordered, delivered, or stored at the warehouse (e.g. a box of six bottles of soda). As (speaking about food products) the products in the logistic unit are identical – i.e. the same soda bottles - there is no need to reference each product item within the logistic unit separately, it is the entire logistic unit with *X* items inside that is referenced. At the IS level, the logistic unit is represented by the “Product file” (or “Package” concept) which contains the package description, logistic and tariff data. The same IS (conceived for food products) is used for textile product. But applying the same simplified referencing method for textile product, the following has to be considered: textile products have much more variations within the same type as they can exist in multiple sizes and colours. Making (by analogy with soda bottles) a logistic unit contain the same product variation (e.g. a box of 100 jeans {size = S, colour = ‘Navy’}) is not practical. Therefore logistic units for textile products can contain multiple variations of the same product type: a box of jeans: {{S, ‘Navy’}->10; {S, ‘Black’}->10; {M, ‘Navy’}->20; {M, ‘Black’}->10; {L, ‘Navy’}->30; {L,‘Black’}->20}.

Textile business requires the sizes and colors referencing. As the existing system does not support this need, several workarounds and manual fixes were added, for instance, a “package content File” describing the content of the logistic unit was added to inform points of sale about the quantity of products in terms of sizes and colors contained in each logistic unit. This indicative information provided by the referencing system can not be exploited by the points of sale to order a specifc product with specific size and color. The business was constrained by the system limitations causing then the emergence of gaps with the business requirements. These gaps explain several problems mainly:

- Points of sales cannot order only one variation of the product to replenish their stock – they have to order at least one complete logistic unit. This leads to unsold stock, discounting, and regular company loss as a result.
- The marketing department cannot make forecasting based on the logistic units, as it is not known which product was most demanded and brought to the company the maximum profit and which was not sold and caused loss.

3.5 Application of fitness measurements on the constructed data and result analysis

In this section, we present fitness measurements’ results and propose guidelines that can help ABC-Fashion to improve the fit between their business and the existing IS. We note that some problems are detected during the business and IS models building. Indeed this activity is knowledge intentsive and allowed us to have a first qualitative aligment evaluation. The fitness measurements confirm and detail the qualitative evaluation by capturing the malfunctions in more detail and in terms of models’ concepts and allow us to detect how we can act (add such concept if it is absent or extend its states if it is present but mismanaged in the system...) to improve the alignment.

Table 2. Fitness measurement results

Criteria:	Description	Measures:
1. Support ratio	{Number of activities represented by system events/Number of activities}.	7/32 (21%)
2. Goal satisfaction	{Number of business goals represented by the system goals/Number of business goals}	1/11 (9%)
3. Actor presence	{Number of business actors represented by the system user interfaces/Number of business actors}	2/5 (40%)
4. Resource presence	{Number of business resources represented by system classes interfaces/Number of business resources}	0

5. Information completeness	{Number of business objects represented by system classes/Number of business objects}	7/21 (33%)
6. Information accuracy	{Number of business states represented by system states/Number of business states}	21/42 (50%)
7. Activity completeness	{Number of business objects for a given activity represented by system classes /Number of business objects for a given activity}	values for different activities in [0,1]
8. Activity accuracy	{Number of business states for a given activity represented by system states/Number of business states for a given activity}	values for different activities in [0,4;0,72]
9. System reliability	{Number of business laws (where each business state is represented by a system state and the transitions between business states are represented by the transitions	11/31 (35%)

Our study revealed the significant differences between the referencing activity defined for the food and the textile products. This is the reason why referencing of textile products using the existing information system was so problematic in the past. The "misfit" between business and IT is confirmed by the measurements' results shown in Table 2.

1&2. *Support ratio and Goal satisfaction:* Only 20% of business activities are supported by the system and less than 10% of business goals are satisfied by the system. In fact, the significant part of upstream activities related to the planning of commercial operations on textile products (collection and short cycle operations) is not supported by the Product Referencing application.

3. *Actor presence:* the product referencing activity involves five actors. Only two actors interact with the system. The others (marketing, buyers and the head of the point of sale) are involved during the planning phase, which is not supported by the system.

4. *Resource presence:* All business resources required for the product referencing (e.g., specifications, product sheet containing information the product…) are created using Microsoft Excel software and are not integrated in the referencing system.

5. *Information completeness:* only the third of information is managed by the system. Our analysis revealed the following reasons that justify the low value of information completeness: (i) the need for referencing different textile product categories: the referencing of each product category has its own referencing process. These processes are manual or semi-automatic. Indeed, they are part of the planning activity which is not supported by the system. (ii) The specific requirement for referencing related to the textile products, taking into account their colour/size: on one hand, the concept of "Product" is absent in the system. Indeed, what is present in the system is the concept of "package" containing n products and not the product itself (see section 3.4). On the other hand, the size/colour business concept is missing in the system. It is for this reason that the product can not be referenced with the corresponding size and color. This generated the problems cited above and explain why the business goals are not satisfied by the system.

6. *Information accuracy:* Although only third of business objects are represented by system classes, 50% of business states are mapped by system states. This is explained by the fact that system objects are not consistent with business objects (the case of "Product" and "Package" concepts), they are forced to be treated in the same manner.

7. *Activity completeness:* More than half of business transitions are not implemented in the system.

8. *Activity accuracy:* for some activities, even if a business object (BO) is represented by a certain system object, the states of the latter might not represent the states of the BO. In practice, this means that the system counterpart of the BO is not processed by the IS as expected by business – it is not accurate. This explains why the completeness of an activity is higher than its accuracy. For other activities, the accuracy is higher than the completeness. In fact, some BOs are <u>implicitly</u> supported by the system: i.e.

there is no object in the system that represents a given BO, nevertheless the system supports the behaviour of this BO. For example, the system object "*Package*" does not map the *Product* BO in textile business (as explained in "information completeness"); however, it substitutes this BO in certain operations – we can say that the "*Package*" mimics the behaviour of the *Product* in the system.

9. *System reliability:* More than half of business transitions are not implemented in the system. This is explained by the fact that only a few activities are supported by the system.

We note that the fitness metrics organised around the four alignment factors are inter-reliated and complement each others. Indeed, the source of a mismatch detected at the goal level (intentional alignment) is explained in detail by metrics at more operational levels (functional and informational alignment).

As we can observe, there are huge differences in the gaps detected by the fitness metrics. A part of them was covered by workaounds and manual fixes (several treatments are done manually and several add-ons were made). These workarounds were not detected by fitness metrics. Indeed, they (workarounds) correspond to managing the information differently in the system and at the business levels. Whereas, as presented in table 2, the metrics are based on a correspondance between business and system concepts. This concern is beyond the scope of this paper. Metrics are used to detect the gaps, to help us localising the main differences between the business and the system domains and to propose a set of corrective actions which would improve the business/IT alignment. Indeed, it was shown that (i) the existing IS support demonstrates the serious lacks of flexibility: the stock replenishment for POS is supported only on the logistic unit level. We recommended that the IS of the ABC-Supermarket should support the textile product referencing on the product level, rather than on the logistic unit level. (ii) The colour/size management functionality is essential for textile products; we advised that it should be added to the existing IS. (iii) Many business activities are not supported by the system. Consequently, the corresponding actors do not interact with the system and the handled objects and the required business resources are not present in the system. We advocated that the organization should prioritize its business activities and revise the existing IS in order to extend its functionalities to support the critical business activities. The organisation should also verify whether the interaction of some actors with the Product Referencing application would be beneficial for product-referencing processes. If this is the case, new user interfaces should be developed and the business process may be redesigned taking into account the new actors. Organisation should also consider the IS support of identified business resources. Indeed, integration of business resources can increase the interoperability and facilitate the information exchanges between the business and the IS partners.

4 Lessons learned

In section 2.2, four theoretical criteria of validity have been defined. We will now evaluate the results presented in section 3 against these criteria according to two points of view: the researchers' point of view and the practitioners' point of view. The first one allows us to establish if the measure values obtained for the fitness metrics are hundred percent accurate, effective, verifiable and non ambiguous. The other point of view allows us to evaluate if for the practitioners these set of criteria are relevant or not.

4.1 Measurements validity: point of view of the researchers

- *The measurements are based on verifiable observations:* the models required for the measurements application were built up and validated by specialists within the organisation.
- *The measurements' results are non-ambiguous:* the project stakeholders understood the results in the same way.
- *The measurements are effective:* the results have been compared with the study made by the project team, requested by the CEO of the textile trade name. These results were confirmed during discussions with the project stakeholders.
- *The measurements' results are accurate:* the results helped us to localise the misalignments and confirmed the causes of non-fits.

From our point of view, the fitness measurements are valid; they fulfilled all theoretical criteria of validity.

4.2 Measurements validity: point of view of the practitioners

Fitness Measurement Approach was applied by one researcher on a restricted perimeter of the project as we showed in section 3. Practitioners confirm the usefulness of the approach and the effectiveness of its corresponding results. Nevertheless, concerning the reusability of the approach for other projects, the following criteria related issues bring up:

- *The measurements are based on verifiable observations:* Building models requires much time, new skills and further resources. Managers are aware of their data weaknesses and argue that this is not the priority of the company to build and to maintain such data.
- *The measurement results are non-ambiguous:* Managers are aware of their input data weakness and argue that even with ambiguous results, they would be satisfied.
- *The measurements are effective:* Concerning the effectiveness of the measurements, managers are satisfied. They confirmed that we found problems that indeed exist, and localised misalignments. Nevertheless, they deprecate the fact that the results did not indicate the severity of the identified gaps. They asserted that the prioritisation of gaps severity is very important for the decision-making.
- *The measurements' results are accurate:* The accuracy of the results is not important for practitioners. They are interested in getting more results precision only if it is done within a short period of time. Otherwise, it does not have much value. For managers, detailed reports take more time to be done and to be understood. Simpler results are preferred, at least in a first step. Sometimes, intuition is enough.

From the practical standpoint, fitness measurements are useful only if models required for their application are available in the organisation. For the majority of organisations, this is not the priority.

The measurement validity perception of our industrial partners revealed that (i) some of our criteria are not such important for them, and (ii) some criteria appeared to be very important but we did not consider them in our work. Overall, practitioners do not aim a perfect alignment, especially when it requires too much time and resources. Most of the time, they are interested in some aspects of the problem, not all. What is important for practitioners is to do things –approximately– right and fast. Besides the effectiveness, for them, the *efficiency* criterion is crucial. Table 3 summarises the importance of measurement validity criteria viewed from the theory and the practice standpoints.

Table 3. Measurement validity perceptions

	Theory	Practice
Measurement based on verifiable observations	++	--
Non-ambiguity	++	+
Effectiveness	++	++
Accuracy	++	--
Efficiency	--	+++

4.3 Discussion of the obtained results

Several factors may limit the generalisation of our results:

- The applicability of the Fitness Measurement Approach depends on the enterprise models availability in the organisation: if models required for metrics application exist in the organisation, the approach application is just a technical task. Otherwise, required models need to be built [20] and the application of the approach may become a complex and resource demanding task.
- The interpretation of the validity criteria by practitioners depends on the organisation data maturity level. Indeed, the more the data maturity level is high the more practitioners adhere to our validity criteria and confirm our evaluation hypothesis.
- Fitness metrics results depend on the quality (and validity) of the built models. In the big companies, knowledge is spread among many individuals and the understanding of the same part of business by different individuals may vary and may even be contradictory. Extensive cross-checking is thus mandatory.

5 Conclusions and future work

Our study revealed that researchers and practitioners do not have the same understanding of the validity of metrics-based approaches. In fact, some of our hypotheses have been refuted during the case study and new validity criteria emerged. The main requirement of practitioners is that alignment measurements give effective results – even approximately – with regard to the time and the budget constraints of the project. Our experience allowed us to identify practical guidelines to help the successful application of the metrics-based approaches and, more precisely, the enhancement of their applicability in industrial projects. The definitions of these guidelines are based on (i) the observation of the industrial context and (ii) the practitioners' requirements introduced during fitness measurements. We organise them as practical guidelines in three directions:

***Guidance in building models*:** The maturity of organisations (SEI Capability Maturity Model [24]) - has an impact on the metrics applicability. Indeed, metrics rely on models and verified data, which constitute the inputs of the metrics-driven approaches. The availability of such data depends on the maturity level of the organisation. For many organisations required models are often not available, and to build them is necessary to assess the business-IT alignment. Building such models is not a trivial task; the project scope should be well defined to allow the collection of the relevant data. Guidance is thus needed to assist engineers in building the business and IT models required for performing measurements. In [20], we proposed a "build-up process" consisting in four phases: (i) identification of the input data required by the fitness measurement approach and which should be constructed; (ii) initial data collection; (iii) data consolidation; (iv) validation of the consolidated data (which will be used as the input data of the fitness measurement approach).

***Customisation of the approach - Time To Market requirement*:** Business-IT alignment assessment is a sort of internal audit performed by an organisation in order to undertake the corrective actions and to enhance its performance. In an evolving environment, it is very important to react rapidly to the change. If it takes long time to produce and to communicate results, the measurements results become meaningless. Constructing the required artefacts for applying metrics-based approaches takes a long time (data collection and consolidation, and models validation). In order to address this issue, we observed that it is important to find a way to get, interpret and present results in a shorter time. For this reason, we argue that the measurement approaches require more agility, i.e. the results should not be delivered at once and intermediate results to lead the ways to measure are needed. Intermediate results are discussed and a deeper analysis can be undertaken if needed. The measurement cycle can thus be shortened.

Customisation of the approach - Time Boxing/Design To Cost: The main constraints of a project are the time, the cost and the quality of the resulting product. The time boxing (or design to cost) is a strategy used in practice to indicate the quantity of information, which can be delivered, under the constraint of a limited time (x months) and a fixed budget (y K euros). We argue that the approach can gain in usability if it is composed of fine-grained method chunks which can be applied according to the convenience of the *resources* involved in the project, i.e. time, budget and actors.

In our future work, we will explore the three first directions in order to improve the “usefulness” of our approach.

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