Means for Building Models to Align Information Systems Support to Specific Application Domains

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Abstract. Information Systems (IS) are today the cornerstone of modern organizations, in which they support specific application domains or business areas that can give a strategic advantage. In this context, strategic alignment that exists when the IS and business goals and activities are in concordance, becomes crucial. Several approaches have been proposed for building strategic alignment. However, for aligning IS support to specific application domains it is necessary to deal with their specific characteristics. Reviewing the literature, strategic alignment approaches addressing these specific characteristics have been proposed by extending the Strategic Alignment Model (SAM) [1]. Nevertheless, means for building new models from the SAM constitutive elements have not been proposed yet. To cope with this lack, we propose two metamodels: the SAM static view metamodel and the SAM dynamic view metamodel and a methodology to use them. An illustrating example shows the applicability of our approach.

Keywords: Information system · Metamodel · Strategic alignment · Business-IT alignment · Strategic Alignment Model (SAM) · Specific domain

1 Introduction

In recent years several industrial sectors have been strongly impacted by globalisation resulting in increased competitiveness needs [2]. These challenges have encouraged the development of flexible Information Systems (IS) supporting specific application domains such as manufacturing, finance, knowledge management that can give a strategic advantage to companies.

As a result the role and importance of such IS have changed significantly over time shifting from simple activity and business process support to competitive advantage provider [3,4]. To meet this objective IS strategic alignment that

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studies the link between the IS and the business organisation's goals and activities, becomes crucial. It exists when both elements are in harmony [5] and leads to superior business performance [6,7]. It is thus not surprising that executives rank alignment for almost 30 years as a top priority and major concern [8].

Several approaches have been proposed for building strategic alignment [9,10]. Most of them address general characteristics related to Business and Information Technologies (IT) domains. However, for aligning IS support to specific application domains it is necessary to deal with their specific characteristics. Indeed, these domains are characterized by:

- The heterogeneity of the activities involved in their processes [11–13];
- The range of users that are various and not experts in IT. As a result they have specific needs that have to be taken into account through personalization in usability and functionality [14];
- The need for integration between the IS support to these domains and other systems, infrastructures and facilities of the company (i.e. manufacturing infrastructures, ERP systems, ...) [15].

In this way, generic strategic alignment approaches are no suitable as they do not address these specificities. Indeed, these domains have to be taken into account as standalone domains that impact both business and IT domains. In this way, the interrelations between domains can be highlighted and enable to contribute to strategic advantage and competitiveness of the firm.

Reviewing the literature, strategic alignment approaches for specific application domains have been proposed mainly by extending the Strategic Alignment Model (SAM) [1]. The SAM is one of the most widespread alignment model. It has features that are interesting for building alignment. First, the distinction between the external perspective of IT (IT strategy) of its internal development (technology infrastructure and IT processes) explicitly gives a strategic role to the IT domain. Second, the building blocks (strategic fit, functional integration) that are associated to alignment sequences highlight the dynamic of alignment building. In our view, these features can be extracted and applied to IS support to specific application domains. However, the SAM constitutive elements have not been formalized and there are no means of facilitating the creation of new specific models from them. Existing extensions such as [16–18] extends the SAM from scratch, without following any extension formalism or logic, what prevents the fully exploitation of the whole SAM characteristics for alignment [19].

Therefore the objective of this paper is to provide means for supporting the building of models for aligning IS support to specific application domains that can give a strategic advantage to the company. Such means consist in two metamodels of the SAM and an exploitation methodology which allows the construction of new models by the instantiation of its constitutive elements.

To succeed in, firstly we analyse the SAM and its existing extensions in order to extract their constitutive elements. Then, from these elements, we propose two metamodels: (i) the metamodel of the SAM static view (or SAM structure) and (ii) the metamodel of the SAM dynamic view (or SAM alignment sequences).

Lastly we suggest a methodology to use these metamodels for the construction of specific alignment models.

This paper presents our proposal as follows: Sect. 2 presents the SAM and analyses its extensions. Section 3 describes the SAM metamodels. In Sect. 4, we state out a methodology for using the SAM metamodels and illustrate its applicability on a study case related to IS supporting product manufacturing. Finally, Sect. 5 concludes the paper and outlines future work.

2 The Strategic Alignment Model (SAM) and Its Extensions

2.1 The SAM Structure

The SAM [1] is structured in terms of three classes of concepts:

- Domains: two domains are involved: Business and IT;
- Perspectives or levels: these split domains into two subdomains: external (strategy) and internal (structure);
- Components: each subdomain is further detailed through three components describing the set of decisions to be taken in the alignment border: scope, competencies and governance in the external level; infrastructure, skills and processes in the internal level.

2.2 SAM Building Blocks and Alignment Sequences

The SAM is conceptualized in terms of two fundamental characteristics of strategic management also called building blocks [1]:

- Strategic fit: the interrelationships between external and internal levels of a domain and
- Functional integration: integration between the Business and the IT domains. On the internal level, it is named operational integration. On the external level, the link between Business and IT strategies refers to strategic integration.

According to [20], a domain can be classified according to its position in an alignment sequence as (i) Anchor domain; (ii) Pivot domain; (iii) Impacted domain. In [1] four alignment sequences are provided that address strategic fit and functional integration. They follow three building rules:

- Alignment rule A: An alignment sequence deals with a cross-domain relation in the form of a strategic fit and a functional integration, implying three domains.
- Alignment rule B: An alignment sequence runs from the anchor domain to the impacted domain through the pivot domain.
- Alignment rule C: the SAM considers only planned sequences as a result the anchor domain takes place at the external level.

The four proposed sequences are described in Table 1 in which we represent the anchor domain with a square, the pivot domain with point and the impacted one with a triangle.

Table 1. SAM alignment perspectives adapted from [1]

Name of the perspective	Perspective	Anchor domain
Strategy Execution		Business strategy
Technology Transformation		Business strategy
Competitive Potential		IT strategy
Service Level		IT strategy

2.3 SAM Extension Works

SAM extensions aim at giving a strategic role to specific application domains and to deal with their specific characteristics and concerns. Among the extensions we can find the Generic Framework [17], the Integrated Architecture Framework (IAF) [16], the Unified framework [21] and the Knowledge Management Strategic Alignment Model (KMSAM) [18]. A detailed analysis of these extensions has been made in [19] in order to verify the potential contributions of these works to our goal. This analysis shows that works extending the SAM structure add new:

- Domains: Works adding new organizational domains like [16–18] attempt to give a more strategic role to these domains, taking advantage of their features, to improve the performance of the organization or strengthen its position on the market.
- Levels or perspectives: Works adding new perspectives or levels to the original SAM [17,18] intend to synchronize strategic objectives, placed externally and generally defined to long-term, and the deployment of resources, placed internally and generally defined to medium/short term.
- Dimensions: The only work adding a new dimension is the IAF [16]. It aims at integrating concerns related to "governance" and "security" to the 4 domains proposed in this framework.

These works do not detail the nature or composition of the dimensions, levels or domains added. Indeed, the generic framework is the only work describing the components that constitute the added domains. However, this description is fairly general and does not specifically detail the decisions and activities relating to each component.

Concerning the alignment sequences, the extension works, with exception of the KMSAM, do not provide new ones for aligning the new domains to those already existing in the original SAM. The KMSAM provides two alignment sequences for integrating the Business, Knowledge Management and IT strategies. However, these alignment sequences do not support the implementation and execution of these strategies because the internal level is not taken into account.

2.4 Towards the SAM Metamodels

A metamodel abstracts the concepts and relations of a specific domain and represents the structure of this specific domain defining what can and cannot be expressed in the models [22]. Typically, the process of models and metamodels construction follows a chronological order where the metamodel is created before the model. However, in some contexts this is not the case [23].That is the case of strategic alignment context, in which the construction of the SAM and its extensions models did not follow this order. In fact, the SAM was proposed by replicating the Business domain structure in order to build up the IT domain. Therefore, as the Business domain involved two levels (external and internal) and three components at each level, the IT domain includes: two levels with three components at each level. Furthermore, as we argued in the last subsection, the SAM extensions for specific applications were built up mainly by replying this same logic.

In order to facilitate the construction of new SAM extensions we propose to metamodel the SAM structure and alignment sequences. Indeed, the instantiation of the resulting metamodels will allow the building of the structure for specific strategic alignment models as well as the proposition of specific alignment sequences. To succeed in we undertake the following work in the next section:

- An analysis of the structure of the original SAM and its extensions, what we call the SAM static view, in order to identify their structure principles and provide the static metamodel view.
- An analysis of the alignment sequences of the original SAM, what we call the SAM dynamic view, in order to find out their building principles and provide the dynamic metamodel view.

3 The SAM Metamodels

A metamodel is a way to describe the elements of the reality and the valid ways to relate them [24]. Thus, using metamodels is very pertinent in the strategic alignment field as alignment models need to be built by following semantic concepts representing components, issues, concerns.

3.1 Static Metamodel View

As we showed in the last section, the static view of the SAM and its extensions includes structure elements such as: domains, levels, concerns and components. In fact, the SAM domains are devised by levels and are characterised by components on which concerns must be addressed. We propose thus to take into consideration four structure elements for the static metamodel view (see Fig. 1):

- Domain: representing functional areas, organisational areas, organisational viewpoint etc.
- Level: dividing domains and giving them abstraction or implementation hierarchy.
- Component: complex constituent grouping decisions with similar characteristics for the domains.
- Concern: representing matters or issues (governance, security, etc.) on related components.

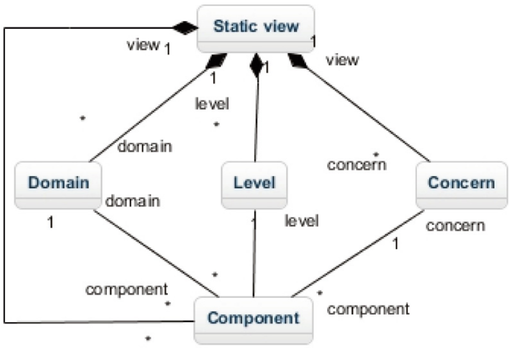

Fig. 1. Metamodel of the SAM static view

3.2 Dynamic Metamodel View

As we showed previously, alignment between SAM domains involves the following conceptual elements that we take into consideration for the dynamic view metamodel (see Fig. 2):

- Building block: relationship representing alignment between two domains or two levels.
- Alignment sequence: cross domain relationship that involves more than one building block.
- Role: characterising domains in the alignment sequence.
- Building Rules: principles that governs the construction of alignment sequences.

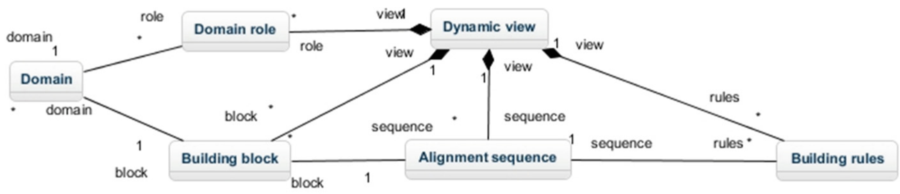

Fig. 2. Metamodel of the SAM dynamic view

4 Using the SAM Metamodels

4.1 Metamodel Use Methodology

The working out of domain specific alignment models by instantiating the proposed metamodels, consists in two parts: one for the static view and one for the dynamic one. For each part, we propose the following steps:

Using the Static Metamodel View

1. Instantiating the static metamodel view: it consists in determining which domains, levels, concerns and components will compose the specific alignment model static view.
2. Analysis of research works for the specific alignment model: the aim of this step is to carry out a research in the knowledge area of the selected domains in order to define decision groups or categories to form them.
3. Mapping of concepts: this step consists in making a mapping between the state of the art made in step 2 and the SAM components defined in step 1. This enables to describe and give meaning to them.

Using the Dynamic Metamodel View

1. Instantiating the dynamic metamodel view: as domains have been already instantiated in the first part, it consists in defining building rules, building blocks, and domains roles to describe alignment sequences.
2. Describing alignment sequences: it consists in creating alignment sequences from the elements instantiated in step 1. Here, the alignment sequences should be described according the anchor domain.

4.2 Study Case Description

We illustrate the use of SAM metamodels for the alignment of manufacturing IS. Manufacturing is the application domain of the IS under study. Even though it is somewhat as a business type domain, taking this as a standalone domain enables us to separately define its specific characteristics and study its interrelations with other business areas and the IT domain.

Manufacturing IS are systems, where humans and machines exist and work together [25]. This kind of IS provides two major functions: managing product data (storage, control, retrieval, etc.) and managing product development processes (approval process, authorizations, engineering change orders, deviations, configurations and other processes that impact on product data) [26]. These systems help companies to improve return on investment by reducing in-process inventory and associated carrying costs. To succeed in, the alignment of such IS require alignment models in order to address specific manufacturing strategic and operational characteristics.

Instantiation of the Static Metamodel View

1. Instantiating the static metamodel view (see Fig. 3):
   - Domains: Business, IT, and Manufacturing
   - Levels: External and internal
   - Components: 6 components for each domain: scope, competencies and governance at the external level; processes, infrastructure and skills at the internal level.
   - Concerns: No special concerns to be taken into account.

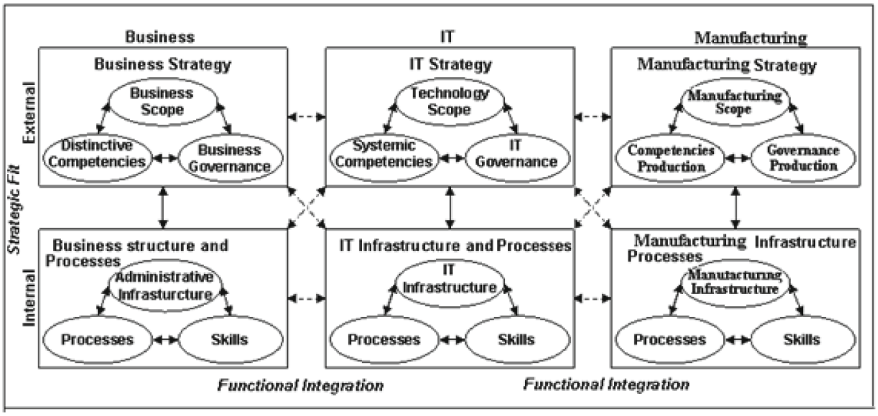

Fig. 3. Instantiation of the static metamodel view for the manufacturing IS

2. Analysis of research works for the specific alignment model:
   For Business and IT domains, we rely on the description made by [1].
   For the Manufacturing domain we rely on works dealing with manufacturing strategy like [27–30]. In these works, the manufacturing strategy is defined through a set of decisions (see column Decision category in Table 2) that, over time, enables an organisation to achieve a desired manufacturing structure, infrastructure, and specific capabilities.
3. Mapping of concepts: For the manufacturing domain, the mapping performed between the decision categories and the manufacturing components is synthesized in Table 2.

Table 2. Mapping between manufacturing components and categories of decision

Level	Component	Decision category
External	Scope	Scope/new products
	Competencies	Capacity Quality
	Governance	Vertical integration Vendor relations
Internal	Infrastructure	Facilities Infrastructure
	Processes	Processes/Technologies
	Skills	Human resources

Instantiation of the Dynamic Metamodel View

1. Instantiating the dynamic metamodel view:
   Building blocks: as in the original SAM: strategic fit and functional integration.
   Domains roles: as in the original SAM: anchor, pivot and impacted.
   Building rules: we took inspiration from the original rules to derive the specific rules for the specific model. These rules are described as follows:
   - The original building rule A describes how to work out consistent alignment sequences. In the case of our model, we derive three rules:
     - Building rule AA: an alignment sequence consists of a set of strategic fits and functional integrations implying at least four of the six domains;
     - Building rule AB: at least a strategic fit is required to align the internal and the external levels;
     - Building rule AC: with three domains, at least, two functional integrations are required to align the three domains.
   - The original building rule B remains unchanged for the extension: An alignment sequence runs from the anchor domain to the impacted domain through pivots domains.
   - The original building rule C remains unchanged for the extension: the anchor domain takes place at the external level. It reflects the fact that [1] take into account strategy driven sequences also called planned because they are the most important.

   As we focus on the integration of strategic alignment concerns into the design and development of manufacturing IS we add the following rule:
   - Building rule D: the impacted domain is always the IT internal domain. Indeed, during an IS implementation project, the main objective is to design and develop the corresponding IS. In this view, the domain that will most be affected with the changes is the IS designed.

2. Describing alignment sequences:
   By using the concepts and rules above defined, we propose ten alignment sequences (see Fig. 4). We classify them according the anchor domain. For example, three alignment sequences could take place when the business strategy is the anchor domain. Sequences 1 and 2 consist in assessing the implementation of the chosen business strategy through the appropriate manufacturing strategy that in turn becomes the pivot domain. At this point, there are two possible paths: (i) a strategic integration implementing the chosen manufacturing strategy through the appropriate IT strategy (sequence 1); or (ii) a strategic fit by translating the selected manufacturing strategy into the related manufacturing infrastructure and processes (sequence 2). Both sequences end with the identification of the corresponding IS architecture. In sequence 3, the business strategy is implemented in a business structure that takes the pivot domain role. Then this business structure is inevitably linked, through a functional integration, to the manufacturing infrastructure by, among other, the configuration of appropriate manufacturing structure and processes. Later manufacturing infrastructure is aligned with IS infrastructure (impacted domain) by the design of the IS support architecture and processes.

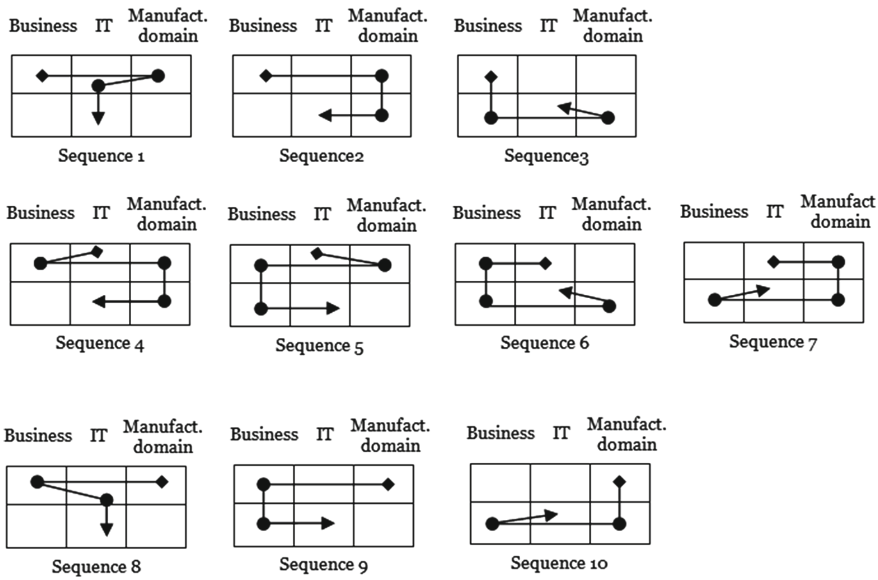

Fig. 4. Instantiation of the dynamic metamodel view for the manufacturing IS

5 Conclusion

Strategic alignment is a crucial concern for many companies seeking the best value from their IT investments. To succeed, analyst need models on which they can rely. In this boarder, our objective here is to provide means to work out such models that are adapted to specific concerns and application areas such as manufacturing, product design or finance. Therefore we propose to extract the metamodels of the SAM that is one of the most widespread models of alignment. On the one hand we build the static metamodel view formalizing the concepts of domain, level, component and concern. This view enables the formalization of the decisions that have to be made to build strategic alignment. On the other hand we propose the dynamic metamodel view. It formalizes alignment building blocks, domain roles and building rules for building specific alignment sequences. These represent the way the decisions are interrelated during alignment. We complete these metamodels with a methodology for working out alignment models of specific areas of concerns. We show the applicability of our propositions by building an extended SAM structure for the manufacturing application domain and ten alignment sequences. The metamodels make the link between specific knowledge of the domain and the concepts that underly alignment. It is useful when dealing with specific areas of concern that need to be taken into account as standalone elements having their own logic that has to fit with business and IT logics.

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