MISALIGNMENT SYMPTOM ANALYSIS BASED ON ENTERPRISE ARCHITECTURE MODEL ASSESSMENT

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ABSTRACT

Business–IT alignment and misalignment are duality-like concepts referring to the harmony or disharmony between business and IT. The state between these two areas can be viewed either through its presence (a.k.a. alignment) or through its absence or difficulties (a.k.a. misalignment). Most of alignment studies deal with alignment achievement, while misalignment issues (detecting, analysing and correcting misalignment) are underemphasized in the literature. This paper relates to misalignment assessment. It connects misalignment analysis to enterprise architecture models with the aim to set up an enterprise architecture-based (mis)alignment assessment method. The paper first introduces the primary building blocks of architecture-based misalignment analysis. Based on the theoretical foundation the paper aims to establish the conceptual body of enterprise architecture-based misalignment symptom analysis. Different misalignment symptoms are located on TOGAF metamodel in order to detect the presence of misalignment. At the end of the paper conclusions are drawn concerning the symptom-location experiment.

KEYWORDS

Business-IT Alignment, Strategic Alignment, Misalignment, Enterprise Architecture, Architecture Alignment

1. INTRODUCTION

Business–IT alignment has been one of the top information management concerns since the organisational role of information systems has accentuated. The need to align business with information systems is unquestionable and is regarded as one of the most important issues on information systems (IS) research. The concept of business-IT alignment has to be present among the top concerns of an organisation, since information systems play an important role in business strategy: they facilitate the success of business strategies. This connection indicates the importance of alignment between business and information systems. The need for aligning

business and IT consists of several reasons, e.g. using IT effectively to achieve business goals, capturing the ability of IT to create business value, bridging the gap between business and IT or integrating IT to business strategy, mission and goals (Chan – Reich, 2007).

While organisations address alignment achievement, they are continually suffering from *misalignments*. These difficulties (the misalignments) encumber the achievement of alignment. It indicates that misalignment analysis is an important step in achieving alignment. Understanding the underlying cause of misalignments, as well as trying to correct the existing misalignments is one of the possible ways to achieve alignment. Misalignment analysis is therefore a supporting tool for business-IT alignment. It helps to understand the nature of alignment.

Most of traditional alignment studies deal with achieving alignment. On the contrary, misalignment issues (detecting, analysing and correcting misalignment) are considerably underemphasized in the literature. The low attention on misalignment is inadmissible, since organisations are in the state of misalignment as long as they achieve the state of alignment. This fact indicates that more attention ought to be paid to the phenomenon of misalignment, as well as to its symptoms and effects. There are several questions among misalignment. Hence, the most important issues of misalignment are the following: 1) How to detect misalignment symptoms? 2) How to alleviate the identified symptoms? 3) How to reveal the underlying causes of misalignment? and 4) How to address these underlying causes? Answering these questions contributes to alignment achievement.

This paper deals with misalignment, with special attention to architecture-based misalignment symptom analysis. It connects the concepts of enterprise architecture and (mis)alignment. EA-based misalignment symptom analysis is part of the post-implementation phase of the IS lifecycle. It is a post-implementation assessment in which IS developments are evaluated 1) whether they fit into the enterprise IS architecture from a strategic alignment perspective, 2) whether there are areas for further development. The paper first aims to establish the literature body of architecture-based misalignment symptom analysis. It introduces the main building blocks of the topic: strategic alignment, misalignment and enterprise architecture. Based on the theoretical foundation the paper aims to connect these building blocks to each other in order to create an architecture-alignment perspective.

The paper has 6 main parts. In the next section a short summary is given on strategic alignment, misalignment and enterprise architecture. Section 3 deals with architecture-based (mis)alignment analysis. Section 4 proposes an initial research concept on architecture-based misalignment analysis. In section 5 a thought experiment is conducted. Discussion part deals with interpreting the results of the experiment. At the end of the paper conclusions are drawn concerning the symptom location-experiment.

2. THEORETICAL CONTEXT

2.1 Strategic Alignment

The first building block of the literature review is the concept of strategic alignment. In this part we present different alignment definitions, alignment dimensions as well as well-known alignment models.

Alignment has different perspectives in the literature, hence, they always have the same essence. Alignment is a situation when organizations apply appropriate IT instruments which are congruent with business strategy. Alignment is considered: 1) as a degree of fit between business and IT strategy and infrastructure, and 2) as a level how IT strategy can support the business strategy. Business-IT alignment takes place if the organizational goals and activities are in harmony with the supporting information systems (Luftman – Brier, 1999).

There are several alignment dimensions which approach the alignment issue in different ways (Reich – Benbasat, 1996; Chan, 2001):

1) *Strategic* dimension of alignment means the degree to which business strategy and IT strategy are connected to each other.
2) *Structural* dimension of alignment refers to the business – IT structural fit.
3) *Informal* structures are relationship-based structures in an organisation. Informal dimension transcends the formal structure (e.g. division of labour, coordination of tasks); in this dimension business and IT is aligned via informal lines.
4) *Social* dimension of alignment means the state in which business and IT units understand each other and are committed to business and IT strategies and goals.
5) *Cultural* dimension refers to the cultural elements of alignment, such as business planning style, communication style and common language.

Alignment models are holistic approaches which can be used in a prescriptive manner. Although there are several alignment models in the literature, some alignment models are particularly influential and recognized, such as the MIT model (Scott Morton, 1991), the Baets model (Baets, 1992) and Henderson and Venkatraman's (1993) Strategic Alignment Model (SAM).

The SAM model can be referred to as the most cited alignment model in the literature. The model has four key domains of strategic choice: 1) business strategy, 2) organizational infrastructure and processes, 3) IT strategy and 4) IT infrastructure and processes. The external axis of the model consists of the business and IT strategy domains, while the internal axis contains organisational and IT infrastructure and processes. Business axis refers to business strategy and business structure, while IT axis consists of IT strategy and IT structure. The SAM model is based on two primary building blocks: 1) strategic fit and 2) functional integration. The strategic fit dimension means the need to align the external and internal domains of IT, while functional integration consists of the need to integrate business and IT domains. There are four dominant alignment perspectives, so-called cross domain relationships in the SAM: 1) Strategy execution, 2) Technology transformation, 3) Competitive potential and 4) Service level.

2.2 Misalignment

The second building block of the literature review is the concept of misalignment. We introduce different misalignment definitions, explain misalignment via different symptoms and show misalignment management steps.

The state of business-IT alignment can be analysed either through its presence (alignment) or through its absence or deficiencies (misalignment). In this sense misalignment can be referred to as a state when organisations fail to achieve or sustain alignment. This definition stresses the state-like nature of misalignment, i.e. misalignment is an undesired state which has

to be avoided or corrected. Another perspective declares that misalignments are different problems occurring while an organisation is trying to achieve alignment. According to this concept, misalignments are aggravating circumstances. If we accept that alignment is a desired state of an organisation, we define misalignments as complicating factors with which organisations are facing while achieving alignment (Carvalho – Sousa, 2008a).

Misalignment has several symptoms through which an organisation can detect its existence. Misalignment symptoms (or signs) are evidences of inefficiencies, difficulties, inabilities concerning business and IT strategies and structures. Misalignment symptoms – the evidences of disharmony – demonstrate the state of misalignment in an organisation. There are several misalignment symptom collections in the literature (e.g. Carvalho and Sousa (2008a), Pereira and Sousa (2005), Sousa et al. (2005) and Chan and Reich (2007)).

Misalignment is a non-desired state, what organisations want to eliminate. Organisations can avoid this condition by detecting, correcting and preventing misalignment(s). The triad of detection, correction and prevention is the general process of handling the phenomenon. (Chen et al., 2005; Carvalho – Sousa, 2008b).

1) *Misalignment detection* means the diagnosis of this undesired state. It includes the processes of a) misalignment identification and b) symptom analysis.
2) *Misalignment correction* is the process of realigning business processes with information systems. The correction step is about terminating the symptoms by correcting the malfunctioning procedures.
3) *Misalignment prevention* is the process that helps to avoid the state of misalignment. Prevention means an array of activities with which the non-desired condition can be avoided.

The most famous misalignment models are the BISMAM model (Business and Information Systems MisAlignment Model) by Carvalho and Sousa (2008b) and the BITAM method (Business IT Alignment Method) by Chen, Kazman and Garg (2005). The BITAM approach gave the first structured conceptualisation on misalignment. It dealt with business and IT architecture misalignment management. It was an engineering-principled misalignment detection and correction method which set up 12 steps to detect and correct misalignment. The BISMAM model gave special attention to the detection-correction-prevention triad. In the model an analogy was shown in which medical sciences approach was used to set up misalignment nomenclature. The model introduced misalignment from a medical science perspective, using the analogy of detecting, correcting and preventing illnesses. The approach defined a basis for misalignment classification and misalignment techniques, based on detection, correction and prevention steps.

2.3 Enterprise Architecture

The third building block of the literature review is about enterprise architecture (EA). We approach the concept from an interpretational perspective, then we introduce the most important EA frameworks.

Architecture is the fundamental organisation of a system, including its components, and their relationships. Architecture is a formal description of a system; it shows the structure of components and the main architectural principles and guidelines. *Enterprise architecture* is the fundamental organisation of an enterprise, described with its components and the relationships

to each other and to the environment. Enterprise architecture is a possible organizing structure of the business processes and IT infrastructure in an enterprise. The main idea behind enterprise architecture is the need to a primary enterprise logic in order to review, maintain and control the whole operation of the enterprise (TOG, 2009).

Enterprise architecture is a structure which helps 1) to capture a vision of the entire system in all its dimensions and complexity, 2) to coordinate the many facets that make up the fundamental essence of an enterprise and 3) to provide a structure for business processes and supportive information systems. It is an organising logic which acts as an integrating force between aspects of business planning, business operations and the enabling technological infrastructure of the business. Enterprise architectures help to integrate the different information systems and business processes into a coherent map. Enterprise architectures support IT strategy, IT government and business-IT alignment (Zachman, 1987).

An enterprise architecture framework is a collection of methods to create and manage the enterprise architecture. There are several enterprise architecture frameworks available, e.g. the Zachman Framework (Zachman, 1987), the TOGAF framework (TOG, 2009), or the DODAF framework (DOD, 2009). The most recognized frameworks are the Zachman Framework and the TOGAF framework.

TOGAF (The Open Group Architecture Framework) is a commonly used architecture framework. It is a holistic approach which describes the architecture building blocks, the connections between them, as well as the method how to build and maintain enterprise architectures. The framework has four main components: 1) Architecture Capability Framework, 2) Architecture Development Method (ADM), 3) Architecture Domains and 4) Enterprise Continuum. The latter consists of different reference models (e.g. Technical Reference Model, Standards Information Base, The Building Blocks Information Base (TOG, 2009)). Architecture domains are different conceptualizations of an enterprise. The architecture domains of TOGAF approach are 1) Business architecture, 2) Data architecture, 3) Application architecture and 4) Technology architecture.

TOGAF metamodel is a reference model which sets up the formal structure of an EA model as well as provides an implementation guidance on core building blocks and their relationships. The metamodel depicts the core entities of the 4 architecture domains. Entities are connected to each other within and among architecture domains. Business Architecture is primarily connected with the other 3 architecture domains via Business Service. Business Service is therefore a bridge between several entities, refracting the direct routes between the different items. Figure 1 depicts the TOGAF metamodel.
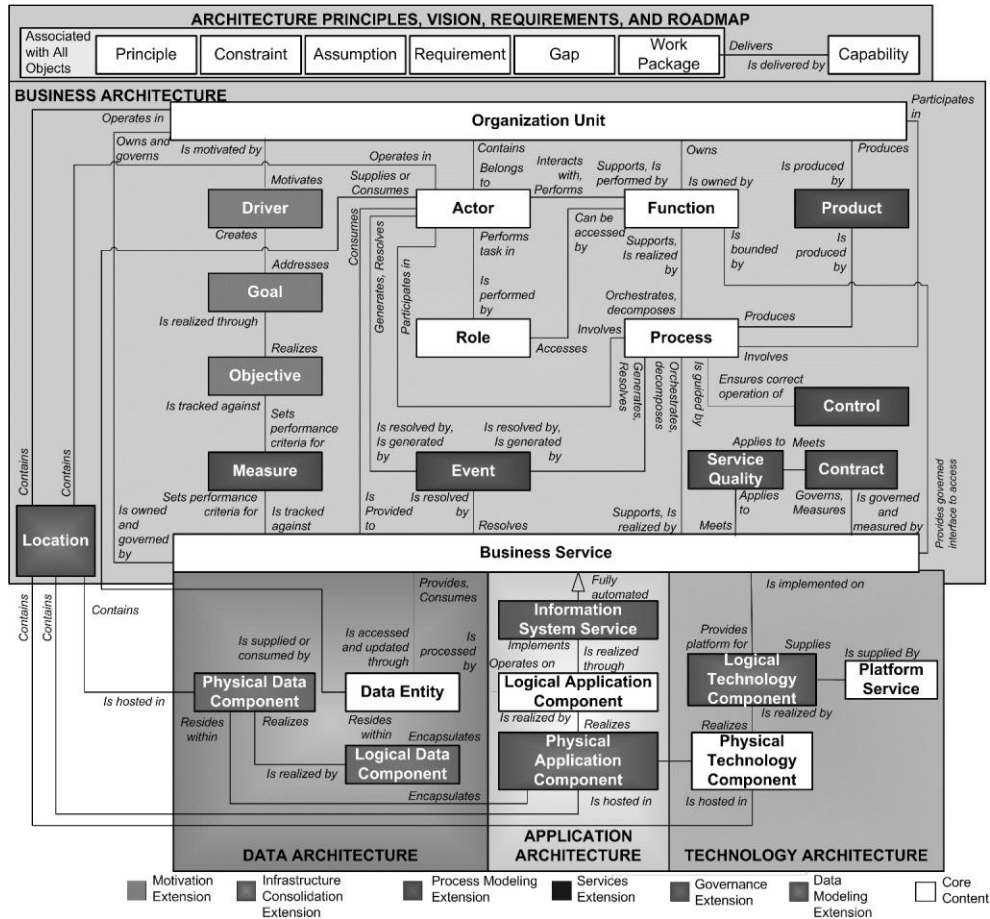
Figure 1. TOGAF metamodel (TOG, 2009)

3. ARCHITECTURE-BASED ALIGNMENT ASSESSMENT

The state of (mis)alignment can be examined via several methods. One of the main research methods of analysing alignment is enterprise architecture-based assessment. This method assesses how IT is aligned with organisational goals. While earlier studies on alignment assessment primarily focused on strategic and holistic perspectives, the innate connection between business models and architectures has not been revealed (Chen et al., 2005). Enterprise architecture describes the logical structure of the different architecture layers and it links all levels from business strategy to IT implementation. In this sense EA enables us to assess the alignment between business and IT. Undertaking an architectural assessment is a helpful way to determine the state of alignment and to identify re-architecture needs. Architecture assessment consists of sole architecture layer analysis, as well as fit analysis

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between the different layers. After architecture assessment realignment (or re-architecture) techniques are used (Enagi – Ochoche, 2013).

Many authors have linked enterprise architecture to strategic alignment. Pereira and Sousa (2004) identified that the operation of the different architecture components relates to alignment performance. Bounabat (2006) clashed the different EA layers in order to assess the state of alignment. Elhari and Bounabat (2010; 2011) set up an architecture-based maturity model for alignment assessment. Wegman et al. (2005) proposed an EA framework that is able to check alignment along functional and organisational hierarchies. Dahalin et al. (2010) proposed a methodology to define how relevant is EA in addressing strategic alignment.

To rephrase the definition of misalignment in the context of enterprise architecture, misalignment is an irregular condition that destroys the different architecture components as well as the desired fit between them. In addition, EA-based misalignment means the inaccurate mappings between the different architecture layers. There are a few studies on EA-based misalignment assessment as well.

Pereira and Sousa (2004) pointed out the relationship between architecture components and alignment performance, stating that alignment performance can be assessed by measuring misalignments between the architecture layers. They introduced a set of questions which helps to detect misalignments between the architecture layers. The BITAM approach (Chen et al., 2005) dealt with business and IT architecture misalignment management. It was an engineering-principled misalignment detection and correction method that connected misalignment with architecture. It set up 12 steps how misalignment can be detected and corrected. A three-level model was defined, in which business model, business architecture and IT architecture were analysed, defining the signs of inappropriate mappings between the different layers. The approach stressed out the effects of misalignment on architecture layers. The BISMAM approach (Carvalho – Sousa, 2008b) also connected misalignment to enterprise architecture. It was a symptom-based approach in which symptom detection methods were proposed. The model consisted of a set of preliminary signs that forecast the danger of misalignment. The approach showed that enterprise architecture alignment is a prosperous way to implement misalignment detection, correction and prevention. Elhari and Bounabat (2011) examined the different relations between the architecture layers. They proposed a platform that measured the difficulties in the IS elements. They stated that these difficulties harm the state of strategic alignment. They suggested different efforts to improve strategic alignment in an organisation.

4. CONCEPTUAL DESIGN

Based on the above introduced literature body this paper particularly deals with EA-based misalignment analysis. As presented before, misalignment can be identified by its symptoms. Since several misalignment symptoms occur in enterprise architecture models as well, architecture assessment is a possible way to detect the state of misalignment.

The research aims to analyse enterprise architecture models to identify different misalignment symptoms. The research primarily focuses on the following research questions:

RQ1: Which misalignment symptoms can be detected via EA assessment?
RQ2: Which architecture layers are needed to detect misalignment symptoms?

RQ3:With which methods can we explore different misalignment symptoms in different EA layers?

RQ4:How do EA layers evince different misalignment symptoms?

It is generally known that not all misalignment symptoms can be detected via EA assessment (e.g. corporate culture or shared values). In addition, due to the lack of documentation, several symptoms will stay hidden in the EA models. The undocumented symptoms cannot be identified via EA assessment. Regarding these limitations the research does not aim to analyse every misalignment symptom, but only the ones that can be detected via EA models. Taking these limitations into consideration the research aims to:

1) detect different misalignment symptoms in EA models,
2) indicate misalignment signs that cannot be detected via architecture assessment and
3) propose suggestions to correct the detected or indicated misalignments.

Based on the recent misalignment studies (especially on BITAM and BISMAM approaches) the research aims to propose a misalignment detection framework through which an organisation is able to detect different misalignment symptoms in their EA models. The goal of the research is to create such methods, techniques, or even software tools which are able to support EA-based misalignment assessment. These methods will help to detect alignment problems between different organisational areas, architecture layers and alignment dimensions.

5. MISALIGNMENT SYMPTOM DETECTION: A THOUGHT EXPERIMENT

While the research questions and goals introduced in the previous section are part of an ongoing research, this particular paper addresses 2 main areas concerning EA-based misalignment analysis:

1) Which misalignment symptoms can be identified by EA models? and
2) In which parts of an EA model can we detect misalignment symptoms?

To approach these areas, a thought experiment was conducted in which misalignment symptoms were located on TOGAF metamodel. The aim of this experiment was threefold:

1) to analyse which misalignment symptoms can be detected via TOGAF metamodel,
2) to determine which architecture domains, entities and entity relationships are involved in misalignment symptoms and
3) to explore how the different metamodel parts (architecture domains, entities and entity relationships) evince misalignment symptoms.

Misalignment symptoms were collected from recent misalignment studies, especially from papers by Carvalho and Sousa (2008a), Chan and Reich (2007), Pereira and Sousa (2005) and Sousa et al. (2005). To ease further references to the symptoms, misalignment symptoms were coded. Table 1 shows the coding of misalignment symptoms.

Table 1. Misalignment symptom coding

CODE	MISALIGNMENT SYMPTOM
S.01.	Unknown process contribution towards organization goals
S.02.	Unknown contribution towards organization goals
S.03.	Unknown responsibilities
S.04.	The ultimate responsible for a business process is not known
S.05.	Lack of required information to support decision making
S.06.	Lack of required information to support day-to-day activities
S.07.	Outdated information are found
S.08.	Information entities do not have a business actor responsible for its coherency and accuracy
S.09.	Time is spent on synchronizing data between applications
S.10.	Non-automatic data management among application systems
S.11.	Frequent periods are found where applications are unavailable
S.12.	Compliance problems with required business level of services due to low application performance
S.13.	Information required for critical processes are not supported by scalable and highly available systems
S.14.	There are processes that do not create, update and/or delete at least one entity
S.15.	There are entity attributes that are not read by at least one process
S.16.	There are business processes that are not supported by at least one application system
S.17.	There are application system functionalities that do not support at least one business process activity
S.18.	Time is spent on reintroducing the same information over different applications
S.19.	An information entity is managed by multiple applications
S.20.	Business process is supported by multiple applications
S.21.	Critical business processes do not depend on scalable and available applications
S.22.	The rate of updates are not correlated with rate of reads
S.23.	Unprotected confidential information are found
S.24.	Confidential/private entities do not depend on restricted access applications
S.25.	Problems with information integrity
S.26.	Unknown reporting lines
S.27.	Repeated logins in different applications
S.28.	Information entities do not derive from known sources

Misalignment symptoms introduced above were placed on TOGAF metamodel, in order to match misalignment symptoms with the different parts of the metamodel. Figure 2 shows the result of the matching-experiment.

Figure 2 can be interpreted as follows: The basis of the figure is the original TOGAF metamodel. Misalignment symptoms are placed on TOGAF metamodel via the use of different symbols. Misalignment symptoms are indicated as black stars connected to different (e.g. solid and dotted) types of lines. Lines connect metamodel entities to each other either in a direct or in an indirect (overarching) way. While solid lines mean direct relationships between two metamodel entities (e.g. the solid line between the entities Goal and Process), dotted lines represent an indirect (overarching) relation between more than two metamodel entities (e.g. the two-piece dotted line between the entities Actor, Data Entity and Information System Service). The black stars as well as the lines connected to embody every misalignment symptom. The location of the misalignment symptom means that the symptom in question can be placed on the relation between the concerned metamodel entities. While some misalignment symptoms

can be connected to the original relation in a direct way (e.g. misalignment symptom S.03. lies directly on the relation between the metamodel entities Actor and Role), other symptoms use figurative relationships between the metamodel entities (e.g. misalignment symptom S.01. connects the entities Goal and Process in a figurative way). The figurative relationships refer to possible ways to connect metamodel entities (e.g. misalignment symptom S.01. can connect the entities Goal and Process via different routes). There is no distinction in symbols between relations within and between different architecture domains. Both direct and indirect lines can connect Business Architecture entities with Data, Application and Technology Architecture entities.
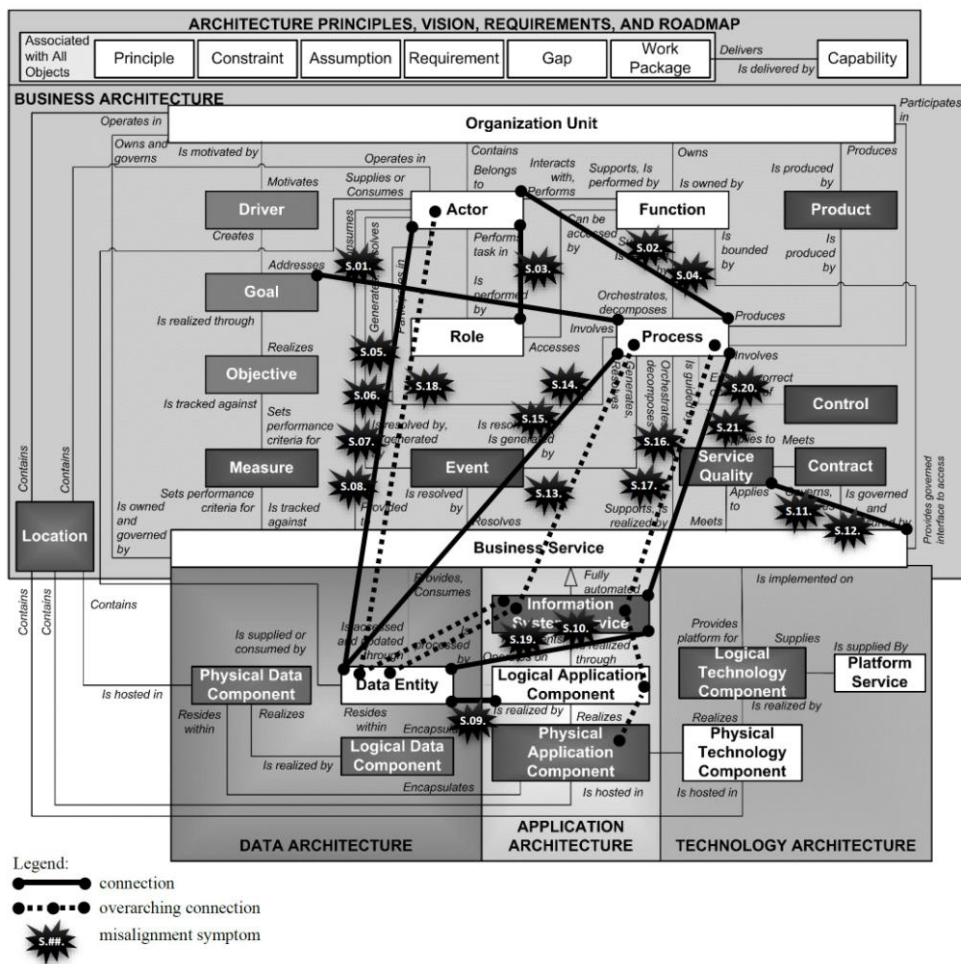

Figure 2. Locating misalignment symptoms on TOGAF metamodel (based on TOG (2009))

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6. DISCUSSION

Locating misalignment symptoms on TOGAF metamodel provided us with several insights regarding the nature of EA-based misalignment symptom analysis. As we can see from Figure 2, misalignment symptoms are located mainly on the *relationships* between the different entities. Misalignment symptoms can be caught by examining the quality, the operation or the functionality of the different relationships. As introduced before, both literal and figurative relationships are used to connect different metamodel entities. While literal relationships refer to the original relation between the metamodel entities in question (relations marked originally on the metamodel), figurative relationships mean newly created relations between metamodel entities in order to identify the location of misalignment symptom in question.

Figure 2 shows that entity relationships can be direct and indirect as well. Direct relationships connect metamodel entities either within a particular architecture domain or between different architecture domains. Indirect relationships connect entities via a third metamodel entity. In the former case the direct entity relationship has to be further analysed. If different architecture domains are involved, the connections between architecture domains have to be examined as well. The latter case means that particular misalignment symptoms overarch different entities (e.g. S.13., S.16., S.17., S.18.). In this situation the whole route between these entities has to be assessed.

There are symptoms, which totally match with existing entity relationships (e.g. S.11. and S.12.). It means that the misalignment symptom in question completely indicates and deals with the improper operation of this particular relationship. On the contrary, there are entities that do not relate directly to each other (e.g. S.09.). These special cases need further examination regarding misalignment symptom interpretation as well as metamodel location.

Several different symptoms match the same entities (e.g. S.02. and S.04., S.10. and S.19., S.11. and S.12). Since they are different symptoms, further examination is needed. On the one hand, a hidden root cause can be identified that collectively gives rise to these misalignment symptoms. But on the other hand, they probably need to be examined separately, because they represent completely different misalignment symptoms regarding the same entity relationship. There are probably different subsequent relationship types between the metamodel entities in question.

Several misalignment symptoms overarched the Business Service entity. The density among Business Service indicates the need for further examination regarding the role of Business Service in misalignment symptom location. Business Service should have multifarious relationships with the surrounding entities in order to cover all types of misalignment symptoms.

Except for one architecture domain (Technology Architecture) every architecture domain was matched with each other. The good coverage indicates that misalignment symptom collection was a decent sample as a first attempt. As introduced before, the overarching symptoms represent the need to align the different architecture domains in order to analyse alignment between the different domains.

Finally, there are some modelling fiascos as well. Firstly, there are symptoms, which cannot be caught in entity relationships (e.g. S.22-S.28.). This fact indicates that not all misalignment symptoms can be detected in an EA metamodel. Secondly, there are entities that are not involved in misalignment symptom location (e.g. Location, Product, Platform Service).

Similarly, there are entity relationships (e.g. the relation between Control and Process, or between Role and Function) as well as architecture domains (e.g. Technology Architecture) that are not involved in misalignment symptom location. These results indicate the lack of completeness in misalignment symptom collection.

The results on Figure 2 clearly indicate that misalignment symptoms can be matched with entities of an EA model. Misalignment symptoms mainly appear in relationships between different EA entities. Some misalignment symptoms can be located in the same architecture domain, while other symptoms overarch different architecture domains. This examination proved that misalignment symptom detection ought to be performed by clashing architecture domains as well as architecture entities within and between architecture domains.

7. CONCLUSION

The paper dealt with the concept of enterprise architecture-based misalignment analysis. It is a post-implementation assessment which evaluates the (dis)harmony between business and IT. After introducing the significance of the topic a literature overview was given on strategic alignment, misalignment and enterprise architecture. In the next section the theoretical context of architecture-based alignment and misalignment analyses were shown. After determining the main building blocks as well as introducing the recent studies on these topics a conceptual context was introduced. It was followed by a thought experiment: misalignment symptoms were collected and located on TOGAF metamodel. After setting up the research model a discussion was given on the results of the symptom location-experiment.

There are different directions for future work. On the one hand discussion part indicates the directions for further examinations: 1) The dense presence of symptoms among Business Service indicates that a deeper examination is needed on the role of Business Service. Further relationships have to be analysed between Business Service and the surrounding entities. 2) Affected entities that are not directly related to each other need further analysis. 3) Hidden root causes have to be revealed as well as unaffected architecture domains have to be involved into the analysis. 4) Finally, the list of misalignment symptoms has to be expanded through primary and secondary research. A broader misalignment symptom list, as well as the re-categorization of symptoms can refine the analysis. On the other hand, further examination methods have to be established in order to approach EA-based misalignment analysis from different directions.

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