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USING A MEDICAL SCIENCES PERSPECTIVE TO HARNESS BUSINESS AND INFORMATION SYSTEMS MISALIGNMENT

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Abstract

Aligning business and information systems has been in the scope of research initiatives from decades. Recently, some efforts emerged with a complementary approach focused on the misalignments study. This paper proposes a misalignment approach based on the medical science perspective for nomenclature, classification and detection of misalignments. We show that a metaphor between disease and misalignment is reasonable and we present how a full set of concepts defined by medical science, such as symptom, sign, syndrome, etiology, diagnosis, therapy and prophylaxis, can be used to address the problem of misalignment between business and information systems. Additionally, each proposed concept is instantiated with a set of examples based on both academic research and professional consultancy.

Keywords: Alignment, Misalignment, Enterprise Architecture, Medical Science.

1 INTRODUCTION

The importance of aligning business and information systems is widely recognized and has been documented since the late 1970s (Luftman *et al.* 1999). Nevertheless, the relevancy and actuality of this topic is unquestionable and remains as important and critical as ever (Pereira *et al*. 2003), due to the competitive environment and pressure put on information systems.

In fact, the business and information systems alignment is perceived as a critical issue and concern for organizations (CSC 2001, SIM 2006), as it directly affects the organization's agility and flexibility (Sousa *et al*. *2004*), as well as, costs and efficiency (Pascal *et al.* 2004). However, organizations suffer on a daily basis several difficulties, the misalignments, which compromise the alignment achievement. Therefore, understanding the misalignments is in the critical path to understand and promote the alignment between business and information systems.

This study tries to tackle the alignment problem, using an approach similar to what medical science adopted to study the human body system, arguing that by observing organizations as systems and using an approach similar to that used in the medical sciences, the misalignment classification and management capabilities are improved. The authors believe that the medical science concepts provide an interesting foundation to set the misalignment semantics and terminology, thus establishing the grounds of a misalignment classification schema and providing techniques to detect, correct and prevent the misalignments between business and information systems. Therefore, such an approach contributes to mitigating the alignment problem.

This paper is structured as follows: section 2 presents the state of the art of alignment and misalignment approaches; section 3 explains the main ideas and justifications to adopt misalignment under medical science; section 4 present the medical science perspective and a set of concepts related with disease; section 5 proposes the nomenclature and classification for misalignment based on a full set of concepts derived from medical science terminology; section 6 presents an initial approach for misalignment management; and finally section 7 concludes this paper with a summary of main conclusions and contributions.

2 STATE OF THE ART OF (MIS)ALIGNMENT APPROACHES

Traditional approaches seek an answer to *how can companies achieve alignment.* These focus on models of alignment and the relationships among the components of the models, either at more strategic level or at more detailed architecture level. Recent studies introduced the subject of misalignments as a relevant topic to understand alignment and another set of questions emerged: *What are the typical symptoms of misalignment? How can symptoms be alleviated? What are the common underlying causes of misalignment? How can underlying causes be addressed?* The following sections present some important research approaches to the alignment and misalignment.

2.1 Misalignment under Strategic Alignment Models

In 1999, Jerry Luftman, Raymond Papp and Tom Brier engaged on a research project with the objective to determine the enablers and inhibitors to align business and IT strategies (Luftam *et al.* 1999), based on the Strategic Alignment Model (SAM), which was proposed in 1993 to support the integration of information technology into business strategy by advocating alignment between and within four domains: Business Strategy, IT Strategy, Organizational Infrastructure and IT infrastructure (Henderson *et al.* 1999).

A five year study (from 1992 to 1997) analysed responses from around one thousand executives representing over 500 US Fortune 1,000 organizations. These executives attended seminars on the

alignment subject at IBM's Advanced Business Institute and were asked to fill out a questionnaire to identify the three top enablers and inhibitors concerning the alignment between business and information technology. The responses were analyzed for similar keywords or phrases to group a set of alignment enabler and inhibitor categories (Luftman *et al.* 1999).

Some years later, Luftman, one of the authors of this study, also proposes a set of symptoms of misalignment that organizations could suffer (Luftman 2003), symptoms that when experienced indicate that an organization is not optimized, not achieving all potential. The following tables list those symptoms of misalignment:

Poor understanding among IT and business	Projects not used, cancelled, late
Competitive decline	Redundancies in systems development
Frequently fired IT managers	Absent systematic competencies
High turnover of IT professionals	Systems integration difficult
Inappropriate resources	Unhappy users/complaints
Frequent IT reorganizations	Inconsistent project success rate
Lack of executive interest	Ill-performing, unstable technology
Lack of vision/strategy	High employee and/or customer turnover
No communication between IT and users	Low employee satisfaction
Ongoing conflicts between business and IT	Highly charged political environment
Unselective outsourcing of IT function	Slow time to market with products/services
Productivity decrease	Frequent escalation of daily operating issues to executive level

Table 1. Symptoms of misalignment.

2.2 Alignment Assessment under Enterprise Architecture

The concept of Enterprise Architecture has been around from almost two decades and during this period of discussion, several frameworks and definitions emerged (Zachman 1987, Sowa *et al*. 1992, Open Group 2003, Schekkerman 2004). Despite the number of definitions, it seems that all of them share a common concern: enterprise architecture is about the structure of the things of relevance in the enterprise, their components, and how these components fit and work together to fulfil a specific purpose. The business-IT alignment is for several years the top answer to the question *For what kind of issues do you plan an EA Program* in the Trends in Enterprise Architecture Survey (IFEAD 2004).

The enterprise architecture model can be structured in multiple views, each comprising a set of specific concerns. These views often focus on four or five viewpoints, such as (Maes *et al*. 2000, Pascal *et al*. 2004, Sousa *et al.* 2005, ISO 1995):

- Organizational architecture deals with the aspects related with the organization that are not related with the specific business nor with the mechanisms used to accomplish the creation of value. It includes concepts such as mission, vision, strategy, goals, and roles.
- Business architecture results from the implementation of business strategies and the definition of processes. It defines the functional requirements of business process support systems. The core concept within the business architecture is the business process.
- Information architecture describes what the organization needs to know to run its processes and operations. It defines a view on the business information that is system and technology independent. It is structured as a collection of informational entities
- Application architecture supports the business requirements and allows efficient management of the organization's entities. It defines the applications needed for data management and business support, regardless of the actual software used to implement systems.
- Technological architecture represents the technologies behind application implementation as well as the infrastructure required for the deployment of the business process support systems.

To measure the alignment between business, information systems and information, a set of rules and heuristics were proposed based on the alignment dimensions between the architectures within the enterprise architecture (Sousa *et al.* 2004). These state that:

- Business and Information architectures are aligned when business people have the information they need to run the business, meaning accurate, on time and with the right level of detail. The rules defined includes: (i) All entities are created only by one process; (ii) All processes create, update and/or delete at least one entity; (iii) All entities are read at least by one process.
- Business and Application architectures are aligned when the time and effort that the business people spent is devoted to reasoning functions. The rules defined includes: (i) Each business process should be supported by at least one application system; (ii) All application systems must be associated with at least one business process.
- Application and Information architectures are aligned if IT people only spent effort and time coding business functions and logic. The rules defined includes: (i) An entity is managed by only one application system; (ii) The data management should be automatic among the application systems.

2.3 Misalignment Management under Enterprise Architecture

The Business IT Alignment Method (BITAM is a method for detecting and correcting misalignments. It does so by addressing the question of *how can misalignments be prevented* (Chen *et al.* 2005). It is supported on a three-level model that defines the Business Model, Business Architecture and IT Architecture (which is a similar structure to the Enterprise Architecture components) where misalignments are the improper mappings between the layers, and realignment initiatives the activities that restore coherence to the mappings (Chen *et al.* 2002).

Within this approach, BITAM suggests that there are three stages of maturity in an organization's ability to deal with misalignment, in increasing level of maturity:

- Detection: the organization is able to characterize business goals and the relationship between these goals and IT requirements. There is an established process for tracing requirements to their realization in business architectures and from there to IT architectures.
- Correction: the organization is able to characterize the nature of the misalignment and the degree to which the three levels are misaligned. Any method for realignment must include techniques to consider corrective strategies and compare the various strategies, choosing the optimal strategies based on their consequences on all three levels.
- Prevention: the organization is able to prevent misalignment by managing the partial alignments dimensions, based on continuous process through: (i) aligning the business model to the business architecture by creating and exercising operational scenarios that satisfy the business requirements; (ii) aligning the business architecture to the IT architecture by exercising the same set of operational scenarios, and; (iii) aligning the business model to the IT architecture by creating and exercising scenarios that satisfy the business drivers.

BITAM builds each stage on the previous, which means that to be able to correct a misalignment it must be able to detect it, and to be able to prevent misalignment it must be able to continuously perform detection and correction activities (Chen *et al.* 2002, Chen *et al.* 2005).

3 MISALIGNMENT AND THE MEDICAL SCIENCES

Providing a definition for alignment and misalignment is not straightforward. However, it seems that, on the one hand, alignment is perceived as a desired goal or state to achieve and, on the other, misalignment is the opposition or the denial of alignment. This is actually a similar approach, known as naturalist or descriptivist, to the one that was proposed in the context of defining health suggesting

that defining disease is a legitimate approach to the dual problem of defining health as the absence of disease (Lewis 2001).

This paper proposes making an analogy with the concepts as defined in the medical sciences, which already deal with the nomenclature around the disease concept. We believe that the medical science concepts provide an interesting foundation to set the misalignment semantics and terminology, thus establishing the grounds of a misalignment classification schema and providing techniques to manage the misalignments between business and information systems.

The reasons to sustain such belief include: (i) has a set of defined and related concepts; (ii) such concepts are focused on the study of a complex system; (iii) they have been used for a long period of time; (iv) has been subjected to strong and deep discussion and evolution over concepts and terminology; (v) can be easily used as metaphor between disease and misalignment; and (vi) has a set of techniques used for detection, correction and prevention.

While the medical science is focused on the study of the human body, this paper is focused on the study of another complex system, the organization. While the human body requires that a number of organ systems must function together, the organization, as a complex system, can be observed by five sub-architectures that must fit and function together.

4 MEDICAL SCIENCES PERSPECTIVE

Medical Sciences is one of the most ancient sciences with centuries of evolution in the study of a very complex system, the human body, and in the definition of common nomenclature and techniques that are used worldwide (Kornai *et al.* 2004). Within the scope of this nomenclature, one key concept is that of disease. The term disease means a deviation, an abnormal condition of an organism that impairs bodily functions, characterized by symptoms and signs (Kornai *et al.* 2004, Jennings 1986, MedicineNet).

The need for controlled medical vocabularies to classify disease into general groups and for detailed nomenclatures has been a hot topic over the centuries through the development of new and enhanced classification systems (Kornai *et al.* 2004). The approaches and focus on the classification systems have been evolving over the years, while the first efforts grouped diseases by their symptoms, modern systems focus on grouping diseases according to anatomy and causes. The Systematized Nomenclature of Medicine and the International Classification of Diseases are the most recognized disease classification system used by medical communities (Kornai *et al*. 2004).

In fact, the classification of diseases is addressed by a specific discipline, nosology. Nosology deals with the systematic classification of diseases and the naming of clinical concepts characterized by a disease. According to this discipline, diseases can be classified by symptom, etiology, pathogenesis, as well as by organ systems (Paterson *et al.* 2006, Pitchford 2002, Martin 1992). These concepts will be defined next.

4.1 Symptom, sign and syndrome

A symptom is a sensation or change in health function experienced by a patient, such as headache, fatigue, tiredness, pain, or nausea. Symptom is therefore a subjective report or subjective evidence of disease, as opposed to a sign, which is objective evidence of the presence of disease or disorder. So, signs are observable whereas symptoms are not (Crawford 2007). For example, a patient may describe visible sores or invisible pain, which means that the visible complaints are signs (that can be measured) while the invisible ones are symptoms (that cannot be seen or measured). A syndrome refers to the association of related signs and symptoms. As such, the presence of one is an alert to the potential incidence of another.

4.2 Etiology

Pathologists study the causes of diseases within a discipline called etiology (Crawford 2007). Etiology is defined as the study of disease causes or the study of agents that cause disease, e.g. the etiology for some lip cancers is overexposure to sunlight, which means that sunlight is an etiologic agent of these cancers (Crawford 2007). However, the etiology is not always known and sometimes the answers to the cause and the causing agent might not be straightforward. Green proposed the "three C's of etiology", Cause, Contribute and Correlate, and explains that each term refers to factors that may have something to do with the appearance of the condition (Green 1996).

4.3 Organ system

In the medical context, an organ is a relatively independent part of the body that carries out one or more special functions, e.g. heart. A group of related organs is an organ system, e.g. respiratory system, circulatory system. The organs within a system may relate in a number of ways, but functional relationships are most the commonly used (MedicineNet).

4.4 Diagnosis

In medicine, diagnosis or diagnostics is the process of identifying a medical condition or disease by its signs, symptoms, and from the results of various diagnostic procedures. It is an act of discrimination and characterization. The diagnosis process begins with a description of symptoms, and then the doctor obtains further information from the patient himself about their symptoms, his previous state of health, living conditions, and other environmental and social conditions. Additionally, doctor conducts a physical examination to gather disease signs (Crawford 2007, Jennings 1986, MedicineNet).

4.5 Therapy

Therapy is the attempted remediation of a health problem. In medical field, the term *treatment* is used as synonymous for therapy. A treatment should not be undertaken until the nature of a patient's illness is known and it should be rational, based on scientific facts and planned carefully (Crawford 2007). A treatment can be complex as it may require several procedures to be undertaken and different specialists involved (Crawford 2007, MedicineNet).

4.6 Prophylaxis

Prophylaxis is any procedure whose purpose is to prevent, rather than treat or cure, disease. These may include technical procedures such as vaccination and antibiotics, but also simpler initiatives such as daily physical exercise. There are two groups of prophylactic measures, the *primary prophylaxis* whose objective is to prevent the development of a disease, and the *secondary prophylaxis* used when to prevent the further development of an existing disease (MedicineNet).

5 MISALIGNMENT NOMENCLATURE AND CLASSIFICATION

This section presents a proposal for misalignment nomenclature and classification scheme in the context of business and information systems. The proposal is grounded on the concepts previously presented.

5.1 Misalignment nomenclature

The following table presents the misalignment nomenclature.

Concept	Definition
Misalignment	An abnormal condition that impairs organization components (architectures), characterized by typical symptoms and signs experienced by the organizational actors.
Organ System	The organization components, in other words, the architectures involved in the misalignment.
Symptom	Subjective evidence of misalignment that is experienced by organizational actors.
Sign	Objective evidence of misalignment experienced by the organization and observable both to internal and external organizational actors.
Syndrome	Set of symptoms and signs that typically occur together.
Etiology	Study of the underlying factors that cause misalignment.
Diagnosis	Process of identifying a misalignment by its signs, symptoms, and from the results of procedures, such as questionnaire and tests.
Therapy	Actions whose purpose is to attempt correct the misalignments identified by the symptoms/signs and confirmed through the diagnosis.
Prophylaxis	Procedures, principles and common sense rules whose purpose is to prevent, rather than treat, the misalignment.

Table 2. Misalignment nomenclature, concepts and semantic.

The following diagram depicts concepts and their relationships. The misalignment concept is the core concept.

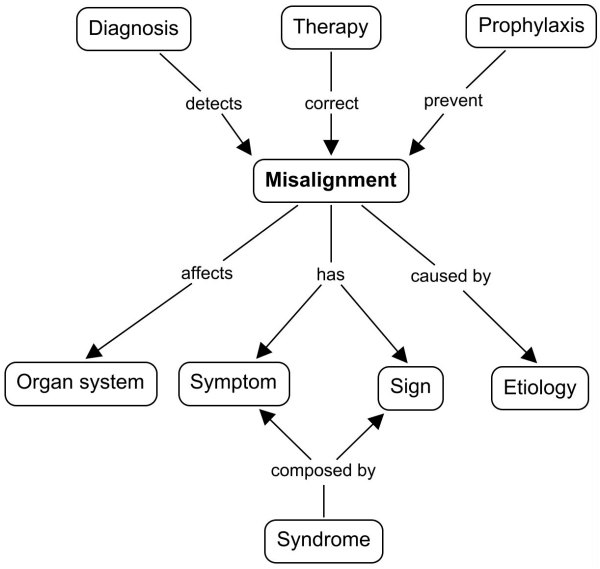

Figure 3. Relationships between the misalignment concepts.

5.2 Misalignment classification

Following the medical science perspective, more specifically the nosology branch that studies the classification of diseases, we propose three axes for classifying misalignments: organ system, symptom/sign and etiology.

The organ system axis is a structural classification dimension and, in this specific context, intends to classify the misalignments under the enterprise architecture components, in other words, misalignments in the organ system axe are classified by selecting the pair of sub-architectures involved in the misalignment:

Name	Organ system
OA	Organizational Architecture
BA	Business Architecture
IA	Information Architecture
AA	Application Architecture
TA	Technology Architecture

Table 4. Misalignment classification by organ system.

The symptom/sign is a behavioural classification. It is one of the core disease classification dimensions and is particularly relevant when there is limited knowledge about the target system. The following table presents a basic collection of symptoms and signs that can be found in organizations

Ref.	Symptom and Sign
S01	I am not aware of the organization's strategy and goals.
S02	I am not aware of the process contribution towards the organization goals.
S03	I am not aware of my contribution towards the organization goals.
S04	I don't know what my responsibilities are.
S05	I don't know what the expectations about my work are.
S06	I don't know to whom I should report.
S07	I don't know with whom I should speak to obtain knowledge about business processes.
S08	I don't know who the ultimate responsible for a business process is.
S09	I need to develop and use end user computing to overcome application functionalities.
S10	I don't know with whom I should speak to obtain the semantics informational entities.
S11	I don't know who the ultimate responsible for a business informational entity is.
S12	I do not understand how to use the same concept in different applications.
S13	I don't have the required information to support decision making.
S14	I don't have the required information to support day-to-day activities.
S15	I have found outdated information.
S16	I spend time reintroducing the same information over different applications.
S17	I have found problems with the information quality.
S18	I have found problems with the information integrity.
S19	I need to repeat the login in different applications.
S20	I have found unprotected confidential information.
S21	I need to use different applications during the day to perform my business activities.
S22	I find the human-application interfaces difficult to use.
S23	I can't generate the required business reports.
S24	I have frequent periods where applications are unavailable.
S25	I can't comply with the required business level of service due to low application performance.
S26	I spend lot of time configuring and updating users' profiles in several applications.
S27	I spend resources in licensing modules and functionalities that are not used.
S28	I spend time synchronizing data between applications.

Table 5. Misalignment classification by symptom/sign.

Etiology was adopted as a disease classification axis after several years of usage and research since it requires deeper knowledge about the system and, even in current days, the factors causing a disease are not always clear. Despite these issues, the next table proposes a set of preliminary etiological factor in the context of business and information systems misalignments:

Ref.	Description
E01	Undefined organizational strategy and organizational goals.
E02	Undefined business process goals.
E03	Business process goals not related to organizational goals.

Ref.	Description
E04	Undefined business roles.
E05	Undefined responsibilities.
E06	Undefined hierarchy or lines of reporting.
E07	Multiple hierarchy or lines of reporting.
E08	Insufficient training.
E09	Lack of skills and competencies.
E10	Lack of data ownership.
E11	Lack of data quality controls.
E12	Undefined business information requirements.
E13	Multiple applications managing the same information.
E14	Unavailable requirements at application level.
E15	Wrong requirements implemented at application level
E16	Users managed differently in different applications.
E17	Lack of applications interfaces.
E18	Undefined security requirements over the information entities
E19	Undefined capacity and performance requirements.
E20	Under capacity infrastructure.
E21	Technological heterogeneity.

Table 6. Misalignment classification by etiology.

Based on the classification scheme described in this section, the following diagram depicts a set of misalignment examples fully characterised in the three axes: organ system, symptoms/signs and etiology. These examples cover the several misalignment dimensions (organ system axe) based on the enterprise architecture components (or sub-architectures): Organizational and Business, Business and Information, Business and Application, Information and Application, Information and Technology, Application and Technology.

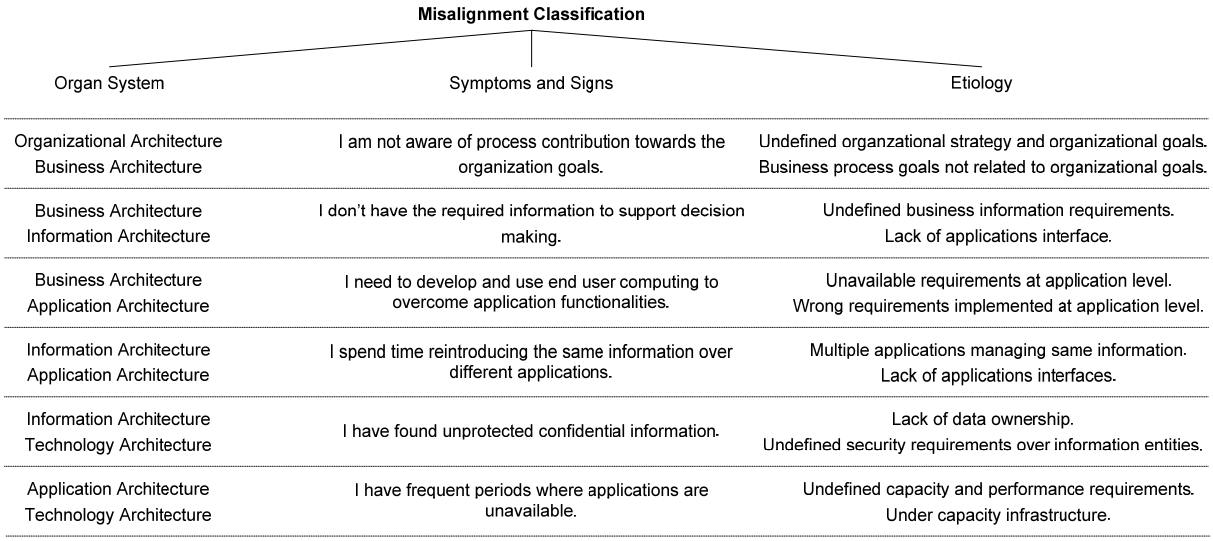

Figure 7. Misalignment classification scheme instantiation.

The analysis of these examples allows us to make some important remarks:

- the same etiology might be the cause for different misalignments, with different symptoms and, even for different (mis)alignment dimensions (see *Lack of applications interfaces*);
- despite the architectures involved, the cause might be either at more high level or more detailed technological level (see etiology for *I found sensitive information unprotected*); and
- an *undefined factor* is frequently the cause for misalignments, which gives a clue for a certain type of relevant prevention techniques.

6 MISALIGNMENT MANAGEMENT

After establishing the misalignment nomenclature and classification, the next step would be the ability to manage those misalignments. Therefore, according to the BITAM study presented in section 2.3, an organization to manage misalignment should be able do detect, correct and prevent it. This section proposes an initial approach to misalignment management techniques.

6.1 Misalignment detection through diagnosis

Misalignment classification, as proposed in the previous section, is a relevant contribution for misalignment detection, since it allows the identification of misalignments by comparison with the symptoms and signs provided by the classification scheme.

Additionally, as much as the physician use the diagnosis to detect diseases through the symptoms reported by the patient and the analysis of signs, this technique might be also a powerful tool to detect misalignments through two different techniques; (i) questionnaires focused on symptoms and possible etiology, and (ii) audits focused on signs validation and interpretation. Considering that the organization is a complex system with several actors involved, the questions might be oriented to different organizational roles such as CEO, IT Manager, Business Director, Business Operational Staff, and IT Staff.

6.2 Misalignment correction through therapy

Therapy is a fundamental technique, as it alleviates the symptoms and corrects the misalignment factors addressing their etiology. The following table presents a set of therapies that might be considered for some of the described symptoms:

Ref.	**Therapy**
T01	Define and communicate strategy and goals.
T02	Relate business process goals to organizational goals.
T03	Define and assign business roles and related responsibilities.
T04	Define and assign business process ownership
T05	Define and assign data ownership.
T06	Perform business process improvement
T07	Implement a workflow system.
T08	Implement a management information system.
T09	Implement a single-sign-on solution.
T10	Implement an identity and access management solution.
T11	Implement data integrity, data consistency and data quality controls.
T12	Perform database consolidation and migrate data.
T13	Implement a load balancing solution.
T14	Upgrade application and database server's capacity.
T15	Implement a failover solution.
T16	Define levels of service and performance indicators.
T17	Reprioritize the project portfolio.
T18	Implement encryption mechanisms to secure confidential information
T19	Implement an enterprise information integration layer
T20	Provide training on specific applications functionality

Table 8. Misalignment therapy examples.

6.3 Misalignment prevention through prophylaxis

Prevention is the ultimate goal for any non-desired situation. The ability of preventing a situation is directly proportional to the ability of detecting and correcting it in a timely and planned manner. In fact, BITAM describes prevention as the third and last maturity stage in the organization's ability to deal with misalignment.

The following table presents an initial list of guidelines that aim preventing the occurrence of misalignments and, therefore promoting the alignment between business and information systems.

Ref.	Prophylaxis
P01	Organization shall define and publish its mission, strategy and goals
P02	Information entities shall have an owner.
P03	Business processes shall have an owner.
P04	Each entity shall be managed by a single application.
P05	Application shall provide services to access and update the entities they manage.
P06	Technology standards shall be defined and followed by all projects.
P07	Data quality controls shall be defined and implemented.
P08	Information entities shall be classified in terms of security requirements.
P09	Security mechanisms shall be implemented according to information security requirements.
P10	Levels of service shall be defined and monitored.

Table 9. Misalignment prophylaxis examples.

7 CONCLUSIONS

This paper deals with the duality of alignment and misalignment. Alignment is an intentional state organizations aim at. Misalignments are the factors that organizations as a whole and its organizational actor as enablers face in their routine business operations. Based on this argument, we have proposed an approach for handling misalignment through the definition of a set of concepts derived from the medical sciences which include symptom, sign, syndrome, etiology, organ system, diagnosis, therapy and prophylaxis. This approach establish the connection between misalignments and the enterprise architecture alignment dimension while complying with the three BITAM misalignment management maturity stages (detection, correction, and prevention).

We believe that this approach contributes to information systems research as it:

- allows for a standard misalignment classification that can be used by all organizational actors within the organization, thus avoiding nomenclature clashes (see Table 5 and Figure 7);
- supports the identification and understanding of misalignments through symptom and sign analysis (see Table 5);
- helps identifying the causes for misalignment (see Table 6);
- facilitates the identification of possible realignment strategies (see Table 8);
- contributes to misalignment prevention through some rules and guidelines (see Table 9).

Additionally, this could be used as basis for benchmarking organizational alignment.

This research is in progress, but with the ongoing work the authors expects to complete the libraries presented in this paper (Tables 5, 6, 8 and 9) and validate this proposal in real-life organizations. As future work and regarding misalignment prevention, we are establishing the relation between misalignment prophylaxis and international reference models, such as Control Objectives for Information and related Technology (COBIT) or IT Infrastructure Library (ITIL).

It is clear that this proposal is not a complete solution, but it is a step forward in understanding how misalignment occur and can be mitigated through a structured approach that assists misalignment classification, detection, correction and prevention.

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