Alignment in Enterprise Architecture: A Comparative Analysis of Four Architectural Approaches

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Abstract: As modern organizations struggle with the complexity and dynamicity of their business environments, they increasingly turn to Enterprise Architecture as a means to organize their capabilities. However, adopting Enterprise Architecture is hardly a straightforward matter as the practical guidance available is plagued by disparity in nomenclature as well as content. The purpose of this paper is to take a first step in remedying the dearth of rational appraisal of approaches to Enterprise Architecture by closer examining a handful of guides and frameworks. Our ultimate aim in this paper is to provide knowledge about the various dimensions of enterprise architectures that demand alignment between its constitutionals parts. Therefore the efforts of our study were focused on elucidating the following issue: How are the various forms and aspects of architectural alignment treated by the investigated approaches to Enterprise Architecture? Due to the lack of commonalities between the assorted approaches, an independent metric is required. We therefore utilize the concept of alignment and analyze how the various forms and aspects of architectural alignment are treated by formalized approaches to Enterprise Architecture. This methodology was applied to the Zachman Framework, The Open Group Architecture Framework (TOGAF), the Extended Enterprise Architecture Framework (E2AF) and the Generalised Enterprise Reference Architecture and Methodology (GERAM). Our investigation clearly demonstrates that: 1) Approaches to Enterprise Architecture provide guidance for structural and functional alignment, but not for infological or socio-cultural alignment. 2) The area of contextual alignment is described in a simplistic manner. 3) None of the investigated approaches discuss the mutual interdependence that exists between the various forms of alignment. Our work serves to further the understanding of multi-dimensionality of Enterprise Architecture in general and architectural alignment in particular.

Keywords: enterprise architecture, architectural alignment, Zachman framework, TOGAF, GERAM, E2AF

1. Introduction

The organizations of today are facing a world fraught with uncertainty. Increasingly capricious and demanding consumers necessitate careful consideration in to which products or services to offer at any given time. Meanwhile, competition is no longer limited to a geographical region as corporations are able to vie for business on a global market. The traditional modus operandi based on command and control is no longer able to satisfy the needs of the modern enterprise in this brave new world of opportunism and innovation.

It is clear that the modern organization needs a new blueprint in order to stay ahead of the game – or at the very least stay in the game. To this end, much attention has been paid to Enterprise Architecture over the past couple of decades – not just as a means to improve competitiveness, but also to reduce complexity, increase changeability, provide a basis for evaluation et cetera.

A literary review by Schöenherr (2009) clearly shows that the level of interest in Enterprise Architecture is indeed increasing. Although the term architecture was limited to information systems when originally adopted by John Zachman (1987), the concept has since then been expanded to encompass the entire enterprise and interpreted by academia as well as the private and public sectors. The different views on how to approach Enterprise Architecture are often documented and compiled into “guides” or “frameworks” which are intended to instruct practitioners in how to apply this concept to their organization. However, the numerous approaches all present disparate views on what exactly Enterprise Architecture entails and how it is best administered (Rood, 1994; Whitman, Ramachandran & Ketkar, 2001; Sessions, 2007; Schöenherr, 2009). This essentially leaves the practitioner in the dark as the approaches offer virtually no common ground, no common language and no common orientation on which to base a comparison.

The purpose of this paper is to take a first step in remedying the dearth of rational appraisal of approaches to Enterprise Architecture by closer examining a handful of guides and frameworks. Due to the lack of commonalities, we intend to utilize the concept of alignment as a metric. Alignment is

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said to describe the condition of IS/IT being in harmony with business needs (Henderson & Venkatraman, 1992). This would not only ensure full utilization of resources, but also drive synergic effects (Luftman, 1996; Papp, 2001) – a situation very much in conformity with the aims of Enterprise Architecture. Succinctly put, we wish to analyze following question: How are the various forms and aspects of architectural alignment treated by the investigated approaches to Enterprise Architecture? In pursuing this line of inquiry, we wish to expand the current stream of research into Enterprise Architecture. Furthermore, we would like to emphasize architectural alignment in particular.

2. Related research

While it is not within the scope of this paper to provide a comprehensive literary review, we have identified certain streams of research into alignment that carry relevance to our own research. Furthermore, we have reviewed alternative avenues to evaluate and contrast architectural approaches in order to illustrate the lack of academic convergence.

2.1 Alignment

With the diffusion and decentralisation of processing power (via the personal computer) in the 1980s, many companies invested heavily in IT without deriving expected benefits. This gave rise to what was often referred to as the productivity paradox (Brynjolfsson, 1993). Henderson and Venkatraman (1992) claimed that part of the reason for this state of affairs was the lack of alignment between IT and business which prompted them to present their Strategic Alignment Model (SAM). SAM was not the first conceptualization of alignment, but it has certainly dominated subsequent research efforts into the field. SAM stresses the importance of integration between business and IT, as well as the need to adapt the internal structure of the enterprise to marketing and strategy. In order to achieve this, the business strategy must be accompanied by an IT strategy. There are a number of subtle differences in how these may influence one another, but Henderson and Venkatraman stress the constancy of business as the driver and IT as the enabler.

While research into alignment to a large degree has followed in the path set by SAM (often referred to as Business-IT alignment), there are several authors that view this model as limited. Ciborra (1997) offers one of the more astringent criticism as he dismisses SAM outright, claiming that lines and shapes on a diagram hold no real bearing on the realities of business. Maes, Rijsenbrij, Truijens & Goedvolk (2000) claim that SAM is overly simplified and ignores the middle ground that ties strategy with operations and business with IT. They therefore expand upon SAM by adding the interim layer *structure* between strategy and operations as a means to emphasize the importance of architecture in modern enterprises. Furthermore, business and IT represent different professions – each with their own sense of culture and expertise. One must therefore take care to facilitate the exchange of *information* between the two areas. The importance of fostering inter-departmental communication has also been highlighted by Luftman (2000) as well as Walentowitz, Beimborn, Schroiff and Weitzel (2011).

Baker and Jones (2008) take an interest in sustaining strategic alignment as opposed to merely viewing it as either a process or an end-state. They pursue this line of inquiry through expanding upon SAM by recognizing five different types of alignment needed to fully acknowledge the complexity faced by the modern enterprise. They refer to these types of alignment as business alignment, IT alignment, contextual alignment, structural alignment and strategic alignment. By widening the strategic discourse among stakeholders, the authors theorize that a wider understanding of the enterprise will prove beneficial to sustaining strategic alignment.

Chan and Reich (2007) distinguish between several dimensions of alignment based on an extensive literature review. These are enumerated as the strategic and intellectual dimension, structural dimension, social dimension and cultural dimension. The authors note that research into alignment is heavily biased towards strategy and structure as these dimensions of alignment form a more direct causal link to performance. While social and cultural issues should not be overlooked, they are typically perceived as contextual issues rather than integral components of alignment.

Based on our review, we may draw the following assumptions regarding alignment. First, the concept has been heavily influenced by SAM over the past decade. Therefore, research into alignment has been focused on realising formal business strategies. Second, the scope of alignment is often limited to the duality between IT and business. Even though some authors have highlighted the need for a

more multi-dimensional perspective, the focus is still on extrinsic values such as performance whilst omitting intrinsic values like comprehension and acceptance.

2.2 Approaches to Enterprise Architecture

The past decade has seen several attempts to juxtapose architectural approaches. Given the diverse nature of available frameworks and methodologies, such an undertaking carries with it an inherent difficulty in that one runs the risk of "mixing apples and oranges." Consequently, the roads travelled are almost as winding and diverse as the approaches they seek to analyze. Please note that we utilize the term architectural approach as a generic term for the assorted frameworks and methodologies that strive to guide the practice of Enterprise Architecture.

A relatively direct analytical technique entails simply mapping one or more approaches(s) onto one another. This avenue has been pursued by Urbaczewski and Mrdalj (2006) as well as Noran (2003). Urbaczewski and Mrdalj analyze several frameworks employed by practitioners by mapping them against one another based on views, abstractions and life cycle. They arrive at the conclusion that the Zachman framework possesses the most comprehensive guidance due to its explicit description on stakeholder viewpoints. Noran follows a narrower – yet profoundly deeper – procedure when he maps the Zachman framework onto GERAM. His analysis is based on enterprise modelling and to what extent the Zachman framework corresponds to the extensive provisions offered by GERAM in that department. His conclusions are limited to ascertaining that although explicit comparisons are difficult, one may make implicit connections based on content rather than nomenclature.

Other juxtapositions have been undertaken based on less direct forms of comparison. Leist and Zellner (2006) also take a specific interest in enterprise modelling – albeit not from the point of any specific architectural approach. Their evaluation is based on the premise that the chief purpose of architecture (the authors do not specify type of architecture) is to reduce perceived complexity and increase comprehensibility. Following this line of reasoning, their analysis is based on the extent to which architectural approaches provide guidance regarding meta-models, procedure models, modelling techniques, participating roles and specification documents. Based on their evaluation, Leist and Zellner conclude that none of the frameworks included in their analysis meet all the desiderata for an architectural approach.

Franke, Höök, König, Lagerström, Närman, Ullberg, Gustafsson and Ekstedt (2009) utilize a meta-framework in order to provide a common platform for evaluating architectural approaches. This framework – designated Enterprise Architecture Framework Framework (EAF^2) – is based on a selection of several existing architectural approaches. These are put through an iterative cycle of analysis where entities are identified, extracted, defined in general terms and consolidated into the final meta-framework. The authors assert that this meta-framework is a viable means to not only compare architectural approaches, but also combine them as EAF^2 stipulates the provisions and omissions of each approach.

Several authors have adopted external metrics that are inherently independent from the terminology and methodology of any single approach as a means for juxtaposition. Tang, Han and Chen (2004) evaluate several approaches based on what they specify in terms of goals, inputs and outcomes. Based on these metrics, they conclude that the architectural approaches covered in their analysis can be delineated into those that are suitable for Enterprise Architecture, and those that are more suited to Software Architecture. Abdallah and Galal-Edeen (2006) adopt a somewhat similar research methodology, but in addition to goals, inputs and outcomes they add a fourth metric which they aptly designate "other". The authors refrain from drawing any definitive conclusions beyond stressing the need for adaption to individual needs regardless of which architectural approach one adopts. Odongo, Kang and Ko (2010) take this basic approach even further by establishing eleven separate metrics on which to base an evaluation as well as an algorithm to perform the analysis of architectural approaches. By weighing and subsequently ascribing a numeric value to each metric, the prospective user is then able to aggregate the numbers for each approach analyzed and thus see which one is better suited to one's needs.

Sessions (2007) provides a practitioner perspective on a few of the more widely adopted architectural approaches. Based on his comprehensive – albeit pragmatic – analysis, the author surmises that none of the approaches are sufficiently comprehensive by themselves. They all feature strengths and weaknesses that may or may not be relevant to the practitioner. Based on this conclusion, Sessions

urges prospective users to develop their own architectural approach in order to meet the specific circumstances facing each enterprise.

Given the diverse avenues pursued and conclusions reached through the various analyses outlined above, it is obvious that there is no clear-cut consensus to be found. We may however highlight two salient points. First, the majority of evaluations adopt a relatively mechanistic perspective and perceive enterprise Architecture as a means to design and govern artefacts rather than consider how they relate to the enterprise as such. Second, most evaluations bring up the need for adapting architectural approaches (as well as the analysis thereof) to the idiosyncrasies of the individual enterprise. What these idiosyncrasies entail is however usually addressed in a perfunctory manner or not at all.

3. Research model

Given the inherent difficulties in the comparison this paper seeks to carry out, we feel that previous efforts to evaluate architectural approaches fail to the requirements of the enterprise as a whole. The same can be said for the bulk of the stream of SAM-based research into alignment. Instead, the most meaningful approach would in our opinion be to analyze architectural approaches to actual organizational needs and practices. Furthermore, we will present an alternate view on alignment that will encompass a wider view of the enterprise than just the business strategies.

As a baseline for our evaluation, this comparison will utilize the MIT1990s framework for organizational research (Morton, 1991). Furthermore, we will expand upon this model using research by Dahlbom (1996), Magoulas and Pessi (1998), and Spanos, Prastacos and Poulymenakou (2002). Our research model defines the realized architecture of an enterprise in five basic areas of interests. They are: (1) the area of goals, objectives and values, (2) the area of enterprise activities and their management, (3) the area of decisional rights and responsibilities, (4) the area of primary stakeholders and lastly, (5) the area of information systems and the corresponding ICT. These resources together define the information infrastructure of the enterprise.

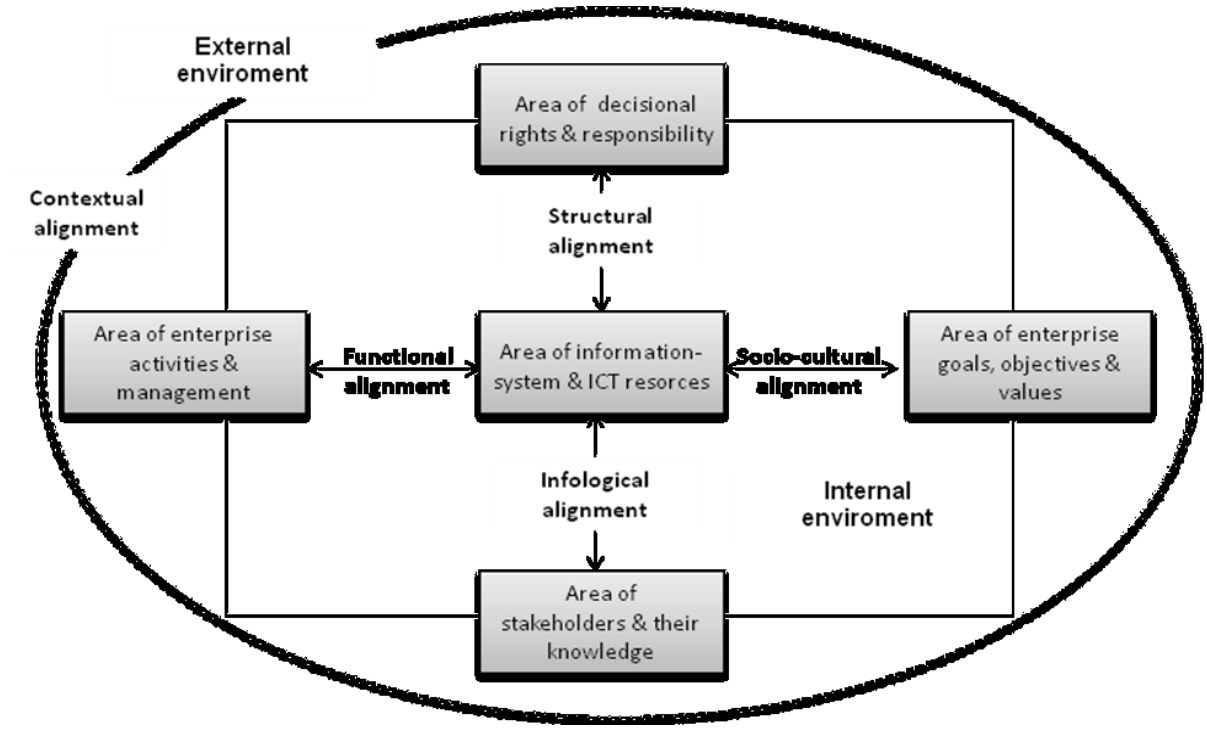

Figure 1: Model for research

3.1 The area of enterprise goals, objectives and values

Whereas goals and objectives usually take the shape of a hierarchy, other aspects like values, norms, culture et cetera define the conditions under which this hierarchy is formed. Thus, within the context of informatics, the structure of goals may be either asymmetric hierarchies or symmetric networks since

they are established through negotiations (Hedberg, 1980; Langefors 1975, 1986). Furthermore, the social organization should not limit its concerns to profitability, but must also promote a favourable environment for the individuals that work towards collective goals (Ackoff, 1967; Hedberg, 1980). Failure to do so may lead to dispassionate employees which would certainly impede progress in the long term. The individual must therefore feel that his or her own goals are accommodated by the organization.

3.2 The area of enterprise activities and management

A process may be defined in terms of a group of activities organised in such way as to produce a certain product or service. Thus, any form of process transforms a certain object from a certain state to another desired or expected state. In the same sense the knowledge to do such a thing is called technology (Mackenzie, 1984). Hence, the concepts of process and technology are integrated to each other and the interdependence of the involved activities becomes the subject matter of coordination. In the same sense, several activities of processes may share the same kind of resources. This fact creates another requirement for coordination. The transformation may employ different kinds of tools and may be either structured or unstructured. In any case, every form of process states the requisite for both skills and knowledge. Processes may be described as being of a coordinative, evaluative, innovative or developmental character; which in turn affects their need for functionality, flexibility, efficiency, quality, et cetera.

3.3 The area of decisional rights and responsibilities

Usually, social structure is the result of design rather than cultivation. This is either achieved through the decomposition of enterprise ends into a comprehensible structure of elementary task-based units (Simon, 1962, 1969), or the integration of existing task-based units into a comprehensible structure of authority and responsibilities (Churchman, 1971).

The shape of the social structure depends on the situational characteristics of the environment such as legal and ethical responsibility. Therefore, at any moment in time the structure is expected to meet expectations from society while simultaneously satisfy systemic desirability (Checkland, 1981, 1985; Hedberg, 1980; Magoulas & Pessi, 1998). The concept of social structure covers such aspects as the division of work, structures of power, patterns of communication, allocation of authorities and responsibilities, et cetera.

3.4 The area of stakeholders and their knowledge

The stakeholders are the backbone of all organizations. They may be executives, employees, support staff, customers, suppliers, shareholders, local communities or other groups concerned with the enterprise. The stakeholders are the source of knowledge and experience as well as conflict due to their individuality. The individuality of the stakeholder may clash with the participatory nature of systems. Lastly, the most significant aspect of stakeholders may be given in terms of collaboration, communication and commitment (Ackoff, 1967; Checkland, 1981).

3.5 The area of information systems and ICT resources

From the perspective of alignment, information systems and Information and Communication Technology (ICT) forms a natural centre as this area permeates all aspects of the enterprise. While information systems today tend to be computerized, the essential feature is its emphasis on proper procedure (Putnam, 1966). If collectively viewed, the information systems architecture (not to be confused with Enterprise Architecture) defines those systems that provide the enterprise with information and services. These may be transactional, relational, informative, decisional or innovative in nature (Magoulas & Pessi, 1998). This area covers activities such as project planning, project management, modelling, architectural design and simulation.

4. Aligning the constitutional parts of an Enterprise Architecture

The concept of alignment has been expressed in several ways. As a result, alignment is treated synonymously to the following ideas: (1) fit, (2) link, (3) harmony, (4) balance, (5) fusion, (6) integration, (7) relationship, (8) compatibility and (9) conformity (see for instance Avison, Jones, Powell & Wilson, 2004). However, within the context of informatics, the concept of alignment is given in terms of harmonious relationships between two areas of interest in general and the enterprise as a

whole in particular. In the latter case, the alignment is called contextual and we discuss it briefly later on.

4.1 A sense of socio-cultural alignment

Socio-cultural alignment is reflected in the harmonious nature of relationships between the areas of information systems and the areas of goals, objectives and values. The crucial assumption here is that information and knowledge is the glue that holds business and/or social communities together (Magoulas & Pessi, 1998). Such alignment can be defined as:

Stakeholders Expectation (Time) = Delivered contributions (Time)

The notion is to determine how shared values, mutual goal-commitments and collaborative behaviour are addressed within the enterprise. The soundness of the socio-cultural alignment may be expressed and assessed in terms of cultural feasibility, i.e. shared values and priorities, social feasibility, co-determination, shared visions, shared goals as well as continuity of mutual commitments. Furthermore, it is of profound interest to determine the manner in which the organization settles upon its common goals.

4.2 A sense of functional alignment

Functional alignment is a state of harmonious relationships between the area of information systems and the area of activities and processes. The fundamental assumption here is that information and knowledge are critical and in many cases strategic resources (Magoulas and Pessi, 1998). Such an alignment can be defined in the following manner:

Required information capabilities (Time) = Available information capabilities (Time)

The equation represents the essentials of Galbraith's (1973, 1977) contingency theory, and essentially expresses the necessity for the enterprise to satisfy its need for information in a timely manner.

Any form of informational activity performed by the systems may be seen as a non-separated part of an enterprise activity. In several approaches, enterprise processes are treated as the "creator" as well as "user" of information. In other words, while the quality of information systems depends on the quality of enterprise processes, the quality of enterprise processes depends on the quality of information systems.

The dimension of functional alignment ultimately boils down to issues of coordinated development, i.e. how the development of the information systems has been synchronized with the development of enterprise processes. The soundness of functional alignment should therefore be based on process effectiveness; support, flexibility, inter-dependency, quality improvement, degree of required co-ordination, degree of required synchronisation and economy.

4.3 A sense of structural alignment

Structural alignment defines and integrates the area of information systems with the area of power, i.e. sources of authorities and responsibilities. The crucial assumption here is that information and knowledge are significant sources of power (Magoulas & Pessi, 1998). Therefore the concept of "Information Politics" used by Davenport (1997) reflects the very same issues as structural alignment. In any case, structural alignment concerns the harmonious relationships between the structure of power and the information systems. Such alignment can be defined as:

Established structure = Accepted structure

A balanced equation means that the established structure is accepted by the stakeholders of the enterprise. A misaligned structure can manifest itself in terms of conflicts, alienation, absenteeism, et cetera (Hedberg, 1980; Davenport, 1997). However, this form of alignment is impacted by the requisites of comprehensibility. A lack of comprehensibility leads to inability to manage both processes and information. Therefore, rather than technological sophistication, the requisite of simplicity (and efficiency) of processes should dominate the structuring of the enterprise.

Furthermore, the structure of information-flows should map the boundaries of responsibilities. Unclear, complex and incomprehensible information structures lead to loss of manageability. There is a broad consensus regarding the various models that promote or inhibit the structural alignment. Among the more commonly referenced are: Business monarchy, IT-utopia, federalism, feudalism, dualism and anarchism (Davenport, 1997; Ross, Weill & Robertson, 2006; Boddy, 2009).

4.4 A sense of infological alignment

Infological alignment reflects the harmonious relationships between the area of information systems and the area of the individual stakeholders. The basic assumption in this case is that information is knowledge communicated through our language (Langefors, 1975, 1986).

Infological alignment expresses the requisites for locality, comprehensibility and meaningfulness. Cognitive distance, working styles, decision styles, communicative styles and perspectives can be seen as significant factors for the actors' willingness to use and accept the information systems. Such alignment can be expressed as:

Required information = Provided information + extra information

However, information is knowledge communicated through the use of data. Accordingly, infology comprises different approaches to further sound communication. Yet communicating information outside its natural (local) boundaries can be problematic (Langefors, 1975, 1986; Hugoson, 1989, 1990; Magoulas & Pessi, 1998). In many cases the communication of information requires additional information. Furthermore, the value of information and information systems depend entirely on the effects that these tools have on the individual and his social surrounding.

Not all kinds of information can be universally communicated. The globalisation of information should receive specific treatment and should be established through negotiation (Hugoson, 1989). Information systems should support the learning processes that take place within the functions of the organisation. Hence, standard operating procedures should be avoided as much as possible – especially in dynamic environments. In a situation where information gathering and storage becomes institutionalized, there is a clear risk of encountering what may be referred to as the information paradox. This paradox is characterized by a situation where there is a vast amount of data in the information systems, yet none of it is relevant or useful. Concomitantly, the information that actually is needed is not accessible as it is merely present in the minds of employees or in unsanctioned, "feral" information systems (Houghton & Kerr, 2006).

Lastly, the goodness of infological integration can be measured in terms of infological completeness; that is to say a clear and unequivocal understanding of means and ends. A state of infological alignment can thus be demonstrated when information conforms to the tacit knowledge of actors in terms of validity, functionality and relevance (Langefors, 1975, 1986; Mendelson, 2000; Argyris, 1980; Hewitt, 1986; Ackoff, 1967; Simon, 1962, 1969).

4.5 A sense of contextual alignment

Contextual alignment concerns the harmonious relationships between the enterprise as a whole, its information systems and its external environment. The concerned relationships have only an indirect impact on the information systems and the different areas of interests. These areas may at first glance seem unrelated, but since the flow of information permeates the organization, it is necessary to be mindful of the subtle manner in which different areas influence one another. Contextual alignment also includes the enterprise's boundaries as well as its interaction with its environment (Tichy, 1983). Although it may be difficult (or even impossible) for the organization to affect any change beyond the limits of its enterprise areas, one should be mindful of opportunities and impediments as they are usually the impetus for organizational change. Such alignment can be defined as:

Expected enterprise behaviour = Observed enterprise behaviour

Those factors that relate to the indirect interaction between organizational areas as well as environmental circumstances are critical to attaining contextual alignment.

5. Comparative analysis of approaches

The approaches addressed in this paper are the Zachman Framework, The Open Group Architecture Framework - TOGAF, the Extended Enterprise Architecture Framework – E2AF and the Generalised Enterprise Reference Architecture and Methodology - GERAM. The first and second of these frameworks were elected due to their popularity, E2AF due to its explicit focus on the extended enterprise and GERAM due to its focus on customization.

The Zachman Framework (Zachman, 1987; Sowa & Zachman, 1992) was originally developed by John Zachman and extended to its current scope with the aid of John Sowa. In its inception, the purpose of the framework was to steer organizations away from the widespread practice of viewing the enterprise through static and disconnected models.

The Open Group Architecture Framework (The Open Group, 2009) was originally released in 1995. At the time, it was based upon TAFIM, a framework for information management developed by the United States Department of Defense. Currently in its ninth revision, TOGAF has gradually expanded its scope from strict management of IT towards a broader business orientation.

The Generalised Enterprise Reference Architecture and Methodology (Bernus & Nemes, 1994; IFIP-IFAC Task force on Architectures for Enterprise Integration, 2003) is the product of the IFAC/IFIP Task Force on Architectures for Enterprise Integration, founded in 1990. GERAM is designed so that the practitioner is able to combine different frameworks or methodologies in order to custom design a new architecture. Consequently, it is an extensive standard that includes meticulous descriptions of reference architectures, modeling languages, techniques and tools.

The Extended Enterprise Architecture Framework was created by Jaap Schekkerman in 2001. Rather than any unified documentation, E2AF is documented in several separate documents that are incremented in a piecemeal fashion. E2AF assumes a holistic approach to architecture, stating that an enterprise that is to function as a whole must be designed as a whole (Schekkerman 2006:b). Strong emphasis is also placed on contextual awareness and stresses constant awareness of threats and opportunities in the environment (Schekkerman 2006:a, 2006:c).

The study at hand has been conducted using the best, first-hand literary sources available. It is however possible that some documentation regarding these approaches is unavailable due to reasons pertaining to intellectual property or fragmented documentation.

The tables below express the manner in which the investigated approaches address the various forms of alignment. “Clear” denotes the presence of explicit guidance regarding architectural alignment whereas “unclear” denotes the absence or lack of salience.

5.1 Socio-cultural alignment

A state of socio-cultural alignment reflects the harmonious contribution of the information systems & ICT to the ever changing expectations of internal as well as external stakeholders of the enterprise. In many cases, the lack of socio-cultural guidelines can be attributed to the underlying paradigms of the investigated approaches. That is to say, some approaches presuppose that information resources should be treated as independent of organization and culture.

Table 1: Results of analysis vis-à-vis socio-cultural alignment

	ZACHMAN	TOGAF	GERAM	E2AF
Clear				
Unclear	Insufficient guidance regarding relationship between IS and objectives of planner and owner.	Insufficient details offered regarding concept “enterprise benefits”.	Alignment based on requirements of IT and rather than objectives of business.	Advocates satisfaction of collective needs of the extended enterprise, but offers little practical guidance.

5.2 Functional alignment

The functional alignment concerns the harmonious contribution of available information systems & ICT capabilities to the information, service, transactions, and relations required by either the business processes or business units of the enterprise. Lack of clarity is often based on the fact that architectural approaches refer to the architecture as a singular information system that serves the whole enterprise and its surroundings. Another cause for concern is the fact that the investigated approaches tend to describe the processes and activities in isolation rather than their relationships to other areas of the enterprise.

Table 2: Results of analysis vis-à-vis functional alignment

	ZACHMAN	TOGAF	GERAM	E2AF
Clear		Alignment ensured by operational contracts between customers of and providers.	Harmonization between required IS services and provided IS services.	Alignment between business processes & IS ensured through basic principles.
Unclear	Insufficient guidance regarding business processes and the area of IS & ICT.	Insufficient guidance on how services are integrated into business processes and subsequently implemented.	Insufficient practical guidance regarding the modelling of the various entities of an enterprise.	

5.3 Structural alignment

Structural alignment reflects a situation where information systems & ICT capabilities are characterized by a clear, comprehensible, and accepted form of authority and responsibility. Unclear guidance regarding structural alignment is often derived from the propensity of approaches to describe responsibilities in themselves rather than in relationship to area of information systems. Another source of potential misgivings is the paradigm underlying each one of investigated approaches. Much like with socio-cultural issues, some approaches presuppose that information resources should be treated as independent of organization and structure.

Table 3: Results of analysis vis-à-vis structural alignment

	ZACHMAN	TOGAF	GERAM	E2AF
Clear		Based on governance contracts, IT responsibility, data trustees, ownership of common applications.	Clear view of responsibilities & roles of functional areas.	Offers guidance based on level of influence of concerned stakeholders.
Unclear	Insufficient or missing guidance regarding the areas of authority and responsibilities with the areas of IS & ICT.	Insufficient guidance regarding the relationship between the area of responsibility and the business objectives.	Insufficient guidance regarding harmonization of operations with capabilities of IS & ICT.	

5.4 Infological alignment

Infological alignment concerns the sound use of available information systems & ICT capabilities to satisfy the required informational, transactional and relational needs of human stakeholders. In many cases, infological ambiguity can be a presumption by architectural approaches that facts are always facts. By assuming this position, issues like cognitive distance and occupational proficiencies are in effect ignored.

Table 4: Results of analysis vis-à-vis infological alignment

	ZACHMAN	TOGAF	GERAM	E2AF
Clear				Collective understanding advocated through communication between internal and external stakeholders.
Unclear	Insufficient guidance regarding how information requisites such as quality, availability, comparability, consistency, etc. are treated.	Insufficient guidance on how to avoid information paradox and still promote sharing and availability of data.	Insufficient guidance on how to align stakeholders to IS & ICT. Insufficient guidance on aligning human capabilities, mental models, etc and IS capabilities.	

5.5 Contextual alignment

The most essential property of contextual alignment is given in terms of harmony between the external and internal environments of the enterprise. Since the enterprise is unable to directly control its environment, it is only natural for architectural approaches to focus on guidance concerning internal assets. Contextual harmony fills in the blanks with regards to the plurality of legal regulations, rules of intellectual property and political issues that surround the enterprise.

Table 5: Results of analysis vis-à-vis contextual alignment

	ZACHMAN	***TOGAF***	***GERAM***	***E2AF***
Clear		Alignment between EA and governance established through operational and governance contracts. Stipulates enterprise conformance with regulations, laws and intellectual property.	Securing architectural alignment between areas of enterprise by crossing functional barriers. Integration and interoperability between the heterogeneous environments of enterprise.	Advocates economic, legal, ethical and discretionary viewpoints. Strong emphasis on external partners.
Unclear	Insufficient guidance regarding how IS relates to the enterprise and its surrounding environment. Unclear guidance as to how the parts of the architecture fit together. Unsatisfactory guidance regarding how the architecture differentiates between physical possibilities and system rules.	Framework does not cover issues of alignment between business & IT strategy. Insufficient guidance regarding how the alignment between EA and enterprise mission is established. Scarce guidance regarding how the alignment between EA and its implementation is managed.	Insufficient guidance regarding how the role of IS promotes the responsiveness of the enterprise to environmental changes.	Lack of guidance regarding how to manage conflicting expectations and viewpoints of partners.

6. Discussion

The common denominator of any enterprise architecture is given in terms of various forms of sound alignment between its constitutional parts. Thus, without alignment any sense of architecture disappears. Hence, the ultimate aim of our efforts was to improve the existing body of knowledge regarding architectural alignment and how it is treated by a handful of architectural approaches: Zachman framework, TOGAF, GERAM and E2AF. Each one provides a collection of concepts, principles, guidelines and/or values that is intended to support any effort in the process of designing, developing implementing and evaluating an enterprise architecture that is capable of maintaining alignment between its constitutional parts. Thus, our focus has been to clarify how each one of the investigated approaches treats the issues associated with alignment. We will now briefly discuss the manner and extent to which the investigated approaches offer guidance on socio-cultural, functional, structural, infological, and contextual alignment.

Our investigation into the socio-cultural dimension shows that none of the architectural approaches covered in this paper provide clear guidance with regards to socio-cultural alignment.

Our analysis of the functional issues indicates that three of the four approaches – TOGAF, GERAM and E2AF – offer clear guidance on the different aspects of functional alignment. However, the Zachman framework offers little support and may therefore be considered unsatisfactory in terms of attaining architectural alignment.

Moving on to the structural dimension, our evaluation suggests that the situation is to a large extent the same. That is to say, three of the four approaches - TOGAF, GERAM and E2AF – offer strong practical support on attaining structural alignment. Again, the Zachman framework is lacking in guidance for structural issues.

The analysis of the infological dimension shows that only one of the investigated approaches – E2AF – offers suitable guidance with regards to infological alignment. The support offered by the three remaining approaches – Zachman framework, TOGAF and GERAM – is either doubtful or brief with few clear guidelines.

Finally, the analysis of the contextual dimension shows that three of the investigated approaches – TOGAF, GERAM, and E2AF – provide comprehensive, albeit somewhat simplistic, support regarding contextual alignment. Again, the Zachman framework does not provide any discernible guidelines. It does bear mentioning that among the architectural approaches evaluated; only E2AF offers what may be considered a somewhat nuanced view of contextual issues. By and large, the environment is simply seen as a source of requirements such as legal restrictions and contractual obligations. This is perhaps no great surprise given the sheer complexity of our world at large. However, given that the "outside world" is the source for many of the challenges faced by modern enterprises, one would assume that some manner of guidance would be in order.

It is prudent to point out that this evaluation rooted in the Scandinavian school of informatics which carries with it explicit consideration of hard (mechanistic) & soft (humanistic) aspects of systems thinking. This also extends to our view of organizational design in general and alignment of Enterprise Architecture in particular. Practical examples of architectures that align hard and soft aspects of the enterprise can also be found within international companies such as Xerox (Howard, 1992).

Set against a delineation of Enterprise Architecture into hard and soft aspects, we can discern that the architectural approaches which we have analyzed seem to gravitate towards the hard aspects of architectural design. Hence, these approaches offer a great deal of guidance regarding enterprise activities and formal responsibilities. This provides a stark contrast to the soft aspects of architectural design where very little practical support is offered. It is not within the scope of this article to formulate advice or guidelines to practitioners, but we would suggest caution against underestimating the humanistic aspects of architectural design. Stakeholder discontentment, lack of comprehension and a myopic focus on requirements rather than goals may prove equally (if not more) crippling compared to poor process management or unclear responsibilities.

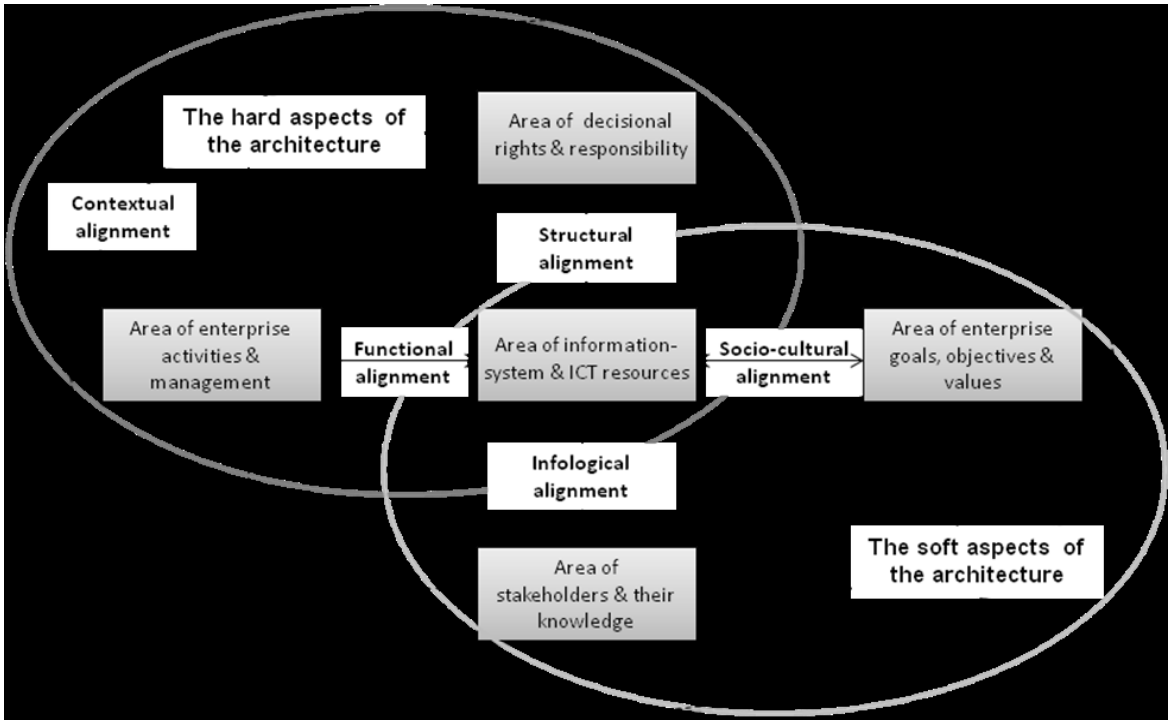

Figure 2: The hard & soft aspects of the architecture

7. Conclusions

The primary aim of this paper has been to ascertain how the various forms and aspects of architectural alignment are treated by formalized approaches to Enterprise Architecture. This issue has been investigated with respect to socio-cultural, functional, structural, infological and contextual alignment. Our study has provided us with the following conclusions:

Firstly, our investigation clearly demonstrates that approaches to Enterprise Architecture provide guidance for structural and functional alignment, but less so for infological or socio-cultural alignment. A possible explanation may be that investigated approaches follow a paradigm that demands the independence of information and information systems from cognitive, organizational and technological aspects (as explained by Brancheau & Wetherbe, 1986). Another feasible interpretation is that investigated approaches are derived from a tradition of engineering design rather than architectural design. This would account for the focus on requirements and constraints found in the "hard" aspects of the enterprise, rather than the "softer" aspects such as goals and decision making that characterizes architectural design.

Secondly, the area of contextual alignment is described by all investigated approaches as being relatively simplistic and stable. Some forms of contextual alignment are established through contractual agreements while others are dictated through laws and regulations. This is presumably in response to the heterogeneity inherent to most environments.

Finally, none of the investigated approaches discuss the mutual interdependence that exists between the various forms of alignment. However, the architectural patterns of the enterprise are the result of organizational forces rather than rationality. This follows previous research by Mintzberg (1989).

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