A Collaboration Process for Enterprise Architecture Creation

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A Collaboration Process for Enterprise Architecture Creation

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Contents

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Chapter 1

Introduction

Abstract. There hardly exists a clear and flexible procedure that guides and supports the execution of collaboration dependent tasks during enterprise architecture creation. Collaboration dependent tasks are enterprise architecture development guidelines that require enterprise architects to consult and deeply involve their clients (i.e. organizational stakeholders) when designing baseline and target enterprise architectures. Motivated to underpin such guidelines with collaboration support, this research scrutinizes the skillful and complementary adoption of Collaboration Engineering and Soft Systems Methodology with the aim of informing the execution of collaboration dependent tasks.

1.1 Chapter Overview

This chapter presents the research problem area, problem definition, research motivation, research questions, research objectives, gap analysis and research contribution, and the adopted research methodology. Some parts of this chapter are a (slightly) modified version of sections of work that appeared in [84, 88, 90, 91].

1.2 Problem Area

This section first gives the context in which enterprise architecture comes into play along with the traditional approaches or standards of managing change in organizations. Thereafter, it defines what an enterprise architecture is, gives the benefits of enterprise architecture, and discusses the fundamental aspects involved in developing an enterprise architecture.

1.2.1 Application Context of Enterprise Architecture

Enterprises face numerous challenges that call for *change* in the business environment [96]. According to [43, 52, 96], examples of these challenges or "*change initiators*" include globalization (and other associated issues like trade liberalization, increasing preference of free markets to monopolized or regulated economies, and increased global competition), the alignment of business and Information and Communication Technology (ICT), new technologies, new business models, privatization, rapidly increasing mergers (and acquisitions and networked or cooperating businesses), and legal demands for transparent enterprise operations. These change initiators are pointers to avenues for innovative revision of an enterprise's product portfolio and/or service portfolio and the business processes, information systems, and IT infrastructure associated with the provision of these portfolios [43]. This implies that for an organization to survive, it has to deal with these challenges or respond to these change initiators by being innovative (i.e. creating and seizing new business opportunities) [96], agile (i.e. quickly adapting to changes in the business environment) [8, 52, 67, 96], and transparent [52].

In [67, 96], traditional approaches that organizations use to manage change are described, and the role of enterprise architecture in addressing the weaknesses of these approaches is also given. This information is synthesized in table 1.1. From the 3rd and 4th columns of table 1.1, it can be noted that the deployment of other traditional approaches seems to be inclined to the existence and availability of a well defined strategy. Strategy definitions focus on aligning business strategy and IT strategy, but not implementing IT [30]. Thus, strategy definition efforts are usually unsuccessful not because of uncertainties as often claimed, but due to the impaired ways that are used when implementing strategies – and as a result strategy implementation is uncontrolled and ineffective [52, 76]. Successful strategy implementation requires that the definition of the strategy is explicit, SMART (i.e. specific, unambiguous, achievable, relevant, and actionable), and based on a comprehensive analysis of the possible effects of the planned change [96]. An effective approach to formulating such a transparent strategy definition and successfully controlling its execution, is enterprise architecture [29, 96, 43].

Table 1.1: *Traditional Approaches used to Manage Organizational Change*

#	Change management approaches(Lankhorst et al., 2005; Op't Land et al., 2008)	Major concepts involved in the approach (Lankhorst et al., 2005; Op't Land et al., 2008)	How enterprise architecture comes into context (Lankhorst et al., 2005; Op't Land et al., 2008)
1	Strategic management	• Formulate a strategy that will help an enterprise to adapt to changes in its business environment. • Implement the strategy and evaluate it.	Without enterprise architecture, it is difficult to: • Ensure that a strategy is defined in a detailed and explicit way such that it can be properly implemented. • Evaluate the impact of the strategy or future changes.
2	Programmatic steering of change (which involves general and IT governance, portfolio management, programme management, and project management)	• General and IT Governance: Oversee all processes and IT practices of an enterprise to ensure that they all comply with internal principles of an enterprise and principles from regulatory bodies.	Without enterprise architecture, it is difficult to: • Comprehend the coherence of all business and IT operations and practices that constitute the entire value chain of an enterprise. • Apply all internal and external governing standards.
		• Portfolio management: Oversee and ensure that transformation programs are integrated and coherent.	• Without enterprise architecture, it is difficult to have a common language that defines the business and IT aspects, and the outcomes of each programme.
		• Programme management: Oversee and ensure that all change projects on a given programme are coherent.	• Without enterprise architecture, it is difficult to assess and understand the cohesion of all output from the planned or ongoing projects.
		• Project management: Oversee implementation of projects to ensure that each project realizes part(s) of the desired situation or solution.	• Without enterprise architecture, it is difficult to ensure that output from each project addresses concerns of project stakeholders, and conforms to enterprise goals and principles.
3	Quality management	• Use policies and goals to design and document a quality management system that shows, core business processes, how they are executed, and quality control measures used.	• Without enterprise architecture, it is difficult to have an integrated design, documentation, and management of all business processes in an enterprise and IT systems that support their execution.
4	IT implementation, delivery and support	• Manage the integration of software development projects with other systems engineering projects. • Manage processes and assets associated with IT service level or performance and availability.	• Without enterprise architecture, it is difficult to provide management with a clear profile of the required IT applications and infrastructure, the business processes that are to depend and benefit from these; and constraints and guidelines of individual (software) projects that conform to the enterprise standards.

In addition to the text shown in the 4th column of table 1.1, a very familiar illustration of the application context of enterprise architecture is that of an architecture of a home.

The home architecture analogy states that "*building a room at a time without blueprints for the whole house is analogous to developing business resources and systems without an enterprise architecture, which results in a duplication of function, inefficient information exchanges, and a lack of integration*" (Bernard, 2005; page 32)[8]. Thus, enterprise architecture helps executives and program managers to ensure that efforts of system development in an enterprise (during strategy realization), do not end up yielding *isolated* or disjointed and duplicated business and technology capabilities and application systems [8, 67].

1.2.2 What is an Enterprise Architecture?

Literature reveals several definitions of the term (enterprise) architecture. This section provides some of the most commonly used definitions that we base on to define how enterprise architecture is perceived in this research.

Enterprise architecture is a compound word comprising two terms "enterprise" and "architecture". The term enterprise refers to a *set* of organizations that has common goals and activities, and whose constituents share or exchange information and resources [8, 124]. Examples of an enterprise include: a public or private agency, a department or unit or division of a large corporation, an entire corporation with all its units located in one area or separated geographically [124]. Below are some of the common definitions of the term (enterprise) architecture, and also a derived definition that is used in this research.

1. Zachman [138] articulates that the definition or perception of architecture is relative to what one is doing or practicing e.g.: a programmer perceives it as a structural chart, a business analyst perceives it as a data flow diagram, a program manager perceives it as a detailed program description. The Zachman framework gives one a general impression that architecture is a descriptive representation of an enterprise that helps in the management of the enterprise and also in the development of systems that support the enterprise [139].

2. Spewak [121] also defined (enterprise) architecture as a comprehensive blue print of the data, applications, and technology that are required to support (long-term) business operations of an enterprise, so as to enable it overcome the costly approach of (short term) development and replacement of systems.

3. IEEE Standards Board articulates that architecture is "*the fundamental organization of a system embodied in its components, their relationships to each other, and to the environment, and the principles guiding its design and evolution*" ([54], page 3).

4. Bernard [8] defines enterprise architecture as the documentation that shows the current state and future or desired state of an enterprise in holistic or integrated views that depict the strategy, business, and technology perspectives of the enterprise. Lankhorst et al define enterprise architecture as "*a coherent whole of principles, methods, and models that are used in the design and realization of an enterprise's organizational structure, business processes, information systems, and infrastructure*" ([67], page 3).

5. Dietz defines architecture in a theoretical perspective as "*the normative restriction of design freedom*", and in a practical perspective as "*a consistent and coherent set of design principles*" ([29], page 53).

6. The Open Group defined architecture in two ways which are relative to application context, i.e. it is: (a) "*a formal description of a system or a detailed plan of the system at component level to guide its implementation; and (b) the structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time*" ([124], page 9).

7. Greefhorst and Proper [43] provide a broader perspective of what an architecture is, and also discuss a purpose based classification of architecture definitions.

In this research our perception of enterprise architecture is derived from [8, 29, 67, 124]. Therefore, herein enterprise architecture is understood as the normative means that *shape* (i.e. govern, direct or guide, and inform) the desired or planned transformation or transition of an enterprise. These normative means are represented in form of models which depict (all) the governing operational and technology policies, standards, and requirements of (all) constituent units of the enterprise. Thereby, the role of enterprise architecture is to be a standard instrument (or icon of direction) that helps owners of an enterprise to have integrated and coherent operations and developments during and after any intended transformation or transition.

1.2.3 Purpose and Benefits of Enterprise Architecture

Enterprise architecture is a vital instrument that an organization can use to deal with any inflexibility that may occur in its business (and IT) operations [105], to manage its transformation into the desired state [96], to deal with any complexity in the design and implementation of its systems [29], to balance functionality and complexity of its systems [67], and to effectively align all its constituents or domains [67, 96, 111, 121, 138]. Therefore, according to Op't Land et al. [96], the various ways in which an enterprise architecture is used can be classified into the following four:

1. Enterprise architecture is used to support decision making during a planned or ongoing business transformation [96]. This is possible because architecture provides a basis for analyzing, optimizing, and validating a system; and for enabling further design and implementation of a system or its constituents [67]. Enterprise architecture improves planning and decision making by providing stakeholders with a coordinated vision of the enterprise's strategic direction, business practices, information flows, and technology resources [8].

2. Enterprise architecture is used to formulate the impact of a given business strategy on an enterprise [96]. This is possible because using architecture is the "only feasible way" one can translate the enterprise mission, vision, and strategy into operational guidelines for developing systems that will realize the desired changes [29, 42].

3. Enterprise architecture helps one to specify (business) requirements [96]. Using enterprise architecture, it is possible to define requirements or business and IT solutions that are enterprise-wide and those that are project or mission specific [8].

Thus, using enterprise architecture as a starting point, a requirements engineer can be able to determine where the enterprise problem lies and requirements to resolve it [34].

4. Enterprise architecture helps one to inform and contract service providers that will help in realizing the desired situation [96]. This is possible because a *good* architecture of an object (in this case an enterprise) comprises information about the functionality of the object, and information necessary for constructing and maintaining the object [29]. Thus, architecture is useful in communicating and negotiating contracts with service providers (e.g. developers, partnerships) during the implementation stage and maintenance stage of the capabilities or systems defined in the architecture [54].

Although enterprise architecture offers numerous benefits to organizations, reaping them essentially depends on the successful execution of the enterprise architecture development process. From sections 1.2.1 to 1.2.3, one can start to imagine what this development process entails, and the range of skills that have to be orchestrated in order to successfully accomplish it.

1.2.4 Developing an Enterprise Architecture

Developing enterprise architecture involves three stages, i.e.: creating, applying (or implementing), and maintaining an architecture such that it achieves its planned purpose [96]. This research concentrates on the stage of creating enterprise architectures (i.e. designing them), and excludes the stage of implementing them. However, the discussions herein may rarely veer into maintaining architectures, so as to illustrate the application context of the research.

According to [8, 41, 125], the common drawbacks of ICT-related projects include the lack of effective stakeholder involvement, lack of support and commitment of management, lack of effective communication, and lack of a shared understanding of the purpose of the architecture program. Thus, the success of enterprise architecture development initiatives is rarely impaired by technical reasons [60]. Instead it is often hindered by factors associated with ineffective collaboration (between organizational stakeholders and enterprise architects during architecture creation), let alone the unavoidable barrier of "organization politics" (as reported by [60, 121]). However, in literature (see discussion in chapter 2), existing attempts at improving architecture creation scarcely reveal concrete answers to enabling effective collaboration between enterprise architects and stakeholders. They instead (as shown in the left part of figure 1.1) richly provide insight into the following three aspects:

Category A. Some attempts report challenges or drawbacks or setbacks that are likely to be encountered during enterprise architecture development.

Category B. Other attempts provide guidelines or recommendations for improving enterprise architecture development.

Category C. Other attempts offer approaches and best practices for overcoming challenges encountered in (or fulfilling guidelines for improving) enterprise architecture development.

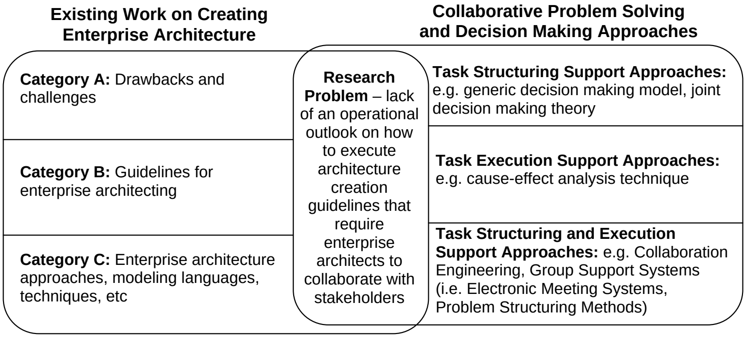

Figure 1.1: *Context of the Research Problem*

On the other hand, as shown in the right part of figure 1.1, literature reveals several approaches that support collaborative problem solving and decision making, but hardly reveals efforts reporting the deployment of these approaches in enterprise architecture creation. Consequently, several questions remain unanswered. For example: when creating an enterprise, how will tasks that require stakeholders' participation be executed? How will the collaborative sessions with stakeholders be structured? Which activities will be executed in these sessions, and how? Certainly answers to such "facilitation-like" questions are not difficult to obtain from professional or skilled facilitators [129]. However, not all enterprise architects are professional/skilled facilitators.

Therefore, as shown in the middle part of figure 1.1, the focus of this research falls in the intersection of the enterprise architecture creation realm (which comprises of work in categories A, B, and C) and the realm of collaborative problem solving and decision making. Literature on categories A, B, and C (see the left part of figure 1.1) is discussed in chapter 2. Literature on collaborative problem solving and decision making approaches (see the right part of figure 1.1) is briefly introduced in section 1.4, and other details are discussed in chapter 3. Sections 1.3 and 1.4 discuss the intersection region of figure 1.1.

1.3 Problem Definition

Currently there is hardly an explicit and flexible procedure that offers insight into *how* enterprise architects can deeply involve organizational stakeholders during enterprise architecture creation, such that collaborative decisions can be made regarding the resultant enterprise architecture. The need for effective collaboration between enterprise architects and stakeholders during enterprise architecture creation has been articulated by several researchers and practitioners (e.g. [2, 3, 41, 57, 60, 67, 79, 96, 105]). However, an explicit operational outlook on how to address this need is still lacking. Although existing enterprise architecture approaches define guidelines for (and outcomes of) enterprise architecting, they lack detailed support for *collaboration dependent guidelines* (i.e. tasks whose successful execution depends on proper collaboration among stakeholders and enterprise architects).

Often architecture initiatives produce models that are complicated and not feasible – an indication of inadequate stakeholder participation in the architecture creation activities, and this is partially caused by the difficult nature of collaboration between architects and stakeholders [105]. Collaboration among stakeholders is mainly affected by their conflicting goals, concerns, and hidden agendas. Yet these conflicting concerns (regarding, e.g., a desired enterprise transformation) should be resolved and an agreement reached on the most appropriate and feasible direction of the transformation [96]. This requires the architect to identify concerns of key stakeholders, and then develop architecture models that explicitly depict how concerns will be addressed and the tradeoffs that need to be made [124]. Consequently, a demand is placed on the methodology for designing architectures [67], since creating models that appropriately address stakeholders' concerns requires the architect to build relationships with the stakeholders [79, 110]. The enterprise architect can achieve this by devising a way of collaborating with clients or stakeholders. Therefore, collaboration among stakeholders and architects is one of the critical factors of enterprise architecting [105].

In order to provide explicit and flexible support for the kind of collaboration needed during architecture creation, it is important to understand the activities that need to be executed, the roles of the stakeholders, and the roles of the mediator who in this case is the enterprise architect. Hence the focus of this research.

1.4 Research Motivation

A comprehensive understanding of organization aspects (such as processes, systems, and stakeholders' concerns) is vital during negotiations on potential tradeoffs that can be made to address the divergent stakeholders' concerns [141]. From this, factors such as collaboration between stakeholders and enterprise architects, negotiation among stakeholders, and shared understanding of organization aspects are some of the underlying phenomena in executing collaboration dependent tasks. Challenges associated with these phenomena can be addressed by approaches (i.e. methods, tools, techniques, frameworks etc) that support collaborative problem solving and decision making. The right part of figure 1.1 shows examples of such approaches. Figure 1.1 shows that approaches that enable collaborative problem solving and decision making can be classified into three:

Task Structuring Support Approaches. These can be adopted or instantiated to provide high level guidelines for addressing demands of a given task.

Task Execution Support Approaches. These can be adopted or instantiated to provide operational ways of achieving the high level guidelines for addressing demands of a given task.

Task Structuring and Execution Support Approaches. These can be adopted or instantiated to provide both high level guidelines for addressing demands of a given task and operational ways of achieving those high level guidelines.

Although approaches in each of these three categories are relevant in this research, it was found rational to give first priority to those in the last category (i.e. task structuring and execution support) as these would eventually invoke the adoption of approaches in the other two categories. In the task structuring and execution support category, we find Collaboration Engineering and other approaches generally referred to as Group (Decision) Support Systems (GSSs). According to Rouwette et al. [113, 31], GSSs are classified into two, i.e. Electronic Meeting Systems (EMSs) and Problem Structuring Methods (PSMs).

A brief introduction of EMSs, Collaboration Engineering, and PSMs is provided below and a detailed discussion thereof is provided in section 3.5.

Electronic Meeting System (EMS). An EMS is a computer-supported setting that enables information sharing and interactions among a group of people that need to coordinate their efforts in order to accomplish a given task [95]. Mulder et al. [78] discuss a three-layered definition of an EMS, i.e. (1) it is an infrastructure of tools for storing and transporting data associated with a meeting, (2) it is an information system that receives, sends, calculates, and derives information associated with a meeting, and (3) it is a social system that enables social interactions of actors so as to create, classify, evaluate, and agree on concepts. These three layers deliver various benefits to group meetings. For example, an EMS enables quick information sharing and access [95], which is offered by its information systems layer [78]. Also, EMS has a *group memory* that is controlled by a facilitator to allow group members to view and update it using their workstations during the meeting [95]. This is offered by synchronized support of the social system, information system, and infrastructure layers of an EMS [78]. Despite these benefits, the core prerequisite of having a professional facilitator in order to successfully use an EMS inspired research into Collaboration Engineering [14].

Collaboration Engineering. Briggs et al. [16, 14, 15, 130] discuss Collaboration Engineering, an approach that focuses on ensuring *sustainable* adoption of EMSs in collaborative initiatives, by enabling the development of collaboration processes. A collaboration process can be perceived as a facilitation procedure or strategy that enables a group to undergo (various) forms of reasoning in order to execute a given initiative [129], which in this case is enterprise architecture creation. A collaboration process is made up of *thinkLets* that can be successfully executed by a practitioner of a given high-value recurring task, even in the absence of a professional facilitator [14, 130]. A thinkLet defines the EMS tool (and/or non-computer based tool) to use when executing a given task, how to setup or organize the tool, and a sequential description of what to do when using the tool [14, 130, 17]. Collaboration Engineering has been used to develop collaboration processes that support various types of tasks (e.g. [129, 83, 11, 61]). Therefore, in this research we were motivated to deploy Collaboration Engineering so as to address demands of executing collaboration dependent tasks during enterprise architecture creation.

Problem Structuring Method (PSM). A PSM enables one to represent a given situation using a model(s) in order to enable stakeholders in that situation to explicitly discuss their (complex) impasse, jointly define their problem and matters associated with it, and consent to remedies for it [74]. Examples of PSMs are discussed in section 3.5.1. Models constructed using a PSM comprise a captivating degree of ambiguity that prompts and incites discussion and negotiations among participants, so as to shift them from their positions to a position of agreement and mutual understanding [32]. Hence the motivation for the complementary adoption of Collaboration Engineering with a PSM. In this research the selected PSM is Soft Systems Methodology (SSM). SSM was selected because of its reputation for managing complex and ill-structured organizational problems and transformations through inciting rational thinking about them [22]. Therefore, in this research we were motivated to deploy SSM so as to address demands of executing collaboration dependent tasks during enterprise architecture creation.

As shown in figure 1.2, this research was motivated to explore how the execution of collaboration dependent tasks during enterprise architecture creation can be supported

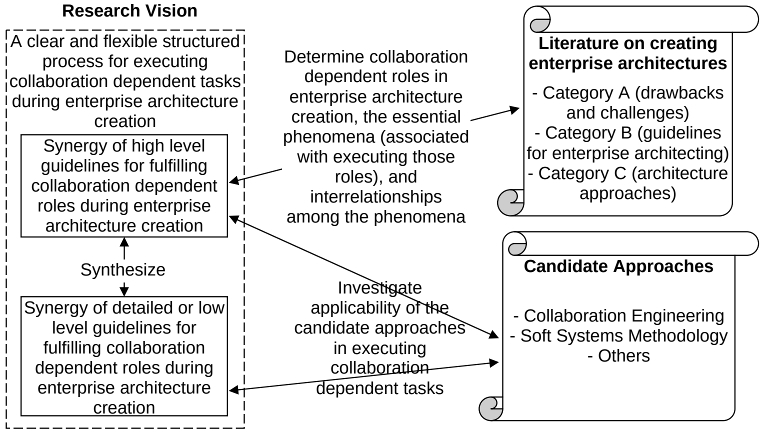

Figure 1.2: *Proposed Solution, Key Research Tasks, and Candidate Approaches*

by a collaboration process (rooted in Collaboration Engineering and SSM) along with enterprise architecture approaches. On the left part of figure 1.2, the boxes represent the composition of the proposed solution to the research problem. On the right part of figure 1.2, the scrolls represent a body of existing literature on creating enterprise architecture and the candidate approaches for addressing the research problem. In the middle part of figure 1.2, the lines with two arrow heads represent the major research tasks associated with attaining the proposed solution with respect to existing literature and the candidate approaches. From figure 1.2, we derived research questions in section 1.5 and research objectives in section 1.6.

1.5 Research Questions

This research sought an answer to the question: how can a process for executing collaboration dependent tasks during enterprise architecture creation be structured? This question was decomposed into the following sub questions.

(a) Which tasks (or roles) during enterprise architecture creation are collaboration dependent?

(b) What are the challenges that enterprise architects face when executing collaboration dependent tasks during enterprise architecture creation?

(c) What are the essential phenomena in the execution of collaboration dependent tasks, and the interrelationships among those phenomena?

(d) How can Collaboration Engineering and SSM be adopted to provide an explicit and flexible procedure that addresses the challenges associated with the essential phenomena in executing collaboration dependent tasks?

Question (a) was interested in having a clear distinction of enterprise architecture creation guidelines that need to be executed by enterprise architects collaborating with organizational stakeholders and architecture creation guidelines that need to be executed by enterprise architects. Question (b) was interested in investigating detailed challenges that architects face when they involve organizational stakeholders in enterprise architecture creation. Question (c) was interested in determining key phenomena associated with executing collaboration dependent tasks and how they can be orchestrated or harmonized. Question (d) was interested in investigating (i.e. adopting and testing) the use of Collaboration Engineering and SSM to address aspects resulting from questions (a) – (c). These questions were derived from concepts represented in figure 1.2 and discussed in section 1.4.

1.6 Research Aim and Objectives

The aim of this research was to design and evaluate a process that provides clear and flexible support for executing collaboration dependent tasks during enterprise architecture creation. To achieve this the following were the specific objectives of the research.

1. To formulate a synergy of collaboration dependent tasks that occur in enterprise architecture creation. This answers research question (a) in section 1.5. Having a clear definition of collaboration dependent tasks helps to determine the scope of involvement of this research in an enterprise architecture creation initiative with respect to existing enterprise architecture frameworks and methods.

2. To investigate challenges that enterprise architects face when executing collaboration dependent tasks during enterprise architecture creation. This can be done by reviewing existing literature and conducting an exploratory survey among enterprise architects. This answers research question (b) in section 1.5.

3. To determine the essential phenomena associated with the execution of collaboration dependent tasks, and formulate a theory (based on existing literature) that explains these phenomena and the interrelationships among them. This answers research question (c) in section 1.5. The resultant theory can be used to guide the formulation of a synergy of collaboration dependent tasks. Such a synergy can incorporate high level guidelines for addressing challenges investigated in objective (2) above.

4. To investigate the application of Collaboration Engineering and SSM in enterprise architecture creation by adopting them to design a process (an artifact per se) that offers detailed guidelines for executing the high level guidelines defined in (3) above. This partially answers research question (d) in section 1.5.

5. To evaluate and validate the resultant artifact (i.e. the process for executing collaboration dependent tasks in enterprise architecture creation) in research objective (4) above. This fully answers research question (d) in section 1.5.

These objectives were derived from concepts represented in figure 1.2 and discussed in section 1.4.

1.7 Gap Analysis and Research Contribution

Communication between stakeholders and enterprise architects is essential for successful architecture creation and can be perceived as a conversation [104], which in the shaded part of figure 1.3 we refer to as the architecture creation conversation. This conversation involves matters on problem solving and decision making regarding the organization's baseline and desired situations, that are to be represented in the enterprise architecture that is to be created. This conversation can involve the use of several types of artifacts. At the top part of figure 1.3 these artifacts are represented using boxes. Literature or knowledge on these artifacts is represented using scrolls that are linked to the respective artifacts using a dashed line with an arrow head (see bottom part of figure 1.3). Dashed lines with arrow heads in figure 1.3 represent information flow between any two representations, while solid lines with arrow heads represent the service artifact(s) can offer to the architecture creation conversation. For example, the left part of figure 1.3 shows that existing artifacts provide architecting guidelines that offer insights into matters to discuss in the conversation, but are silent on a detailed operational outlook on facilitation support for the conversation.

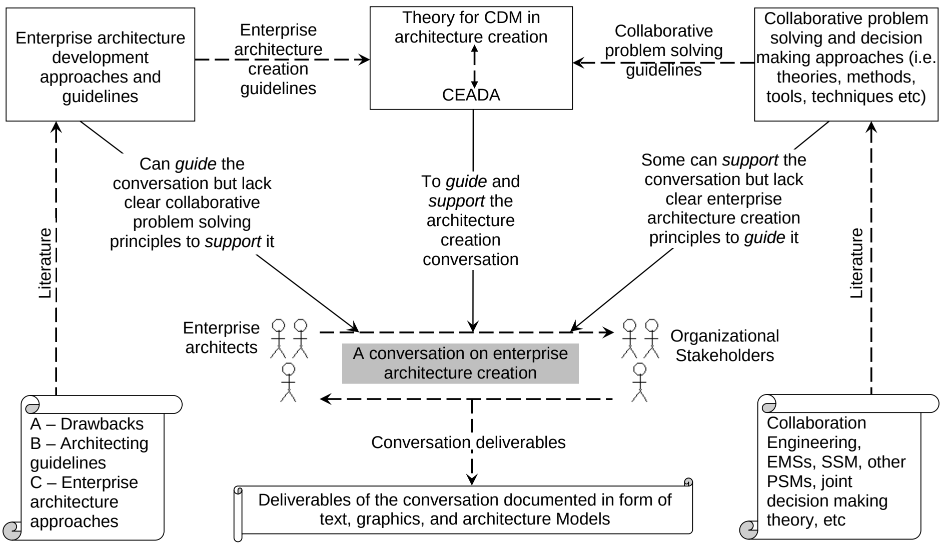

Figure 1.3: *Role of CEADA in the Architecture Creation Methodology*

The problem solving and decision making involved in this conversation is collaborative in nature, since stakeholders and enterprise architects exchange information on problems and experiences and deliberate on alternative courses of action that can be taken to achieve the desired situation. As shown in the right part of figure 1.3, existing artifacts on collaborative problem solving and decision making can offer collaboration support to enrich or facilitate the conversation, but they lack enterprise architecture creation principles to guide the conversation.

Consequently, as shown in the middle part of figure 1.3, architecture creation conversations will benefit from a flexible operational procedure that can guide and offer facilitation support for the enterprise architecture creation conversation. This is the contribution offered by the proposed artifact that has evolved in this research. This artifact is a flexible process referred to as Collaborative Evaluation of (Enterprise) Architecture Design

Alternatives (CEADA), that enables the execution of collaboration dependent tasks during the architecture creation conversation. This name of the artifact was derived from the main reason for executing collaboration dependent tasks, i.e.: to collaboratively evaluate, deliberate, and agree on alternative courses of action associated with achieving the desired situation (this is explicitly revealed in chapter 6). The middle part of figure 1.3 also shows that this artifact is based on a theory, which as stated in section 1.6 offers high level guidelines on executing collaboration dependent tasks or achieving Collaborative Decision Making (CDM) during enterprise architecture creation. Therefore, the gap this research has attempted to fill is the adoption of collaborative problem solving and decision making approaches into enterprise architecture creation to provide facilitation support for the architecture creation conversation.

CEADA in Enterprise Architecture Frameworks. This research does not attempt to present another enterprise architecture framework. Instead it focuses on strengthening the existing enterprise architecting guidelines, or underpinning collaboration dependent guidelines, with explicit and flexible collaboration support. Thus, CEADA can be visualized as a plug-in for enterprise architecture approaches, that can be used during architecture creation to enable the execution of collaboration dependent tasks. Enterprise architecture approaches include The Open Group Architecture Framework (TOGAF), Zachman, Integrated Architecture Framework (IAF), Federal Enterprise Architecture Framework (FEAF), Extensible Architecture Framework (xAF), Design and Engineering Methodology for Organizations (DEMO), ArchiMate among others. Since each of these approaches dictates a particular way of working during enterprise architecture creation, our claim that CEADA is a potential plug-in for enterprise architecture approaches needs to be clarified. For CEADA to be used with any architecture approach, there is need to first consider deliverables demanded by a given architecture approach and correlate them with aspects and activities in CEADA. The procedure for customizing CEADA so as to use it with a given architecture approach is provided in chapter 8 (see figure 8.2). Thus, in this research we follow the customization model in figure 8.2 to demonstrate how CEADA can be used in enterprise architecture approaches, and we use TOGAF as an example in our demonstration. Reasons why TOGAF was used as an example are discussed in chapter 8.

In general the formulation of a theory on CDM in architecture creation and the development of CEADA are positive steps towards improving the enterprise architecture creation methodology. This research is therefore an effort towards filling the gap, highlighted in [96], of the lack of scientific research on success factors for enterprise architecture development.

1.8 Research Methodology

In this research we adopt the Design Science research methodology. Design Science is a utility-oriented problem solving paradigm that facilitates the creation and evaluation of an artifact for solving a pertinent organizational problem [49]. Design Science research can be characterized as prescriptive research because it focuses on using (existing) knowledge to improve the performance of systems [71]. Thus, artifacts resulting from Design Science research are geared towards addressing business or organizational needs in a problem domain [49], or offering opportunities of improving practice (even before practitioners identify any problem with their way of working) [55]. Figure 1.4 shows how Design Science was adopted in the context of this research.

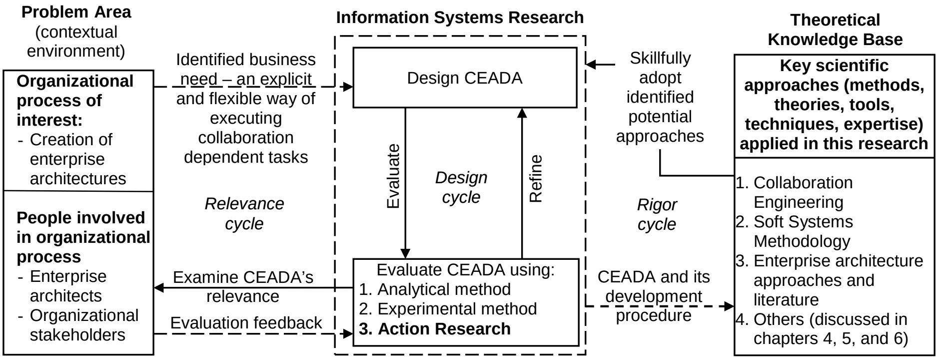

Figure 1.4: *Adoption of Design Science in this Research (based on [49, 50])*

The box on the left part of figure 1.4 represents the problem domain of this research, i.e. the organizational process that this research attempted to improve and key people involved in executing that process. The boxes in the middle part of figure 1.4 represent the two major phases in this research, i.e. the design phase and evaluation phase of the intended artifact (i.e. CEADA). The box on the right part of figure 1.4 shows the core existing approaches that were adopted to rigorously and skillfully design CEADA so that it supports the execution of collaboration dependent tasks during enterprise architecture creation. In figure 1.4 the dashed lines with arrow heads represent information flow between two representations, while the solid lines with arrow heads represent research activities. Concepts represented in figure 1.4 are discussed below in sections 1.8.1 and 1.8.2.

1.8.1 Adoption of Design Science Research Guidelines

Hevner et al. [49] discuss seven guidelines that a complete Design Science research initiative ought to fulfill. The following discussion focuses on highlighting how this research endeavored to fulfil these seven guidelines.

Problem relevance – aim at developing "technology-based solutions" to relevant organization problems [49]. The problem environment mainly comprises people and systems or processes that interact so as to achieve a given goal [50]. In this research, as shown in the left part of figure 1.4, the process of interest in the problem domain is the development of enterprise architectures. The people involved in this process are enterprise architects and organizational stakeholders. Design Science research is initiated by the identification and representation of challenging phenomena in the problem domain [50]. As shown in the left part of figure 1.4, the challenge addressed in this research is the execution of collaboration dependent tasks so as to achieve CDM during architecture creation (see section 1.3). The significance of this problem was highlighted in section 1.7 and a detailed discussion thereof is provided in chapter 2.

Design must yield feasible artifacts – constructs, models, methods, and instantiations [49]. As shown in the middle upper part of figure 1.4, the resultant artifact in this research is CEADA. Its design is based on the theory on CDM in enterprise architecture creation, which was also formulated in this research. A detailed discussion on the theory-driven design of CEADA is provided in chapters 4 – 6. In the case of this research, CEADA's feasibility was determined by evaluating it using methods listed in the box at the bottom center part of figure 1.4. A clearer representation of the activities undertaken in this research to yield CEADA is provided in figure 1.5 and findings are discussed in chapter 7.

The design process of an artifact must involve searching and utilizing ways (that are acceptable in the problem environment) of attaining the research goal [49]. Design involves iterative research activities such as constructing, evaluating, and refining the artifact based on findings [50]. The major design activities undertaken in this research to achieve the research objectives are shown in the right part of figure 1.5. Figure 1.5 shows that all the development activities undertaken in this research have been grouped into phase I, phase II, and a bridging phase (which involved preparing to evaluate the artifact and refining the artifact with respect to evaluation findings). The boxes in figure 1.5 represent the major activities undertaken in this research, the solid lines with arrow heads represent the flow or order in which research activities were undertaken, the dashed lines with arrow heads represent information flow between two or more representations. A detailed discussion on the design of CEADA (i.e. activities in phase I of figure 1.5) is provided in chapters 4 – 6.

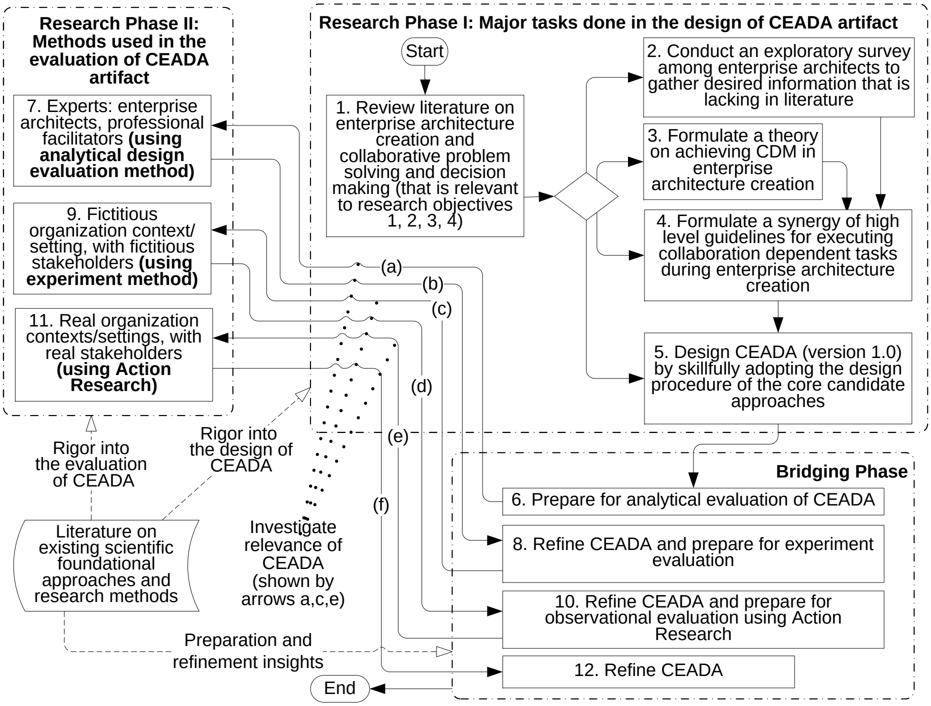

Figure 1.5: *Activities Undertaken to Achieve the Research Objectives*

Research rigor – research must apply rigorous methods when constructing and evaluating the artifact [49]. Design Science artifacts are created basing on existing foundations in a knowledge base which include theories, frameworks, instruments, constructs, models, methods, instantiations, experiences, and expertise [49, 50]. The right part of figure

1.4 shows the core approaches from the knowledge base (i.e. existing literature) that were adopted in the development of CEADA. Chapters 2 and 3 discuss why these approaches are considered core to this research, and discuss other approaches that were selected and adopted in this research. The bottom left corner of figure 1.5 shows that existing literature and experiences were applied in the design, evaluation, and bridging phases of this research. Chapters 4 – 6 discuss the adoption of the selected approaches in the design of CEADA, while chapter 7 discusses the adoption of the selected evaluation methods in the evaluation phase of CEADA.

Design evaluation – properly evaluate the artifact and rigorously reveal its quality [49]. Evaluation of an artifact can be done using empirical and qualitative research methods such as observational, analytical, experimental, descriptive, or testing-oriented methods [49, 50]. Box 10 in the lower middle part of figure 1.4 shows the key design evaluation methods used in this research, while the top left part of figure 1.5 shows the order in which these methods were used in the evaluation phase of the research. Although chapter 7 provides a detailed discussion on why these evaluation methods were chosen, we find it necessary to briefly explain here the reason for using both Action Research and Design Science in this research. The evaluate box in figure 1.4 and boxes 10 and 11 in figure 1.5 highlight the complementary adoption of these two methodologies in this research. On the one hand, Design Science is an engineering-oriented approach where researchers see significant organizational problems as avenues for developing innovative artifacts that are rooted in existing scientific approaches and conform to natural laws [49]. On the other hand, Action Research is a social-oriented form of research investigation where the researchers observe and actively participate in the context they are examining, with the focus of increasing their understanding of the complexities within "*social-organizational problem*" [7]. Figure 1.6 shows how Action Research supported Design Science in this research.

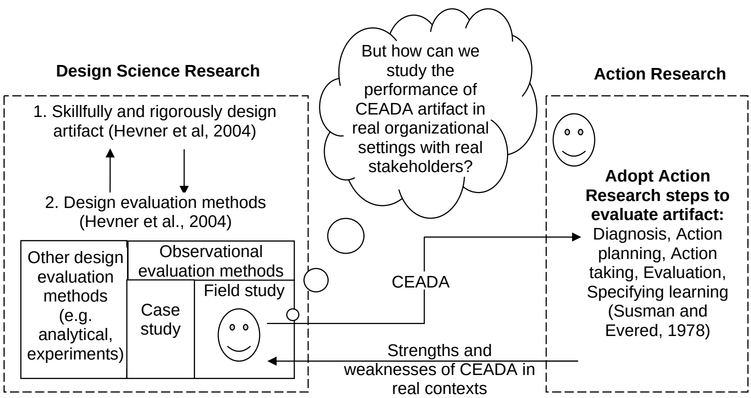

Figure 1.6: *Complementary use of Design Science and Action Research*

The illustration in figure 1.6 is inspired by the following reasons based on [7, 50, 55, 135]. First, although Action Research and Design Science are divergent methodologies, they are not "*mutually exclusive*" because Action Research can be very useful in the evaluation phase of research done based on Design Science [55]. This is indicated at the bottom part of figure 1.6, where the investigation of the performance of the CEADA artifact in real organization settings was done by adopting Action Research. This is because a field study (or observational) evaluation of a Design Science artifact requires one to examine the utility of an artifact in a variety of organizational contexts [49], and this can be done using Action Research [50]. Action Research enables researchers to work closely with the *subjects* they are studying [7], when exploring the usability of the developed artifact [135]. Second, Wieringa [135] presents the technical action research paradigm, which shows how Action Research method can be used during the evaluation and validation stage of a Design Science artifact. Chapter 7 discusses how Action Research and other evaluation methods shown in the left part of figure 1.6 and figure 1.5 were adopted in this research, and the findings from evaluating CEADA using each of these methods.

Research contributions – research must yield explicit contributions to the knowledge base in terms of resultant artifact, design foundations, and/or evaluation methodologies [49]. The lower middle part of figure 1.4 shows that the main contribution of this research to the knowledge base is CEADA and its development procedure. This is discussed in section 1.7 and chapters 4 – 7.

Communication of research – must be directed to "technology oriented" and "management oriented" audiences [49]. Communication of this research has been done in both academic-oriented and practice-oriented audiences. The communication channels that were used in this research were conferences, workshops, and journals where results from this research were exposed to the academicians and practitioners (e.g. [87, 88, 91, 90]).

1.8.2 Inherent Cycles in Design Science Research

Fulfilling the preceding seven guidelines implies that the Design Science research project has undergone three cycles, i.e. relevance cycle, rigor cycle, and design cycle [50]. These three cycles are shown in the left, middle, and right parts of figure 1.4. The research activities undertaken in each cycle are shown in figure 1.5. For example, in figure 1.5 the relevance cycle is represented by activities in steps numbered 6 – 12 and lines labeled (a) – (f). In figure 1.5, the rigor cycle is represented by the continual skillful adoption or application of existing scientific literature. This is indicated by the dashed arrows from the knowledge base to phase I, phase II, and the bridging phase of this research (see bottom left corner of figure 1.5). In figure 1.5, the design cycle is represented by activities in steps numbered 1 – 5 and the refinement activities in steps 8, 10, and 12. A detailed discussion of all activities in figure 1.5 is provided in chapters 2 – 7.

1.9 Thesis Outline

The remaining part of this thesis is structured as follows.

Chapter 2 discusses existing literature on enterprise architecture creation that was classified into categories A, B, and C in section 1.2.4. It also discusses the rationale and design of an exploratory questionnaire survey that we conducted among enterprise architects and the findings from the survey. Sections of work in this chapter appear in [92, 90, 89]. Chapter 3 discusses existing literature on collaborative problem solving and decision making. It also provides an explanation as to why some of the existing approaches were not adopted in this research. It advocates for the deployment of Collaboration Engineering, SSM, and other approaches into enterprise architecture creation. Some sections of work in this chapter appear in [90].

Chapter 4 discusses the solution synthesis of the CEADA artifact. It explains why there was a need to first formulate the theory that guided the design of CEADA. It also discusses the theory on CDM in enterprise architecture creation, and the coordination framework that guided the adoption of approaches that were used to design CEADA. Some sections of work in this chapter appear in [90, 87, 85, 86]. Chapter 5 discusses the synergy of high level guidelines for executing collaboration dependent tasks during enterprise architecture creation. The high level guidelines were derived from the theory on CDM in enterprise architecture creation, and from the survey findings. Some sections of work in this chapter appear in [92, 90, 85, 86].

Chapter 6 discusses the design of CEADA, a flexible process that provides detailed guidelines for executing collaboration dependent tasks during enterprise architecture creation. It also provides clues on how CEADA can be customized to support conversations on enterprise architecture creation in a given organization. Sections of work in this chapter appear in [92, 91, 90, 88, 85, 86, 84]. Chapter 7 discusses the evaluation iterations of CEADA and findings from each iteration. It specifically discusses how Action Research and other design evaluation methods were adopted in this research, and the evaluation goals and performance measures that guided the evaluation. Some sections of work in this chapter appear in [91, 90, 88, 85, 86].

Chapter 8 discusses how CEADA is a plug-in for enterprise architecture frameworks. Discussions focus on embedding CEADA into the Architecture Development Method (ADM) of TOGAF. It also explains why we chose to illustrate the use of CEADA in TOGAF's ADM, and provides clues on how CEADA can be used along with other enterprise architecture approaches. Sections of work in this chapter appear in [92]. Chapter 9 discusses the main contributions and findings from this research and areas for further research.

Chapter 2

Creating Enterprise Architecture

Abstract. The first half of this chapter gives an overview of existing work on enterprise architecture creation. Since architecture creation literature hardly revealed a detailed account of problems encountered when enterprise architects involve stakeholders in architecture creation, it was vital to conduct an exploratory survey through which such information would be gathered. Thus, the second half of this chapter discusses the design of the exploratory survey that we conducted and the findings from the survey.

2.1 Chapter Overview

In Design Science investigating the problem domain helps the researcher to determine the requirement(s) or the business need that the research must address, so as to solve a significant problem [49, 50]. Therefore, this chapter first delves into related work on creating enterprise architecture (section 2.2). Thereafter it discusses the design of, and findings from, an exploratory survey that we conducted among enterprise architects (section 2.3). This chapter therefore mainly serves two purposes, i.e. (a) it demonstrates the relevance of the research problem, and (b) it helps one to understand the breadth and depth of the organizational problem that this research endeavored to address. Some parts of this chapter are a (slightly) modified version of sections of work in [92, 90, 89].

2.2 Related Work

In section 1.2.4, existing work on improving enterprise architecture creation was grouped into categories A, B, and C. This section discusses these categories in more detail and provides a deeper understanding of the existing gap.

2.2.1 Category A – Potential Drawbacks

Enterprise architecture development is mainly confronted by political, project, and organizational management issues [60], and in some incidences, technical issues [60, 99]. Reports on these issues constitute category A, and examples are provided below.

The two main drawbacks in enterprise architecture development are (1) choosing an ineffective leader as the lead enterprise architect, and (2) not involving organizational stakeholders in the architecture initiative [41]. However, involving stakeholders in the architecture development process tends to result in other issues. For example, it is often difficult to make stakeholders understand enterprise architecture models, and to make executives of organizations (used to making decisions in a reactive and proactive way) understand the role of an enterprise architect [60]. This lack of stakeholder understanding and support arises when business stakeholders are not involved in developing the enterprise architecture, when the architecture content is not being used in other projects in the organization, and when management is not understanding the value of enterprise architecture [41]. What triggers these issues is the failure to explain the architecture process and its results in a simple business language that stakeholders understand, and the failure to communicate enterprise architecture content with stakeholders early and frequently [110].

2.2.2 Category B – Guidelines

Researchers and practitioners often provide guidelines and recommendations for improving enterprise architecture creation, or for avoiding and overcoming issues reported in category A. These recommendations constitute category B, and they mainly revolve around three themes, i.e. communication, collaboration, and technical-oriented aspects. Examples of existing work on these themes are provided below.

Communication theme: Gartner [41] advises enterprise architects to enlighten stakeholders about enterprise architecture so as to secure sponsorship from executives, and to develop and execute an enterprise architecture communication plan that consolidates all stakeholder audiences in the organization. Moreover, acquiring a feasible and acceptable enterprise architecture design requires the architect to communicate with all stakeholders, find out their needs, and devise ways of addressing them [67]. Acceptable and understandable enterprise architectures are generally obtained through: (a) modeling and visualization of interdependencies within architecture layers; and (b) creating a shared vision, communicating with stakeholders, and analyzing possible impacts [57].

Collaboration theme: Gartner [41] advises enterprise architects to secure buy-in for the enterprise architecture by (a) collaborating with stakeholders to develop a business context that properly aligns IT with business goals, and (b) forming "*virtual*" teams that will define and agree on enterprise architecture content. Moreover, Raadt et al. [105] report stakeholders' expectations of the enterprise architecture creation process, such that architects may endeavor to fulfill them. According to Raadt et al, stakeholders expect (1) to have their roles in the architecture function explicitly defined, (2) architects to closely work with them so as to understand their goals and problems, (3) architects to ensure that there is effective communication with all stakeholder groups, and (4) architects to have a long-term and realistic view about the realization of the organization's business and IT strategy. Achieving expectations (2) and (4) calls for effective collaboration between stakeholders and architects, such that that the problem and desired situations of the organization can be properly and mutually conceptualized.

Technical-oriented theme: Guidelines on technical aspects in architecture creation are often associated with particular architecture approaches (discussed in section 2.2.3 below).

2.2.3 Category C – Architecture Approaches

Common to categories A and B above is the need for effective communication, effective collaboration, and shared understanding (of aspects pertaining to architecture creation) among organizational stakeholders and architects. On addressing these aspects, various architecture approaches (i.e. constituents of category C) have emerged over time. Enterprise architecture approaches refer to the various frameworks, methods, techniques, languages, and tools used during enterprise architecture development. Existing work on enterprise architecture approaches can be classified into two, i.e. enterprise architecture frameworks, and supporting approaches that address technical aspects and social-technical aspects involved in creating enterprise architectures. Examples of existing work on enterprise architecture approaches are provided below.

2.2.3.1 Enterprise Architecture Frameworks

An enterprise architecture framework specifies constituents of an enterprise architecture [67], or guidelines for developing an enterprise architecture [124]. An enterprise architecture framework provides means for ordering and guarding completeness of architecture results, means for understanding interrelationships of architecture results, and means for enabling traceability of architecture decisions and their impact [96]. Examples of enterprise architecture frameworks include TOGAF, Zachman, IAF, FEAF, xAF among others. In [115] an overview and analysis of several enterprise architecture frameworks is given, as well as insights into selecting the most appropriate enterprise architecture framework, and creating an organization-specific architecture framework.

Since architecture frameworks mainly specify architecture products and do not provide guidance on the way (or process) of creating the products, The Open Group developed TOGAF [124]. TOGAF includes a detailed method, referred to as the Architecture Development Method (ADM), that offers explicit step-by-step guidelines for enterprise architecture development [124].

2.2.3.2 Supporting Approaches in Enterprise Architecting

An enterprise architecture framework provides some sort of orchestration that articulates when to use methods, techniques, languages, and tools that support the execution of enterprise architecture development guidelines. Existing work on these supporting approaches can be further classified into approaches that support (i) architecture modeling, (ii) formulation of architecture principles, and (iii) collaboration between stakeholders and architects during architecture creation. This classification is represented using boxes shown in figure 2.1. The dashed arrows indicate that these approaches are used in a supplementary way during enterprise architecture development. This is because output of one approach can be used as input of another. The representation used in the bottom part of figure 2.1 also shows that among the existing approaches, the ones most relevant to this research are those classified under (iii), and that the resultant artifact in this research can also be classified under (iii).

The left part of figure 2.1 is discussed in the proceeding section. Following is a discussion of aspects presented in the right part of figure 2.1.

(i) Approaches for supporting architecture modeling. Since architecture frameworks recommend the use of a given modeling language and do not define real modeling concepts or constructs for enterprise architecture, the ArchiMate enterprise architecture modeling language was developed [67]. ArchiMate enables the expression of business processes and their IT support in an easily understandable way (without low level implementation details), supports visualization and analysis of organizational aspects, and enhances communication and management of architectures [67]. ArchiMate complements

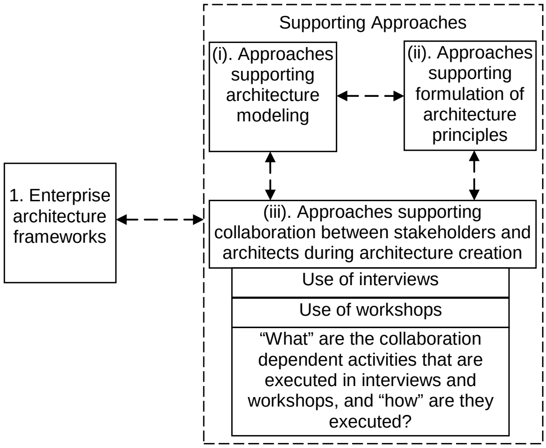

Figure 2.1: *Classification of Enterprise Architecture Approaches*

TOGAF by offering generic concepts that enable creation of consistent and integrated models, which properly communicate architecture views, and enable communication and decision making across enterprise domains [68].

(ii) Approaches for supporting formulation of architecture principles. Attempts have been made to improve the way architecture principles are defined, since they have a significant role in enterprise architecture development. Architecture principles represent general requirements for a class of systems (in this case an enterprise) [37], they guide the enterprise architecting process, and justify decisions made on architecture components [98]. A detailed discussion of the roles of architecture principles in enterprise architecture is provided in [43].

In [97] an enterprise engineering framework is presented, to support (a) the definition of principles in a specific and measurable way, (b) effective and efficient assessment of the impact of principle(s), (c) the detection of possible contradictions in principles so that they can be adequately prioritized or clarified, and (d) the traceability in cause-effect analysis of aspects. In [10] it is demonstrated how the basic logical principles of Object Role Modeling and Object Role Calculus can be used to systematically formulate architecture principles and improve their quality. Moreover, in [83, 97, 98] approaches are presented for enabling formulation of architecture principles in a collaborative context, involving key stakeholders.

Although approaches for defining architecture principles in a collaborative context have been developed, they do not consider how other products of the architecture process can be created in a collaborative context (involving enterprise architects and stakeholders). Enterprise architecture products generally include "*visualizations, graphics, models, and/or narrative that depicts the enterprise environment and design*" [115], and they are not limited to principles [96]. These products describe the enterprise architecture decisions taken, and offer an organization-wide approach for communicating and enforcing such decisions [105]. Thus, during architecture creation, one needs to look into aspects such as creating a shared understanding (of the organization's problem and the desired solution) among stakeholders and architects, building consensus on the requirements that the enterprise architecture must address, and collaboratively evaluating design alternatives for the enterprise architecture. Attempts that are very close to addressing these issues (and those in categories A and B in sections 2.2.2 and 2.2.1 above) include the following.

(iii) Approaches for supporting collaboration with stakeholders during architecture creation. These include approaches that support information gathering and processing during architecture models.

In [9, 124] Business Scenarios are discussed as a technique for defining business requirements before or during enterprise architecture development. According to Blevins et al. [9, 124], the Business Scenarios method involves three phases which involve gathering, analyzing, and reviewing information on (a) the problem driving the scenario, (b) the business and technical environments associated with the scenario, (c) the business objectives, and (d) the human and computer actors involved, and their responsibilities in the scenario. In the gathering phase, Blevins et al recommended several techniques that can be used (*e.g. "basic research, qualitative and quantitative analysis, surveys, requests for information, business scenario workshops"*) to elicit the required information from stakeholders. However, details are not given on *how* to use the prescribed techniques in a workshop or *how* to facilitate a business scenario workshop.

In addition, Spewak [121] reveals the Enterprise Architecture Planning (EAP) method. EAP describes how to obtain the following deliverables of the Zachman framework (a) an organization's business objectives, (b) scope, and (c) a high level business, data, applications, and technology architecture models. Spewak gives a detailed description on how interviews can be used during enterprise architecture creation, but discourages the use of workshops. Spewak recommends the use of interviews to gather, organize, and verify information that is used to develop a detailed baseline business model of the organization. While EAP interviews are not opposed here in anyway, we advocate for an alternative view that group sessions involving key stakeholders can also be used to effectively and efficiently gather such information. Group sessions can help architects to avoid conducting an overwhelming number of interviews, and to address conflicting aspects in the information gathered from individual stakeholders. In contrast, Spewak argues that group meetings are not suitable because they tend to focus on design issues (or answering "how-to" questions), yet architecture planning should focus on defining the business and not designing systems. However, depending on how group meetings are conducted, they can be an effective way of communicating with stakeholders when defining the business and designing an organization's enterprise architecture. Also, group meetings or conversations on enterprise architecture creation can be structured in a way that enables stakeholders to answer the "what" and "why" questions, and the "how" questions (if necessary). Chapter 3 discusses approaches that can realize this by enabling flexible facilitation of group meetings.

Regarding communication in architecture creation, Proper et al. [104] discuss how communication between stakeholders and architects during architecture development is a conversation that (1) aims at achieving certain goals, (2) is affected by several parameters, and (3) can be implemented using techniques (such as workshops, interviews, or mailing systems). Moreover, Green and Bate [44] present the VPEC-T (i.e. Values Policies Events Content Trust) framework that enables effective communication between business stakeholders and IT professionals during systems development. Although the VPEC-T framework is generic to IS development, its concepts can be adopted to improve communication in enterprise architecture creation, by providing a standard vocabulary between stakeholders and architects.

Information that is still unknown. In category C it is evident that aspects related to executing collaboration dependent tasks during enterprise architecture creation have been superficially addressed. Janssen and Cresswell [57] note that support for creating a shared understanding is lacking in many architecture approaches, and they encourage the use of simulation techniques and workshop sessions during architecture creation. However, it is still implicit how the workshops or group sessions can be facilitated in order to achieve repeatable results when using enterprise architecture approaches along with simulation techniques. In general, there is still lack of a clear and flexible operational perspective on *how* to execute collaboration dependent tasks. As noted in categories A (section 2.2.1) and B (section 2.2.2), most work mainly gives prescriptions of what should be done to improve enterprise architecture creation through encouraging collaborative decision making, but details of how to realize the prescriptions are hardly found. Even closer attempts to implement these prescriptions (classified in figure 2.1 and discussed above) appear in a generic form – remaining rather silent on some essential operational details. In particular there is still lack of an in-depth procedural specification of how to conduct workshop or group sessions during architecture creation, such that collaborative decisions can be reached regarding the constituents of the resultant enterprise architecture. Thus, detailed answers to several "how-to" questions on executing collaboration dependent tasks during enterprise architecture creation, are left in the hands of a skilled or professional facilitator. The implications of this are provided in chapter 3.

We acknowledge that the above attempts (discussed in categories A, B, and C) define very useful concepts that were adopted in this research to (a) provide a basis for investigating missing information in architecture creation literature (see section 2.3), and (b) define collaboration dependent tasks in architecture creation (see chapters 4 and 5).

2.3 Exploratory Survey

For a clear illustration of the rationale for an exploratory survey in this research, activity theory is adopted. Activity theory is a philosophical schema that helps one to explore and understand a given type of practice, as an evolutionary process that interlinks individual and social actions [66]. According to [35, 66, 80, 82], activity theory articulates that an activity comprises the following interrelated aspects, i.e. subject, object, tools, rules, community of practice, division of labour, and outcome. Adopting Engeström's model [35], figure 2.2 shows the internal relations among these aspects and their interpretation in the context of this research.

An *activity* is a "*basic type of context*" or "*development*" that is uniquely identified by its object (or objective), and "*is realized through conscious and purposeful actions by participants*" ([66], pages 255 – 256). As shown in figure 2.2, creating an enterprise architecture can be conceived as a compound activity (i.e. a collection of sub activities that contribute to the objective of the main activity). According to [35, 66, 80, 82], activity theory articulates that *tools* (i.e. symbols or artifacts) mediate between the *subject* (i.e. the important actor(s) for the execution of an activity) and the *object* (i.e. the objective or intended achievement of an activity). Figure 2.2 shows the relevant mediating tools (i.e. the constituents of category C), the subjects, and the intended object of the enterprise

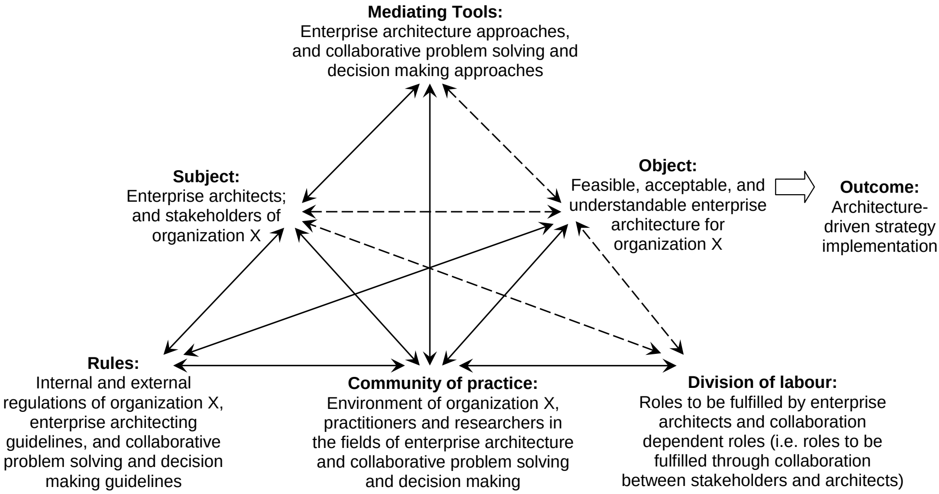

Figure 2.2: *The Activity of Creating Enterprise Architecture (Based on [35])*

architecture creation activity.

Activity theory further articulates that there are various *rules* that govern or influence the execution or practice of the activity, and there is a *community* interested in the practice of the activity or its execution [35, 66, 80, 82]. Figure 2.2 shows that in the architecture creation activity, the rules include (a) principles (and policies, cultural values, strategic business drivers, and business goals) and business requirements of the organization of interest, (b) external laws from regulatory bodies to which the organization is accountable, (c) guidelines in category B and the in-built guidelines of architecture approaches in category C, and (d) guidelines defined by collaborative problem solving and decision making approaches. Figure 2.2 also shows the constituents of the community in which this activity is executed. In the community, the environment of the enterprise in which the architecture creation activity is executed varies due to differences in culture and norms (more on this environment is discussed in sections 4.4 and 6.6).

Moreover, activity theory emphasizes that the execution of the activity requires *division of labour*, such that roles are specified and organized to clearly indicate who does what [35, 66, 80, 82]. Almost all aspects of the activity theory are explicitly answered when one attempts to perceive enterprise architecture creation as an activity, except this aspect of division of labour. The bottom right corner in figure 2.2 indicates that division of labour during architecture creation involves roles that must be accomplished by the enterprise architects, and those that are collaboration dependent. Sections 2.2.3 and 1.7 indicate that the execution of the former is richly addressed in literature, while it is implicit how the latter should be executed and how labour should be broken down during the execution. Thus, there is lack of an explicit and detailed orchestration of sub-roles of the subjects (i.e. stakeholders and architects) during the effort of fulfilling the collaboration dependent roles.

Consequently, the dashed lines in figure 2.2 indicate the scarcity of a mediating artifact that is engineered to support stakeholders and architects when fulfilling the collaboration dependent roles, so as to achieve the intended object of the architecture creation activity. Moreover, although the division of labour (or dissemination of roles) during execution of collaboration dependent roles is challenged by several factors (e.g. organization culture, expertise of stakeholders in the enterprise, organization politics etc), a detailed account of these factors is scarce in the architecture creation literature. Literature in category A (in section 2.2.1) hardly provides an elaborate description of challenges that occur when enterprise architects deeply involve organizational stakeholders in architecture creation. Yet understanding the details of these challenges is a prerequisite for devising a relevant solution to practitioners (in this case enterprise architects). In Design Science the significance of the research depends on the views of practitioners in the problem environment, as they will be willing to deploy the resultant artifact if it solves their problems or if it avails ways of improving practice [49]. Therefore, an exploratory survey was conducted among enterprise architects with the aim of investigating challenges they face when they involve stakeholders in enterprise architecture creation. Section 2.3.1 elaborates this. Section 2.3.2 presents the design of the survey and section 2.3.3 discusses survey findings.

2.3.1 Focus of the Survey in the Research Framework

This section provides an overview of how information that was gathered from the exploratory survey is associated with other key aspects in this research. This overview is shown in figure 2.3. In the top left part of figure 2.3, the circle represents an existing enterprise and the dashed arrows pointing to the circle represent various challenges an enterprise can encounter (as discussed in section 1.2.1). These change initiators may motivate the enterprise to get involved in meetings or conversations associated with creating an architecture that will guide its transformation from the baseline situation to the target situation (as indicated by the hollow right-facing arrow at the top part of figure 2.3). Aspects discussed in the meeting (such as courses of action) are documented in enterprise architecture models (as indicated by the scroll in the right part of figure 2.3).

The hollow bottom-facing arrow in the top left part of figure 2.3 represents a link between the meetings or conversations conducted and their attributes. The attributes of the meetings are represented using boxes shown in the left part of figure 2.3. The research questions associated with these attributes are shown in the middle part of figure 2.3. The boxes with dashed edges in the left, middle, and right parts of figure 2.3 represent groupings of aspects, i.e. the three levels of interactions that occur in meetings (as defined in [78]), the research questions (in section 1.5), objectives (in section 1.6) and the research deliverables.

Mulder et al. [78] suggest that interactions in meetings occur at three levels, i.e. social, information system, and infrastructure levels (as indicated by the grouped boxes in the left part of figure 2.3). In this research, the social level describes interactions (among humans or actors in the meeting) which are influenced by the agenda of the meeting and the tools and techniques used in the meeting. This is indicated by the upward facing arrows among the un-grouped boxes in the left part of figure 2.3. The infrastructure level and information system level are perceived as a collection of tools and techniques that are used before, during, and after meetings. These tools can be computer-based or paper-based [14, 78], as indicated by the boxes in the bottom left part of figure 2.3. More details on these tools and techniques are discussed in chapter 3. As indicated by the face symbol and the question marks above it (see middle part of figure 2.3), the research questions are

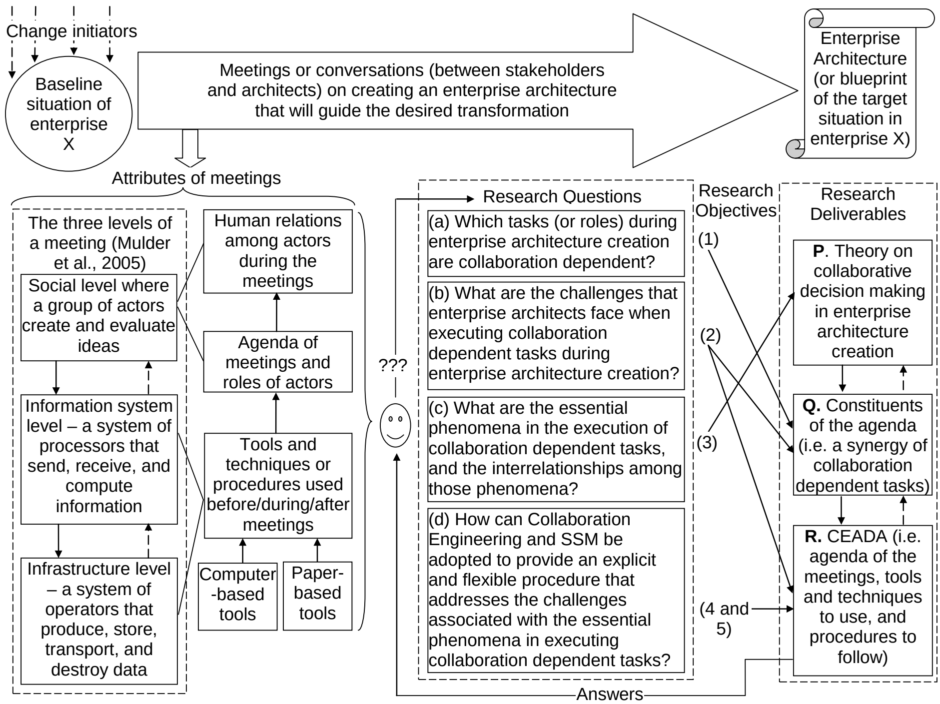

Figure 2.3: *Focus of the Survey in the Research Framework*

concerned with the agenda of the meetings on enterprise architecture creation, the roles of actors in those meetings, and the tools and techniques that can be used to conduct the meetings.

As indicated in the box with research question (b) in figure 2.3, the exploratory survey was an effort towards gathering insights (from enterprise architects) into answers to research question (b) and research objective (2) in sections 1.5 and 1.6 respectively. Findings from the exploratory survey were useful in achieving research deliverables Q and R (see right part of figure 2.3).

2.3.2 Survey Design

This section discusses the aim of the survey, target respondents, survey questionnaire, sample size, sampling method used, the way in which the survey was conducted, and limitations of the survey.

Aim of the survey. The main aim of the exploratory survey was to investigate challenges that enterprise architects face when executing collaboration dependent tasks during the activity of creating an enterprise architecture. From figure 2.3 (in section 2.3.1 above), these challenges were assumed to be associated with the collaborative relations among actors, the agenda, and the tools and techniques used. Thus, questions were formulated on the following three topics.

- Factors that hinder effective collaboration among stakeholders and enterprise architects during enterprise architecture creation.

- Methods that architects use to manage the execution of collaboration dependent tasks with stakeholders, and the strengths and weaknesses of those methods.
- Recommendations on how to overcome the challenges encountered during execution of collaboration dependent tasks, and on factors for successful enterprise architecture creation.

Target respondents and questionnaire used. The (target) respondents in this survey were enterprise architects. A self administered questionnaire was first designed with open-ended questions that investigate matters associated with the above three topics (see appendix A, figure A.1). The questionnaire with open-ended questions was then tested among ten (10) enterprise architects. This was done by emailing the open-ended questionnaire to fourteen (14) enterprise architects, ten of whom responded. Thereafter, responses from the ten enterprise architects were reviewed, coded, and used to formulate possible responses to majority of the open-ended questions in the questionnaire. Thus, the first version of the self administered questionnaire was refined (by converting the majority of the open-ended questions into closed questions) based on responses or insights that were gathered from the ten architects who participated in the questionnaire testing. The refined version of the self administered questionnaire is provided in appendix A (see figures A.2, A.3, and A.4) and was the one used in the actual exploratory survey.

Sample size and sampling method used. For the actual survey to be conducted, there was need to first estimate a feasible sample size and to choose an appropriate sampling method. According to [65, 69, 114], the appropriate sample size to use in a survey depends on factors such as (a) the size of the population and its heterogeneity with respect to the features of interest, (b) the acceptable sampling error (i.e. the error that occurs in survey results due to studying a sample instead of the whole population), (c) the desired level of accuracy (or confidence), and (d) the desired statistical value (i.e. population mean or proportion – the percentage of individuals who fall into a given category). In this survey it was difficult to estimate the actual size of the population of enterprise architects (as they were our target respondents). Thus, we considered to conduct the survey by contacting enterprise architects through their mailing lists. This is because we assumed that the subscribers to these mailing lists were enterprise architects. Thus, we did not have to inquire whether one was an architect or not for him or her to participate in the survey.

In addition, in this survey it was considered feasible to have an accuracy level of at least a 95% confidence interval and a sampling error of at most ± 10%. The statistical value that was considered from the survey was the percentage of enterprise architects who experience or do not experience the aspects this research was investigating. Therefore, the following formula, as defined in [65, 69, 114], was used to calculate the required sample size in this survey:

$$s = \frac{z^2(p(1-p))}{e^2}$$

Here s represents the required sample size, z represents the number equivalent to the desired level of confidence, p represents the estimate of the proportion of people (i.e. enterprise architects) who experience or do not experience collaboration-related aspects or issues during enterprise architecture creation, and e represents the acceptable sampling error. Since the self administered questionnaires were to be posted on mailing lists of enterprise architects, it was assumed that 90% of the enterprise architects (i.e. subscribers to these mailing lists) experience collaboration-related aspects or issues during enterprise architecture creation. Hence the value of p (in the formula above) is 90%. Moreover, since the desired level of confidence was 95%, then the z value from the z statistical tables is z = 1.96. Since the sampling error was at most ± 10%, then in the formula above e = 0.1. Inserting these values in the equation above gives s = 35. Therefore, in this exploratory survey the minimum required sample size was 35 enterprise architects. The next step was to determine an appropriate sampling method for selecting the sample of enterprise architects.

Sampling method that was used. Sampling methods are divided into two categories, i.e. probability sampling methods (which are used when the list of the whole population of study is available and it is possible to determine the likelihood of selecting any of the population units) and non probability sampling methods (which are used when the list of the population of study is not available and is difficult to obtain) [65, 100, 114]. In this survey the list of the target population (i.e. all enterprise architects) was not available and was difficult to obtain. Therefore, a non probability sampling method was used, which is referred to as purposive (or purposeful) sampling in [65, 100, 114]. Purposeful sampling is used when there is need to study and understand something about, or features of, a specific (small) group of people [100].

The way in which the survey was conducted. The survey was conducted online (via http://www.thesistools.com/), where the target respondents received the questionnaires through the mailing lists of enterprise architects. The survey was active online for a period of three months.

Response Count. At the end of the three months, 70 enterprise architects had participated in this online survey. This response count doubled the sample size of 35 participants (that was estimated above), and consequently lowered the sampling error from ± 10% (if only 35 architects had responded) to approximately ± 7% (since 70 architects actually responded). The new mentioned sampling error of ± 7% is got by substituting the response count (i.e. s = 70) into the equation above. The resultant value is e = 0.07, which is the sampling error of ± 7%.

Limitations of the survey. Since it was difficult to estimate the actual figure of the target respondents, we can not determine detailed aspects of the survey such as the non-response rate in this survey, the accuracy of a sample size of 70 enterprise architects who participated in the survey. Also, the survey questionnaire did not investigate details of heterogenous factors in the population of architects (e.g. their age, gender, years of experience, number of architecture projects they have been involved in, organizations they are affiliated to, their successful and failed projects, etc). Moreover, we notice that ± 7% is a relatively high sampling error. Therefore, in this research, results from the survey are treated as pointers to the breadth and/or depth of the issues that need to be dealt with in the effort towards achieving CDM in enterprise architecture creation. This implies that we use survey results as a source of information (about the problem domain) that can be used to elaborate the research problem, but we do not use the statistics (such as percentages) that are associated with the exploratory survey findings as a basis for testing hypothesis or drawing predictions or conclusions on matters associated with this research. Section 2.3.3 discusses survey results that were considered relevant in this research.

2.3.3 Survey Results

Survey findings have been classified into three topics, i.e. (i) challenges faced during execution of collaboration dependent tasks, (ii) methods used in practice (and their strengths and weaknesses) to support execution of collaboration dependent tasks, and (iii) recommendations from enterprise architects on how the problems encountered can be overcome (i.e. success factors for enterprise architecting). This is because in this research we were interested in the issues that architects reported with respect to these three topics (this is elaborated in section 2.3.2). These issues are presented in this section, while details of percentages of architects who reported particular issues are provided in appendix A.

2.3.3.1 Challenges in Executing Collaboration Dependent Tasks

Exploring problems faced in executing collaboration dependent tasks was necessary for motivating and informing the development of detailed operational support for these tasks. Details of percentages of architects who reported particular problems are provided in appendix A. For proper understanding of the various problematic issues that were reported by architects, there was need to first categorize them. This would enable us to first deal with a given problem category, and thereafter deal with specific sub problems within that category. The categorization of problems reported in the survey resulted into seven major problems that are discussed below. Constituents of each main problem are sub problems or causes or effects thereof. The challenges or problems categorized below generally include those that hinder effective collaboration between stakeholders and architects, those faced when evaluating enterprise architecture design alternatives with stakeholders, and those faced when delivering architecture products.

Ineffective communication. Architects reported that communication is problematic because the language they use to explain the value of architecture to stakeholders is abstract, while stakeholders use words that do not have the same meaning for everyone. Specific issues under this category include the following:

- It is difficult to use the right language such that every stakeholder understands the architecture aspects.
- Limited awareness of the architecture (and its relevance, goals, content or views, and its implications on business operations) among stakeholders, causing them to perceive architecture to be about only technology.
- The old fashioned distinction between business and IT.

Lack of a shared understanding and shared vision or strategy. Architects reported that since it is difficult for some stakeholders to imagine a new situation, there is often lack of a shared understanding and vision of the business, its future development, its enterprise architecture, and the consequences of the architecture on the organization's sub levels. Specific issues under this category include the following:

- There is lack of shared agreement among stakeholders and it is hard to reach a compromise or to get everyone to agree with the same result.
- The lack of documentation of knowledge in the organization.

- The complexity in bridging the gap between the abstract long term consequences and the more concrete examples that stakeholders can understand.

Social complexity. This issue appears in form of:

- Conflicting stakeholders' interests and differences in perception, and stakeholders climbing the ladder of inference – overreacting or quickly drawing conclusions based on personal beliefs and insecurities.
- Key stakeholders having no or insufficient time (or low priority) for participating in collaborative tasks, and yet project time schedules are tight.
- Organization politics and hidden agendas, which result in fuzzy decision making and blockage of long term visions to achieve short term and selfish needs.
- Biased scores or judgments due to personal preferences, agendas, visions, or the "Not Invented Here" syndrome among stakeholders.
- Difficulty in reaching a compromise on crucial aspects.

Lack of long term planning. Architects reported that in some organizations, long term effects may not be considered as part of the business case, and the business and IT staff that should participate in the architecture project may be unknown, or project managers may be assigned late when the projects are already on critical path. In addition, lack of commitment from people who were not earlier involved in the architecture process, or sometimes concerns arise from other stakeholders who were not seen as key stakeholders before.

Lack of a clear decision making process or unit in the organization and architecture governance. This problem comprises the following:

- Architects reported that this problem results in stakeholders not being accountable for their decisions.
- Since architecture is often perceived to be about only technology, some organizations lack a governance process for ensuring architecture compliancy.
- For organizations that lack a clear decision making or governance structure, a contradictory situation arises where during architecture creation there was a loud applause to matters discussed, but after there is no action taken towards supporting their realization. This can occur if architecture conclusions conflict with personal ambitions, or when the architecture is too complex for the decision making unit or organization maturity level. It therefore becomes difficult to translate enterprise architecture products to program start architectures.
- Habitually, architecture products do not deliver what has been promised or what was required.
- Sometimes stakeholders do not want to (or are not able to) follow the advised architecture, or where the created architecture shows that the impact of the business strategy is higher than anticipated. Incase of the latter, the client organization may change its business plans. The architecture requirements management phase of TOGAF ADM gives insights into how this situation can be dealt with [124].

Lack of supporting tools and techniques for executing collaboration dependent tasks. No other problems were identified under this category. Related issues to this problem are shown in figure 2.5.

Other factors.

- Financial budgets and time schedules are too constrained to allow sufficient interactions with stakeholders, so as to minimize diversity and complexity in evaluating alternative courses of action.
- The "100% syndrome" of some architects impairs collaboration with stakeholders.
- Some stakeholders have an attitude of "the outsider is the expert, but the outsider does not understand our situation".
- It is difficult to quantify the advantages and disadvantages of design alternatives so as to enable informed evaluation or tradeoff analysis.
- Some stakeholders are unqualified to execute the tasks assigned to them.

2.3.3.2 Further Classification of the Reported Challenges

For better conceptualization of the problems architects face in executing collaboration dependent tasks, we further classified challenges by determining possible relations between or among the categories of problems presented in section 2.3.3.1.

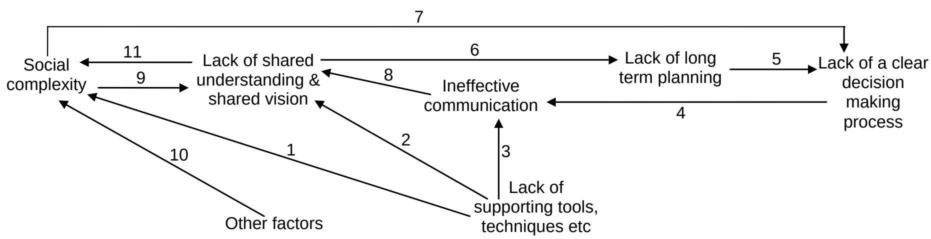

Figure 2.4: *Challenges in Executing Collaboration Dependent Tasks*

Figure 2.4 shows that ineffective communication causes the lack of a shared understanding and shared vision (see line 8). The lack of a shared understanding and shared vision or strategy is also caused by the lack of supporting techniques for collaborative tasks (see line 2) and social complexity in the organization (line 9). Social complexity is partly caused by the lack of supporting techniques to enhance effective collaboration among stakeholders, or by other factors (see lines 1, 9, and 11). Figure 2.4 also shows that the lack of long term planning is partly caused by lack of a shared understanding and vision (line 6). The lack of a clear decision making process or unit in the organization and architecture governance is partly caused by social complexity and lack of long term planning, but it is also one of the causes of ineffective communication (see lines 7, 5, and 4 respectively). The lack of supporting tools and techniques for executing collaboration dependent tasks is partly the cause of ineffective communication, lack of shared understanding, social complexity, and consequently the lack of long term planning (see lines 3, 2, 1, and 3 – 8 – 6 respectively).

2.3.3.3 Findings on Collaboration-Support Methods Used by Architects

To address issues associated with executing collaboration dependent tasks during enterprise architecture creation, there was need to also find out the methods architects use to execute such tasks, and the strengths and weaknesses of those methods. The strengths and weaknesses of the methods currently used gives insights into what needs to be done in order to improve collaboration between stakeholders and architects. For example, knowing weaknesses that need to be addressed in a particular method helps to improve the method through refining it or supplementing it with other methods. Figure 2.5 shows an overview of the methods used, the percentage of architects who use them, and the strengths and weaknesses that architects reported about the most widely used methods (i.e. interviews and workshops).

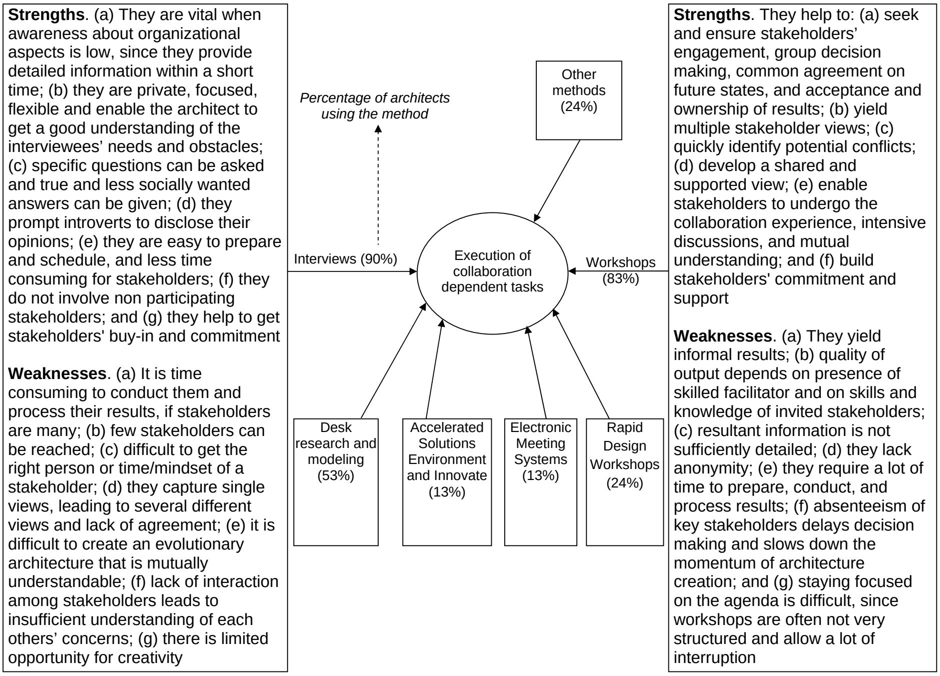

Figure 2.5: *Methods Used When Executing Collaboration Dependent Tasks*

Architects reported that if workshops are prepared and conducted properly, they are a more efficient way of executing collaboration dependent tasks than interviews. Architects who use Electronic Meeting Systems (defined in sections 1.4 and 3.5.2) in their workshops reported that it is an effective and efficient way of sharing and storing content in a workshop, although it requires a lot of preparation time. Also, the successful use of workshops during architecture creation remains ad hoc and relies on existence of a professional or skilled facilitator (see item (b) in right bottom part of figure 2.5). Since workshops are widely used to support collaboration between stakeholders and enterprise architects during architecture creation, there was need for an explicit and flexible approach of facilitating them. Explicit in this context refers to a possibility where an enterprise architect can be able to successfully use the approach to execute collaboration dependent tasks, without relying on the presence of a professional facilitator.

Figure 2.5 also shows the desk research method. It was reported that this method is useful in almost all cases, because it helps one to get a deeper understanding of various aspects in an organization. However, it is difficult to divide work among architects, and it is time consuming to process data gathered using this method.

Figure 2.5 also shows the rapid design workshops and the Accelerated Solutions Environment (ASE). These are generic methods used in practice to create commitment, agreement, and approval of a business transformation initiative among a large group of critical stakeholders [51]. Although ASE covers several types of business transformation initiatives, its concepts are also used in enterprise architecture creation to secure stakeholders' commitment and approval. In the survey, architects acknowledged these methods for their support for thorough discussions and interactions among stakeholders, and the good speed at which things are done. It was also reported that the success of these methods depends on the presence of a skilled or professional facilitator. However, enterprise architects reported the following two issues that are associated with these approaches: First, ASE is sometimes too fixed on achieving a specific task. Secondly, these methods support a limited depth of problem solving and elaboration of aspects.

Other methods used include: gaming, massive emailing, thematic work groups, peer reviews, elaborate-review sessions, crowd sourcing or co-creation methodologies.

2.3.3.4 Recommendations From Enterprise Architects

Architects gave a number of recommendations on how the challenges they face could be addressed, and success factors for enterprise architecting. Details of percentages of architects who gave particular recommendations are provided in appendix A. Below is a categorization of the recommendations.

Explicitly define purpose of enterprise architecture creation

- Get the business goals clear and know the reasons for creating the architecture, or which organization problems should be solved by creating the architecture.
- Create a vision of the enterprise architecture and ensure that it is shared and owned by top management.
- Evaluate projects basing on long term contribution, rather than just time and budget as is normal practice.

Collaborate with the right people

- Select the right stakeholders and collaborate with them early in the architecture process.
- Create a situation where all stakeholders experience the development process by scheduling short group sessions that fit in the schedules of key stakeholders early in the process.
- Ensure good collaboration with owners or subject matter experts in order to create a strong sense of cooperation and shared objectives.

- Architects, project manager(s), and business executive(s) need to respect each others' roles.

Communicate clearly and regularly

- Ensure regular communication with stakeholders (e.g. problem owners or subject matter experts) to keep everyone on track.
- Give stakeholders an understandable and visible translation of business goals into the architecture, since architecture is purely a means by which an organization can achieve its goals. Architecture creation entirely involves translating strategy into desired business operations [59, 96].
- Show short-term and long-term benefits of architecture, and develop architecture roadmap that fits to the organization's overall maturity, ambitions levels and change proficiency (e.g. the organization's change management potential could be taking little steps at a time – slow change management approach).

Ensure establishment of a clear decision making process and governance framework

- Ensure establishment of a clear decision making process or architecture board which can make decisions, or give a clear mandate to architects to make decisions within agreed boundaries.
- Ensure that the architecture function is clear and linked to other management frameworks in the organization.

Other

- Start on architecture creation as soon as possible and deliver results to key stakeholders in the shortest possible time.
- Quality of architecture team and the level of collaboration among architects.

2.4 Summary of Survey Findings

In section 2.3.3 survey results have been categorized to have a holistic understanding of them and determine coherent ways of addressing issues reported and recommendations given in the survey. Table 2.1 shows the problem categories that were derived from the problems reported (column 2) and recommendation categories that were derived from the recommendations given (column 3) by enterprise architects who participated in the survey. In table 2.1, we have matched a given problem category with a recommendation category. As shown in the 6th row of table 2.1, no matching recommendation category was found to the problem category of "lack of supporting tools and techniques for executing collaboration dependent tasks". However, we acknowledge that this problem category is one of the causes of the other problem categories (see figure 2.4).

Findings from the exploratory survey generally indicate that although involving stakeholders in enterprise architecture creation is vital, it results in several issues. These issues

Table 2.1: *Summary of Survey Findings*

#	Category of problems reported in the survey	Category of recommendations given in the survey to address a given category of problems
1	Lack of a shared understanding and shared vision or strategy	Explicitly define purpose of enterprise architecture creation
2	Social complexity	Collaborate with the right people
3	Ineffective communication	Communicate clearly and regularly
4	Lack of a clear decision making process or unit in the organization and architecture governance	Ensure establishment of a clear decision making process and governance framework
5	Lack of long term planning	
6	Lack of supporting tools and techniques for executing collaboration dependent tasks	Other
7	Other problems	

justify the need for supplementing existing enterprise architecture approaches with support for collaborative problem solving techniques. This will, for example, help to create a shared understanding of the problem and solution aspects among stakeholders. Recommendations from the survey give insight into how collaboration between stakeholders and architects can be improved during architecture creation.

In the perspective of Design Science [49], the problematic aspects presented in this chapter were perceived as problems that had to be addressed (to some extent) by the research. The left part of figure 2.6 shows that this chapter mainly highlights the theoretical and practical insights into problems the research had to solve. First, the discussion of literature in categories A, B, and C in section 2.2 points to issues that need to be addressed in order to achieve collaborative decision making during enterprise architecture creation (details on this are discussed in chapters 4 and 5). Secondly, the survey findings reveal problems faced in practice during execution of collaboration dependent tasks. This gives insight into the practical relevance of developing an artifact that enables proper stakeholder involvement, so as to achieve collaborative decision making during architecture creation.

Moreover, in the survey architects suggested possible solutions to the problems they encounter during architecture creation. These are discussed in chapter 5, as part and parcel of the requirements for realizing collaborative decision making during enterprise architecture creation. Thus, as shown in figure 2.6, chapter 5 provides a high level operational viewpoint on how to execute collaboration dependent tasks, while chapter 6 provides a low level operational viewpoint on how to execute collaboration dependent tasks. However, prior to discussing the solution to the research problem, there is need to delve into the knowledge base again, so as to determine the most appropriate approaches that can be deployed or adopted to address the breadth and depth of the required solution. As shown in figure 2.6, this is done in chapter 3.

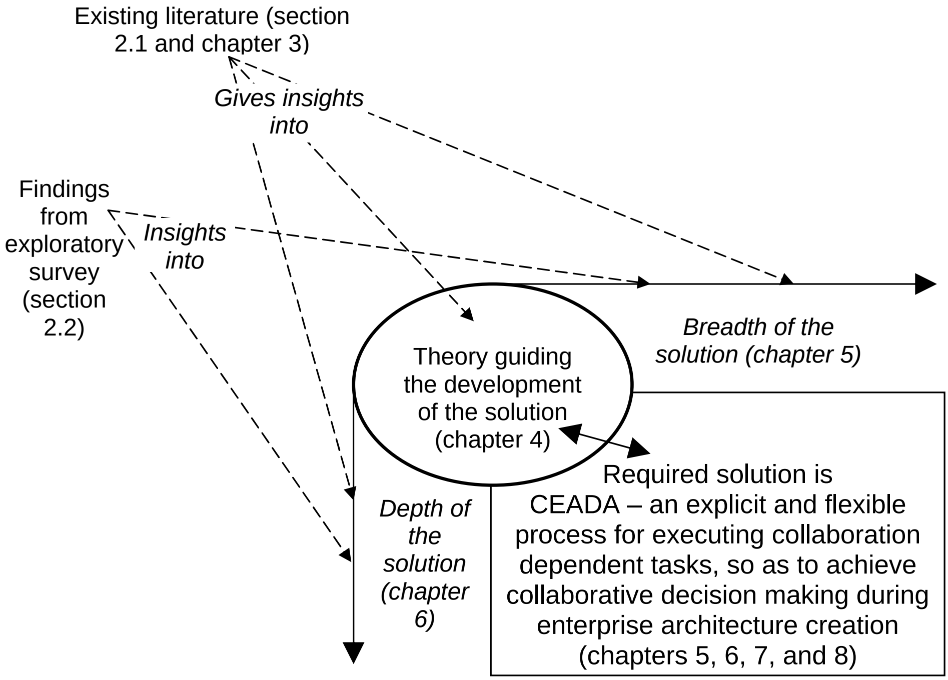

Figure 2.6: *Perspectives on the Breadth and Depth of Required Solution*

Chapter 3

Collaborative Decision Making

Abstract. This chapter discusses the collaborative nature of enterprise architecture creation. Based on that line of thought, it discusses a taxonomy of approaches that support collaborative problem solving and decision making. From the taxonomy, approaches that are considered pertinent in this research are selected and discussed. The core selected approaches are Collaboration Engineering and Soft Systems Methodology.

3.1 Chapter Overview

In Design Science answers to research questions are obtained through adopting (a) theoretical foundations – scientifically proven approaches and experiences that are fruits of various research efforts and can be used in the design cycle of an artifact, and (b) research methods – approaches that guide the evaluation phase of the artifact [49, 50]. In this research, a number of approaches have been adopted in the design and evaluation of CEADA artifact. Approaches adopted in the evaluation of this artifact are discussed in chapter 7. This chapter discusses approaches that have been selected and adopted to design the artifact such that it addresses the research problem (see figure 3.1). The boxes in figure 3.1 represent a research task, the cylinder represents a repository of existing approaches, and the dashed lines with arrow heads represent information flow between two representations.

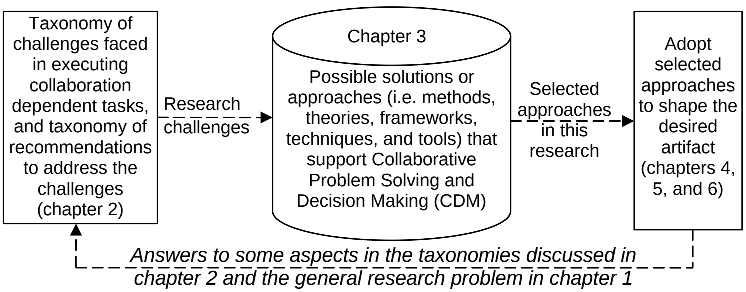

Figure 3.1: *Potential Solutions to the Research Problem*

The middle part of figure 3.1 shows that among the various types of approaches that support Collaborative (Problem Solving and) Decision Making (CDM), some have the potential of providing solutions to the research problem. This chapter presents such approaches and also discusses factors that influenced their selection for adoption in this research. This chapter is structured as follows. Section 3.2 discusses how enterprise architecture creation can be perceived as a type of CDM task. Section 3.3 discusses attributes that can be considered when selecting and adopting approaches that support execution of collaboration dependent tasks in enterprise architecture creation. Section 3.4 discusses the basic nature of the enterprise architecture creation activity. Section 3.5 discusses a taxonomy of approaches that support task structuring and execution. Sections 3.6 – 3.9 briefly discuss selected and adopted approaches in this research, and section 3.10 concludes this chapter. Some parts of this chapter are a (slightly) modified version of sections of work in [90, 88, 94].

3.2 CDM in Architecture Creation

Despite the numerous benefits of enterprise architecture, its value proposition and the role of an enterprise architect are not understood in organizations accustomed to reactive decision making [60]. Program managers in such organizations (or who are used to independently devising mission-specific solutions) perceive enterprise architecture as a "*hostile takeover*" and may resist its creation, for fear of the new language and planning processes associated with it [8]. However, involvement of organizational stakeholders during architecture creation, to ensure that their concerns are considered helps to create stakeholders' support and commitment [57]. Increasing stakeholder involvement in the architecture creation process implies increasing their control in the process, which along with strong executive sponsorship can overcome resistances to architecture creation [8]. However, increasing stakeholder involvement in the architecture process means subscribing to the challenges discussed in sections 2.3.3 and 2.4. Hence the need to identify approaches that can support CDM in enterprise architecture creation.

On the one hand tasks involved in creating enterprise architecture generally include (1) creating a joint conceptualization of the organization's problems, strategies or solutions, (2) understanding the purpose of creating the architecture, (3) determining the (essential) deliverables of the architecture effort, (4) designing the actual process of creating the architecture [96], (5) identifying and refining stakeholders' concerns and requirements, (6) developing architecture views that show how these requirements will be addressed, trade-offs that need to be made to resolve any conflicts [124], (7) assessing alternatives, (8) risk assessment and mitigation, (9) making decisions and determining impacts of those decisions [96], and (10) communicating the architecture creation results [104, 96]. On the other hand, CDM involves (a) having direct and reciprocal communication about the (problem) situation among parties involved, (b) being creative in formulating solution strategies and new alternatives, (c) making shared decisions, and (d) reaping joint payoffs from the decisions made [107].

When tasks (1) – (10) above are perceived with respect to tasks (a) – (d) above, it can be claimed that enterprise architecture creation tasks are a flavor of CDM tasks. DeSanctis and Gallupe [28] communicate that CDM or group decision making focuses on "*situations where groups must, in fact, reach a decision, and where the intention is that the decision be implemented following the collaborative experience of the group meeting*" (page 590). From this notion we derive the basic definition of "CDM in enterprise architecture".

CDM in enterprise architecture creation describes an active and somewhat transparent process that occurs when stakeholders and enterprise architects ought to agree on a course of action, and the main motive of seeking the group agreement on a given course of action is that the "collaborative experience" that the stakeholders undergo will influence them to implement the agreed on course of action. This implies that co-creation of enterprise architecture (i.e. having architects and stakeholders collaboratively define and specify the enterprise architecture) is likely to positively influence the success of implementing the specified architecture. Although we take this assumption to be true, this research does not involve studying the long term impact of architecture co-creation on the success of the architecture implementation. Rather, it involves studying effective and sustainable ways of achieving architecture co-creation, where we suppose that proper stakeholder involvement in architecture creation can be achieved through CDM.

Despite its benefits, CDM involves several challenges, most of which are echoes of the impediments (discussed in section 2.3.3) to effective execution of collaboration dependent tasks. Examples of such challenges include poor planning, poorly defined goals [18, 95], lack of consensus, a poor grasp of the problem, ignored alternatives, groupthink, conflicting interests, digressions and distractions, hidden agendas, wrong group members, premature decisions, lack of focus, misunderstandings, fear of speaking, waiting to speak as other people dominate the meeting discussions [95]. Yet despite these difficulties, collaboration is essential for solving complex problems, since no single individual can possess all the prerequisites (i.e. experience, resources, information) for CDM [18, 64, 95] as well as successful enterprise architecture development. This implies the need for a methodical way of selecting approaches that can support the execution of collaboration dependent tasks, in order to achieve CDM in enterprise architecture creation. Hence section 3.3.

3.3 Selection Criteria of CDM Approaches

Literature (e.g. [6, 28, 77, 95]) indicates that the collaboration support approach used by a group of actors in their endeavor to reach an agreement on a given course of action has major implications on the group's output. Consequently, approaches that support CDM exist in several flavors. Developers of these approaches are motivated by at least three key attributes, i.e. number of actors involved in a group task, their proximity, and the nature of the task [28]. If developers of approaches that support CDM are motivated by these attributes, then the potential end users or consumers can also base on these attributes to select the most appropriate CDM approach to support a given task. Table 3.1 and the discussion below show the application of these attributes in the context of enterprise architecture creation.

As shown in column 2 of table 3.1, the number of actors that constitute the group is a key attribute of CDM approaches [28]. The number of stakeholders in an enterprise architecture creation effort varies across enterprises, since it depends on the size of the organization and the scope of the architecture creation effort in the organization. Thus, as shown in the 4^{th} row of table 3.1, approaches that can support small, medium, and large groups of stakeholders are considered appropriate in this research.

The proximity of actors that constitute the group (where actors can have face-to-face meetings or can be dispersed geographically) is also a key attribute of CDM approaches [28]. Ellis et al. [33] extended this attribute by considering the time a meeting is con-

Table 3.1: *Attributes of Enterprise Architecture Creation Activities*

<table>
<tr><th>#</th><th>Attribute (DeSanctis and Gallupe, 1987; Ellis et al., 1991; Grudin, 1994)</th><th colspan="4">Possible instances with respect to collaboration dependent tasks in enterprise architecture creation (instances adopted from DeSanctis and Gallupe, 1987; Ellis et al., 1991; Grudin, 1994)</th></tr>
<tr><td>1</td><td>Nature of sub activities involved</td><td colspan="4">Enterprise architecture creation is systemic, requiring a wide range of inputs (e.g. information, skills, expertise, supporting approaches)</td></tr>
<tr><td>2</td><td>Type of decisions made</td><td colspan="4">Unstructured and semi-structured decisions</td></tr>
<tr><td>3</td><td>Number of actors or subjects in the group</td><td colspan="4">Not fixed and varies across small, medium, and large enterprises. It also depends on number of units considered in the scope of architecture creation within the enterprise</td></tr>
<tr><td rowspan="6">4</td><td rowspan="6">Proximity (location or place) of actors with respect to time of meeting or interaction</td><td rowspan="2">Place/Location</td><td colspan="3">Time</td></tr>
<tr><td>Same</td><td>Different, but known</td><td>Different and unknown</td></tr>
<tr><td>Same</td><td>X_1</td><td>X_4</td><td>X_7</td></tr>
<tr><td>Different, but known to stakeholders</td><td>X_2</td><td>X_5</td><td>X_8</td></tr>
<tr><td>Different, but some unknown to stakeholders</td><td>X_3</td><td>X_6</td><td>X_9</td></tr>
</table>

ducted, hence the time-place classification of CDM supporting approaches (see 5th row of table 3.1). Grudin [46] also elaborated this attribute by looking into the predictability and unpredictability of the time a meeting is conducted or when the interactions occur and the predictability and unpredictability of the place or proximity of actors. These extensions led to approaches that support incidences in cells marked X_1 ... X_9 in table 3.1. Examples of approaches that support these incidences are discussed in section 3.5. Thus, as shown in table 3.1, approaches that can support group meetings characterized with incidences X_1 ... X_9 were considered appropriate in this research.

As shown in row 2 of table 3.1, the nature of the task that the group must accomplish is also a key attribute of CDM approaches [28]. The nature of a task may dictate the type of decisions to be made, the number of actors to be involved in executing the task, and the proximity of those actors (as indicated by the order in which attributes are presented in table 3.1). Since other attributes presented in table 3.1 seem to be sub-attributes of the "nature of task" attribute, it can be claimed that the key factor for guiding the selection of a CDM approach is the latter. Therefore, in this research prior to selecting the most appropriate approaches that could be adopted to solve the research problem, there was need to first understand the basic nature of the enterprise architecture creation activity. In row 2 of table 3.1, it is claimed that enterprise architecture creation is *systemic* in nature and approaches that support systemic reasoning were considered appropriate in this research. Section 3.4 below elaborates this.

3.4 Systemic Nature of Architecture Creation

Systems engineering successfully solves well-defined technical problems, however the intricacies and confusions in fuzzy and ill-defined management situations (that involve human and cultural factors) dispel the application of systems engineering (i.e. hard systems thinking), and instead demand for soft systems thinking [22]. With the perception of enterprise architecture creation as a CDM task (see discussion in section 3.2), it is rational to claim that the enterprise architecture creation activity demands more of soft systems thinking than hard systems thinking. This claim is justified by two interrelated aspects, i.e. (a) the nature of sub activities involved in architecture creation, or (b) the nature of decisions made during enterprise architecture creation. These aspects are discussed below.

An enterprise has three types of work levels, and the execution of activities in each work level involves making a given type of decision [126]. These work levels and their associated types of decisions or problems include (a) strategic level, which is concerned with handling unstructured problems or decisions, (b) tactical or managerial level, which is concerned with handling semi-structured problems or decisions – those that require both human intuition and standard solution procedures, and (c) operational level, which is concerned with handling structured problems or decisions [126].

With these definitions it can be noted that activities in enterprise architecture creation are concerned with providing a blue print of *what*, *why*, and *how* tasks will be done (or decisions will be made) at each of the three work levels of the enterprise. Thus, as shown in the 2nd row of table 3.1, the nature of activities undertaken and decisions made during enterprise architecture creation are unstructured and (at times) semi-structured decisions. Hence the need for soft systems thinking at the enterprise architecture creation stage, hard systems thinking at the implementation stage, and soft systems thinking at the maintenance stage. Enterprise architecture implementation requires hard systems thinking because it involves structured decision making – the problems it addresses are clearly defined in the created enterprise architecture. For instance, the architecture clearly defines which application systems should be developed, their functionalities, and how they should interrelate. Enterprise architecture maintenance involves unstructured and semi-structured decision making like the creation stage. For instance, the enterprise architecture has to be modified when the enterprise faces new challenges that imply defining new business strategies, goals, and requirements or revising existing ones.

In hard systems thinking, "system" is conceived as something outside ourselves that exists in the world, where different parts of the world are also conceived as systems that can be engineered [22]. On the other hand, in soft systems thinking, "system" is conceived as the process of how we deal with the world to solve a given problem, i.e. "*the process of inquiry into real-world complexity is itself a system for learning*" [22]. Given this distinction, and the nature of activities involved in architecture creation (as discussed above), it can be also claimed that the process of inquiry during enterprise architecture creation is a system in itself. This claim can as well be justified using the fundamental definition of a system. A system is a collection of interrelated objects (i.e. people, resources serving as inputs or outputs) and processes that interact to achieve a given goal, is surrounded by an environment, and includes a feedback mechanism [126]. Therefore, in perceiving enterprise architecture creation as a *systemic* process the following are considered, (a) its inputs are stakeholders' concerns and requirements, (b) it involves several sub processes (see section 3.2), (c) its outputs are the architecture creation products, (d) the environment in which it is undertaken comprises the organization's social and political factors, (e) its feedback is obtained after architecture implementation.

Since enterprise architecture creation is systemic in nature and involves making unstructured and semi-structured decisions, it can be assumed that adopting group (decision) support systems can address the research problem. Section 3.5 below elaborates this.

3.5 Group (Decision) Support Systems

Decision Support Systems are *proactive* applications that support *individuals* or *groups* in their managerial and decision making tasks, that involve dealing with unstructured and semi-structured problems [126]. As shown in the middle part of figure 3.2, this research is interested in DSSs for groups, referred to as Group Decision Support Systems (GDSSs) [28] or Group Support Systems (GSSs) [113]. The middle part of figure 3.2 shows that the field of GSSs offers three main types of approaches that can be adopted in this research. The classification of these approaches and their instances (shown in the right part of figure 3.2), is based on earlier classifications of CDM approaches, i.e. [113, 31, 74, 33, 46, 28, 6, 101, 32].

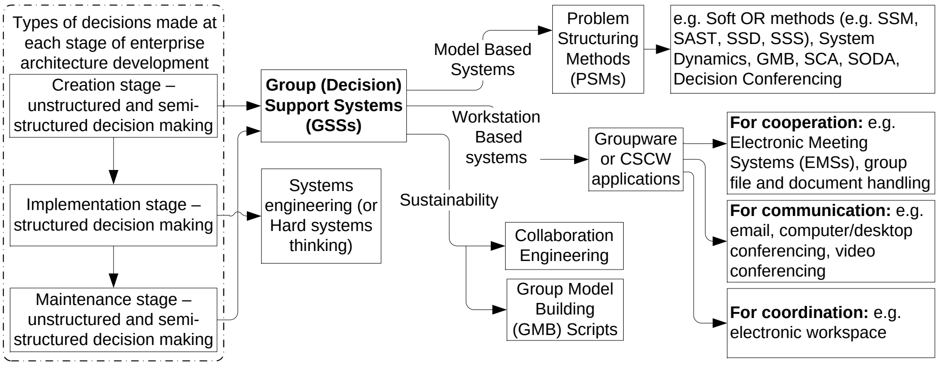

Figure 3.2: *Relevant Approaches in Enterprise Architecture Creation*

From Rouwette et al. [113] the term GSSs[1] is used to broadly include (a) Model-based or model-driven systems, also referred to as Problem Structuring Methods (PSMs) or wide-band approaches, and (b) Workstation Systems, also referred to as Electronic Meeting Systems (EMSs)[2], or technology-based or technology-driven approaches. Herein, the term GSSs is used basing on this collective term. Moreover, workstation systems are also commonly referred to as groupware [33, 46, 131]. Figure 3.2 also shows Collaboration Engineering and/or Group Model Building (GMB) scripts as the third option that can be adopted in this research. Section 3.5.1 discusses PSMs, section 3.5.2 discusses groupware (particularly EMSs), and section 3.5.3 discusses the strategies for sustainable use of GSSs.

3.5.1 Problem Structuring Methods (PSMs)

A PSM is not descriptive and is not limited to simply structuring problems, but it helps one to manage (but not to reduce) the complexity within a problem situation [32], it supports decision making [113], and helps one to seek stakeholders' agreement regarding a given course of action [32]. A PSM helps a researcher or practitioner to acquire a contextual perception of the problem aspects, and the participants' or stakeholders' perception of

[1] GSSs are often referred to as GDSSs in some articles (e.g. Eden [31, 28]).

[2] In some articles, the term GSSs is used to mean EMSs e.g. [70, 95], while in others it is used to mean PSMs e.g. [31].

these aspects [113]. According to Eden and Ackermann [32], PSMs have the following features in common:

1. With a PSM, a model is designed using formalisms and data regarding the problem situation, and it is then used as a "*transitional object*" that is freely analyzed (not with the aim of seeking optimal solutions), but with the aim of sparking off negotiations that will lead to consensus among participants or stakeholders.

2. PSMs aim at increasing the productivity of a group process, since they assume that increased participation of group members is likely to yield agreements that will be implemented.

3. PSMs consider the power and politics within an enterprise, since they acknowledge that the way enterprises are designed encourages people to have different perspectives regarding a (problem) situation.

4. Using a PSM in a problem situation demands the significance of facilitation skills, so as to enable an effective model building process and to help group members to reach agreement.

Examples of PSMs include Strategic Choice Approach [40], Strategic Options Development and Analysis or journey making [31], System Dynamics, Viable Systems Modeling, Robust Analysis, Drama Theory [74], Decision Conferencing [31, 74], Group Model Building [5]. The boundary between PSMs and soft operations research methods or soft systems approaches is fuzzy [74], thus they are often listed as PSMs [31, 136]. Soft systems approaches are based on the notion of soft systems thinking (see section 3.4). Examples include Strategies Assumption Surfacing and Testing [72], Social Systems Design [23, 24], Social System Sciences [1], and Soft Systems Methodology [22].

3.5.2 Electronic Meeting Systems (EMSs)

As shown in the right part of figure 3.2, EMSs can be perceived as a type of groupware. Collaborative efforts can be greatly enriched by using groupware [131]. Thus, figure 3.2 shows groupware as the second category of approaches that can be adopted in this research.

3.5.2.1 Groupware

Groupware refers to *"computer-based systems that support groups of people engaged in a common task (or goal) and that provide an interface to a shared environment"* ([33], page 40). This term is therefore often used to mean collaborative software or systems [6], or group support technology or Computer Supported Cooperative Work (CSCW) applications [33, 46, 131]. CSCW, also referred to as Computer Supported Collaboration (CSC), is a multidisciplinary field that gathers researchers and practitioners who have a common interest in understanding how people or groups work and how computer technology could support their work [33, 46]. CSCW focuses on research into the nature of workplaces, while groupware focuses on (commercial) technologies that can support these [46]. Thus, groupware refers to the technology-based approaches (i.e. hardware, software, services, techniques, tools etc) that support people working in a group, whereas

Table 3.2: *Groupware Instances (Based on [33, 46, 47, 6])*

<table>
<tr><th>#</th><th>Groupware Classification Style</th><th colspan="4">Instances with respect to each classification</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Number of actors supported</td><td colspan="2">Small groups support</td><td colspan="2">Organization wide support</td></tr>
<tr><td colspan="2">Network based applications, desktop conferencing, collaborative writing, and EMSs</td><td colspan="2">EMSs, work flow systems, video conferencing systems, multi-user applications</td></tr>
<tr><td rowspan="5">2</td><td rowspan="5">Proximity of actors with respect to time of meeting</td><td rowspan="2">Location</td><td colspan="3">Time</td></tr>
<tr><td>Same</td><td>Different, known</td><td>Different, unknown</td></tr>
<tr><td>Same</td><td>EMSs, white boarding, text-based chat systems</td><td>Work shifts</td><td>Team rooms</td></tr>
<tr><td>Different, known</td><td>EMSs, desktop conferencing, video conferencing, teleconferencing</td><td>EMSs, electronic email</td><td>EMSs, collaborative writing</td></tr>
<tr><td>Different, unknown</td><td>EMSs, Interactive multicast seminars</td><td>EMSs, computer bulletin boards</td><td>EMSs, work flow systems</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Type of task</td><td colspan="2">Cooperation support</td><td>Communication support</td><td>Coordination support</td></tr>
<tr><td colspan="2">EMSs, group file and document management systems, collaborative writing</td><td>EMSs, electronic mail, desktop conferencing, video conferencing, or teleconferencing</td><td>EMSs, work flow systems, electronic workspace</td></tr>
</table>

CSCW is the study of the psychological, social, and organizational implications of using these approaches [109].

Groupware exists in several flavors and has been categorized in various ways. From the various groupware classification styles that are presented in [33, 46, 6, 47, 101], table 3.2 has been formulated to provide a general overview of the various types of groupware and the kind of support they offer. In the top most part of table 3.2, Ellis et al. [33] and Grudin [46] categorize groupware into applications that support small groups of people and those that support organization wide initiatives. In table 3.2 examples of groupware in each of these two categories are obtained from [46, 73]. The middle part of table 3.2 shows the categorization of groupware with respect to the support it offers a group when two other aspects are considered, i.e. time when the meeting is held (or when interactions occur) and the location of actors. Groupware that supports actors to work simultaneously at the same time is all referred to as real time (or synchronous) groupware, while groupware that supports work that is done at different times is all referred to as non-real time (or asynchronous) groupware [33]. In table 3.2 examples of groupware in each of these two categories are obtained from [46, 33, 18, 73].

In this research the number of participants is unknown (i.e. stakeholder count will vary across enterprises), and the time of meeting with respect to location of participants are also unknown (i.e. these will also vary across enterprises). Thus, it is vital to also consider the classification of groupware according to the type of tasks supported. Group activity is based on mainly three types of tasks, i.e. communication, collaboration, and coordination [33]. As shown in the bottom part of table 3.2, Grudin and Poltrock [47] classify groupware into three, i.e. groupware for supporting personal and business communications, groupware that supports cooperation or collaboration by enabling interaction through information sharing and document management, groupware that supports coordination. In table 3.2 examples of groupware in each of these two categories are obtained from [33, 47, 6, 46, 73].

3.5.2.2 Examples of Groupware

The dominant type of groupware in table 3.2 is EMS. This can be explained in two ways. First, most work in real life is not restricted to only one cell in table 3.2, but generally involves a combination of face-to-face (synchronous) interactions and asynchronous interactions [46]. Second, EMSs comprise several features that enable flexible support for group work with respect to time of interaction among actors and location of actors [73].

In some incidences a team that uses an EMS is often more productive than a team that does not use it (or a conventional team), e.g. the former is characterized by even and full participation during interactions, compared to what happens (e.g. fearing to speak, domination, poor grasp of the problem) in the latter [16, 95]. An EMS supports task-oriented collaborative efforts in (face-to-face) meetings that involve planning, problem solving, decision making, deliberation, generating and evaluating alternative courses of action, negotiation, and building consensus [101]. EMSs help to improve the quality of group decision making in task-oriented group processes, i.e. processes that are complex and yet involve multi-actor, multi-criteria, ill-structured, and evolving dynamic problems that require actors to cooperate and conflict in order to define and solve them [70].

Collaborative tasks may consist of a combination of several unique (but interrelated) meeting processes, which require flexible and efficient facilitation support [101]. EMSs aim at effective and efficient data collection during execution of such tasks [31]. EMSs are equipped with capabilities that enable them to offer flexible facilitation support and enhance effectiveness and efficiency of (and user satisfaction with) group meetings [101]. Examples of EMSs include Meetingworks™, GroupSystems, Facilitate.com, MeetingWare, TeamFocus, Groove [101, 113, 31, 6, 33].

Other examples of groupware are listed below. Detailed discussions on groupware are provided in [6, 77].

- Desktop conferencing, audio conferencing, video conferencing, and teleconferencing systems are used to support group communication by enabling human presence among geographically dispersed parties [6, 47, 46].
- Network based software includes software that enables users on networked computers to interact, and multi-user software applications that have databases which send alerts to a predefined group of people regarding a certain matter [46].
- Electronic mail systems enable computer-mediated communication by allowing users or a group of actors to create distribution lists or communication patterns [46, 33].
- Work flow management systems help in modeling the sequence of tasks that constitute formal and informal work processes, and the actors responsible for executing those tasks [47].
- Electronic workspace (or virtual workspace) refers to organization-wide systems that comprise features for supporting information processing and communication [33].
- Group file and document handling systems and collaborative writing (or authorship) applications comprise features that support access and version control, document searching, and status tracking [47, 46, 6].

3.5.3 Strategy to Sustainable Use of GSSs

From sections 3.5.1 and 3.5.2 two main approaches captivate our attention in this research, i.e. PSMs and EMSs. However, literature (e.g. [32, 14]) shows that the sustainable use of these approaches became a major concern to researchers associated with them. This led to two techniques, i.e. Group Model Building scripts and thinkLets. This section defines these techniques and discusses the possibilities of their adoption in this research.

3.5.3.1 Scripts

The "*problem structuring service*" offered by a PSM depends on a specific situation and is therefore unique [113]. In addition, the effectiveness of a PSM often demands that the originator (or an apprentice) of the method facilitates the deployment of the method [32]. If one has not been a PSM apprentice or has never observed a PSM at work, then it is difficult to acquire the *"craft"* that is required for successful facilitation of a PSM deployment [136]. However, skills acquired through apprenticeship are often specific to a particular PSM and its deployment context, which limits acquisition of craft skills for deployment of all PSMs in general [136]. Therefore, the presence of a professional facilitator is mandatory for effective PSM deployment [5, 113]. This implied the demand for transparency and reduced complexity of PSMs, so that they can be transferred to other practitioners or researchers [32].

A typical example of research efforts towards transparency of PSMs is Group Model Building (GMB) scripts [4, 112, 127, 5]. GMB is a PSM that combines with a hard modeling approach [5]. GMB is an approach used in strategic decision making to (a) create new insights into strategic issues of a problem and enable stakeholders to acquire shared reasoning about a problem, (b) improve communication among the stakeholders, (c) reduce conflicts, and (d) reach a consensual agreement [128]. GMB is "*a system dynamics model-building process in which a client group is deeply involved in the process of model construction*" ([127], page 379). With GMB it is possible to use facilitated face-to-face meetings to directly involve the client group in the process of formulating, explaining, and analyzing the quantitative and/or qualitative models [5].

Although GMB is essentially facilitator driven [5, 112, 127], it can be implemented using *'scripts'* [4]. Scripts are useful for structuring the design of specific GMB sessions [127]. Scripts are pieces of small group processes that can be suitably sequenced for successful execution of a collaborative task [4].

3.5.3.2 ThinkLets

Despite the numerous benefits of EMSs, the low rate of their adoption by organizations raised a key concern to the EMS community [14, 101]. Laboratory and field results from EMS-related research were ambiguous and conflicting [16]. This is (among other factors) due to the following two factors:

1. EMSs have a high conceptual load that requires one to first understand the intended effect of the EMS functionalities for the user, and so organizations resort to hiring (or training) professional facilitators in order to successfully use the technology [14, 16].

2. EMSs are facilitator driven, and yet maintaining professional facilitators is not easy due to economic and political issues faced by organizations [14].

The slow adoption of EMSs implied the need for EMS researchers to ensure that EMS results are more replicable and predictable, by providing clear practical support for EMSs [16]. This was realized through dedicating (some) research efforts into thinkLets – a concept from Collaboration Engineering [62, 14, 15, 130, 16, 129]. A thinkLet can be perceived as a building block for designing collaboration processes, since it defines the type of groupware or other type of tool to use when executing a given task, how the tool can be setup or configured to create the required (patterns) of reasoning among group members, and clear instructions that the group must follow when using the tool [14, 15, 16]. Since training or hiring professional facilitators is an additional cost to organizations, Collaboration Engineering enables one to use thinkLets to develop collaboration processes that transfer relevant facilitation skills and knowledge of EMSs (and group dynamics) to practitioners [14].

From this section it can be noted that collaboration processes can be developed [14] and GMB scripts can be developed [4, 112], that can be effectively executed in the absence of a professional facilitator [14, 4, 112]. In this research this implies that (1) a collaboration process could be developed to support execution of collaboration dependent tasks during enterprise architecture creation, and/or (2) a GMB script could also be developed to support execution of collaboration dependent tasks during enterprise architecture creation. However, the adoption of the latter in this research was limited because PSM deployments are often situation-specific (see discussion in section 3.5.1). Thus, since this research is concerned with flexible facilitation of workshops in which collaboration dependent tasks are executed, the development of a collaboration process was given first priority. This discussion is continued in section 3.7.

3.6 Selection of Approaches for Adoption

The selection of approaches adopted in this research was mainly influenced by at least three factors. First, the core focus of the research, i.e. developing an explicit and flexible process for executing collaboration dependent tasks, which can be successfully executed by enterprise architects themselves (even in the absence of a professional facilitator). Second, implications of survey findings on challenges faced and recommendations provided by architects who participated in the survey. This factor is elaborated in section 5.2. Third, feedback from evaluating the desired artifact from this research (i.e. CEADA). After every evaluation iteration of CEADA, need arose to seek and adopt an approach from the theoretical knowledge base that would address the weaknesses that had been identified (as discussed in chapters 6 and 7). Sections 3.7 – 3.9 give a detailed account of the selected approaches.

3.7 Collaboration Engineering

Collaborative efforts in task execution can be enhanced by support from professional facilitators, since they skillfully align divergent individual goals and group goals [130]. Although the help of professional or skilled facilitators positively affects group productivity, it is quite expensive to rely on their support when executing routine or recurring collaborative tasks [14, 129, 130]. To an enterprise architect, executing collaboration dependent tasks is a recurring task although its complexity varies across client organizations. Thus, it is important that enterprise architects have an explicit and flexible process that will enable them to successfully execute collaboration dependent tasks even in the absence of professional facilitators. Affordable facilitation support can be achieved through adopting Collaboration Engineering, i.e. an approach that guides the design of collaboration processes that can be executed by practitioners of recurring mission-critical collaborative tasks, and can be reused to obtain predictable successful results [14, 15, 63, 130]. This is possible because collaboration processes help to transfer relevant facilitation skills and knowledge of EMSs and group dynamics to practitioners [14]. Aspects that describe the design approach of collaboration processes are discussed below in sections 3.7.1 – 3.7.4.

3.7.1 Way of Thinking in Collaboration Engineering

Vreede and Briggs [130] first classified the way of thinking in Collaboration Engineering to involve defining four layers of group interaction in any collaborative effort i.e. process layer, pattern layer, thinkLet layer, and phenomenon layer (see top part of figure 3.3). Additional research on these layers yielded a seven-layer model of concerns (or guidelines) that collaboration engineers need to consider when designing collaboration processes [13, 132]. These seven levels of concerns and guidelines are pointers to the Collaboration Engineering way of working (see bottom right part of figure 3.3). Section 3.7.2 discusses other details associated with formulating a collaboration process that addresses these seven levels of guidelines or concerns. As for the phenomenon layer, it is a collection of the theories that motivate the designs of collaboration processes i.e. increasing group productivity, enhancing creativity, increasing group satisfaction, creating value for stakeholders, and enhancing adoption of change in practice [130].

3.7.2 Way of Working in Collaboration Engineering

Way of working defines the procedure a process designer takes to design a collaboration process for supporting a given collaborative effort [62, 130]. The bottom right corner of figure 3.3 shows the steps taken in such a procedure. Aspects associated with these steps are briefly explained below.

Goals, Products, and Activities/Processes. Collaboration Engineering way of working uses (a) knowledge on collaboration and facilitation, and (b) knowledge on the task at hand and its required deliverables from the problem domain [130]. For example, in this research two sources were used for problem domain knowledge, i.e. literature on enterprise architecture creation and findings from the exploratory survey among enterprise architects (see discussion in section 2.3.3).

Patterns of Collaboration. Achieving deliverables of activities in the process layer requires people to undergo various reasoning stages or patterns of collaboration [130]. Effective collaboration requires participants to undergo a reasoning process that comprises a series of activities referred to as basic patterns of collaboration or thinking [14, 16]. A pattern of collaboration is a basic activity that enables participants to undergo a given reasoning stage when executing a collaborative task [14, 15]. According to Briggs et al. [14, 15, 130, 16], there are six basic patterns of collaboration (see table 3.3).

Techniques (ThinkLets), Tools, Scripts. Each pattern of collaboration (or some variation of it) is created using a unit known as a thinkLet [14, 16]. A thinkLet "*is the smallest unit of intellectual capital required to create one repeatable, predictable pattern of thinking among people working toward a goal*" [16]. According to [14, 16], a thinkLet consists of three components, i.e. (1) a tool – the specific hardware and software technology that

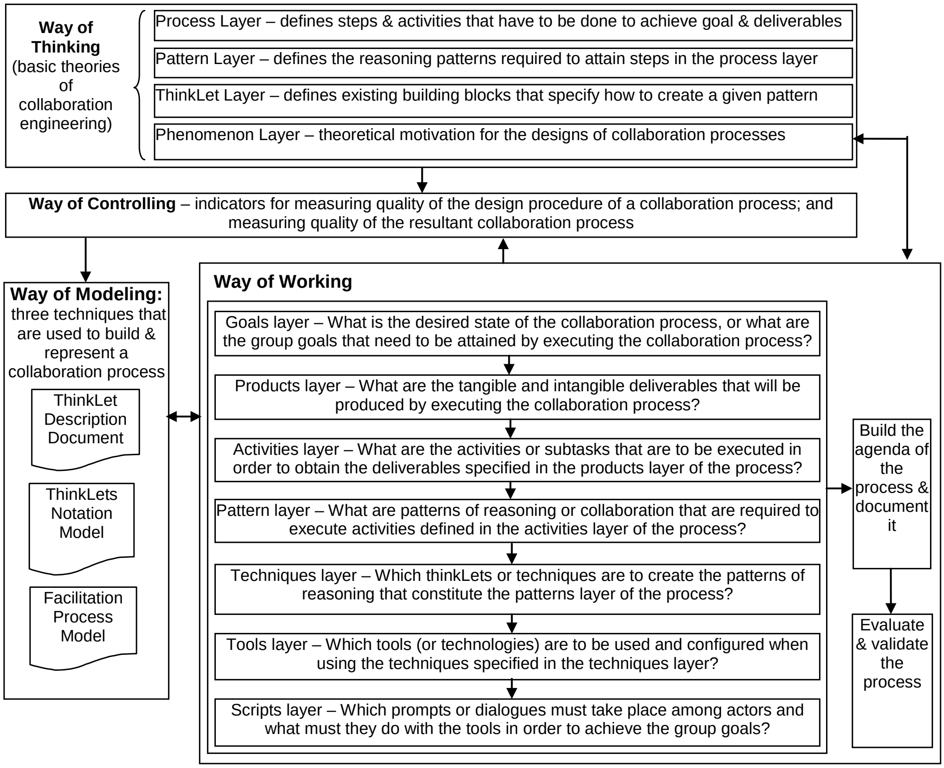

Figure 3.3: *Collaboration Engineering Design Approach* (this model has been formulated based on the discussion in [130, 13, 132])

should be used to create a given pattern of thinking, (2) tool configuration – specification of how the hardware and software have to be configured so as to create a given pattern of reasoning and participant interaction, and (3) a script – the sequence of events the group undergoes (and instructions that have to be given to the participants) so as to create a given pattern of reasoning.

A thinkLet has a unique memorable name which is a pointer to the kind of dynamics it creates in a group in order to help participants to undergo a given pattern of reasoning [16]. For example, using LeafHopper thinkLet implies that participants will start a brainstorming activity with a list of more than one topic, and they will be free to hop among topics to make their contributions on any topic in which they have interest or experience [14, 16]. Table 3.3 gives examples of thinkLets for creating a given pattern of collaboration. Detailed documentation on various thinkLets can be found in Briggs et al. [14, 16, 17].

Selecting ThinkLets. Briggs et al. [14, 16, 17] present various attributes or details of several thinkLets, i.e. (1) a name that is associated with the (group) dynamics that a given thinkLet creates, (2) criteria for selecting or deciding when to use or when not to use a given thinkLet, (3) composition of a given thinkLet, (4) advantages (based on field experience) of using a given thinkLet over other thinkLets that create the same pattern of

Table 3.3: *Patterns of Collaboration and ThinkLets (Based on Briggs et al. [15, 14, 16])*

#	Pattern of Collaboration (POC)	ThinkLets to create a POC
1	Generate – participants moving from a state of having fewer concepts to a state of having more concepts that are shared by the group	OnePage, LeafHopper, etc
2	Reduce – participants moving from a state of having many concepts to having fewer concepts that the group considers worthy of further attention	FastFocus, OneUp, ReviewReflect, etc
3	Clarify – participants moving from a state of having less to more shared understanding of concepts and phrases used to express those concepts	
4	Organize – participants moving from a state of having less to more understanding of the relationships among concepts considered by the group	ThemeSeeker, PopcornSort, etc
5	Evaluate – participants moving from a state of having less to more understanding of the relative value of the concepts under consideration by the group	StrawPoll, MultiCriteria, etc
6	Consensus building – this involves participants moving from a state of having fewer to more group members willing to agree and commit to a proposal or proposed idea	CrowBar, MoodRing, etc

reasoning, (5) real life experiences that clarify circumstances under which a given thinkLet might be useful, and (6) an explanation of the origin of the name of the thinkLet. These details serve as criteria for selecting thinkLets that constitute a collaboration process for supporting a given task.

In [62, 14, 16, 129, 17], other criteria for matching basic activities with suitable thinkLets are discussed. Examples of thinkLets, as defined in [14, 16, 129], are given in table 3.3. They include LeafHopper, FreeBrainstorm (are examples of the thinkLets used to create the 'generate' pattern of reasoning), MoodRing (is one of the thinkLets used to create the 'build consensus' pattern of reasoning), StrawPoll (one of the thinkLets used to create the 'evaluate' pattern of reasoning) etc.

3.7.3 Way of Modeling in Collaboration Engineering

The bottom left corner of figure 3.3 shows three techniques that are used to represent or document information about collaboration processes. These include (1) a thinkLet description document – a textual template defining the selection criteria for thinkLets, (2) a thinkLets notation model – a textual documentation communicating details of the design of a given collaboration process, and (3) a facilitation process model – a graphical representation of the logic of flow of activities in a given collaboration process [130]. Using criteria discussed in section 3.7.2, thinkLets are selected from a thinkLet description document and used as building blocks in a thinkLets notation model and/or facilitation process model for a given process [62, 130].

3.7.4 Way of Controlling in Collaboration Engineering

This defines the means and indicators for measuring the quality of the designed artifact and the quality of the design process of the artifact [130]. Quality goals or criteria that are considered when evaluating the designed artifact can be set by the collaboration engineer, or can be determined based on the needs in the problem domain.

Sections 3.7.1 – 3.7.4 discuss why Collaboration Engineering was adopted and its design approach. Collaboration Engineering is not only associated with groupware, but aims at sustainable use of all collaboration support techniques [14]. This enabled us to use Collaboration Engineering to adopt Soft Systems Methodology (SSM, an example of PSMs) in a flexible way as demanded by this research. Section 3.8 discusses why SSM was adopted. Chapter 6 discusses how Collaboration Engineering and SSM were adopted in this research.

3.8 Soft Systems Methodology

Most soft systems approaches (listed in section 3.5.1) seem to focus more on strategy formulation, and less on strategy execution (which requires having an explicit strategy definition). Yet enterprise architecture creation concentrates more on strategy execution (particularly on devising an explicit or SMART strategy definition as discussed in section 1.2), and offers insights into future strategy formulation. This implies the need for adopting Soft Systems Methodology (SSM) in this research.

The initial seven-stage model of SSM was unable to support its flexible use in practice, thus a four-stage model (with an amendment of analyzing cultural factors) was developed [22]. Discussions herein are based on the four-stage SSM model, which according to [22] includes the following activities.

1. Investigating all aspects (including cultural and political) in a problem situation, and then representing them in a "*Rich Picture*" (so as to encourage a holistic and exploratory thinking about the situation) or performing "*Analysis One Two Three*" (so as to explicitly show the actual problem owners and the social and political factors in the situation).

2. Formulating purposeful activity models that describe the desired situation. This is done by (a) using "*Root Definitions*" – short phrases that define the required transformation processes for realizing the desired situation, (b) performing "*CATWOE*" analysis – assessing **C**ustomers or stakeholders that will be affected by the transformation, **A**ctors who will perform activities in the transformation, **T**ransformation process(es) that are to be changed, **W**orld perspective on the transformation, **O**wner(s) controlling the transformation, and **E**nvironmental and external issues affecting the desired transformation, and (c) assembling transformation process using models.

3. Debating the problem situation using the activity models in order to (a) define desirable and (culturally) feasible changes that would improve the situation, and (b) seek and find accommodations between conflicting interests so as to take action.

4. Taking action so as to realize the desired improvement.

Checkland [22] clearly recommends the use of interviews in activities at stage 1 of SSM to gather information that is vital for formulating the Rich Picture and performing Analysis One Two Three. In activities of stage 2, Checkland further clearly describes the use of root definitions, CATWOE analysis, and multi-level (or hierarchical) thinking.

However, SSM is somewhat silent on *how* the problem solvers interact with stakeholders (or problem owners) to formulate, e.g., the root definitions that make up the purposeful activity models. In activities at stage 3 of SSM, it is still implicit *how* the debate is to be successfully conducted. The methods are not given that are to be used to successfully facilitate the debate when identifying desirable and culturally feasible changes in the activity models, and seeking accommodations between conflicting interests of stakeholders. Thus, SSM is somewhat silent on *how* to acquire a shared understanding among stakeholders (or problem owners), and how the evaluation of decision alternatives or alternative courses of action is done. These issues being key in the architecture creation process, there was need to deploy additional techniques if SSM was to be adopted in this research to support execution of collaboration dependent tasks. Despite these implicit issues, SSM techniques (i.e. Rich Picture, Analysis One Two Three, Root Definitions, CATWOE analysis, and multi-level thinking) were adopted in this research. Chapter 6 discusses how SSM techniques were adopted in this research.

3.9 Others

Other approaches that were selected for adoption in this research offer either task structuring support or task execution support. These are presented in sections 3.9.1 – 3.9.3.

3.9.1 Cause-Effect Analysis Concept

In cause-effect analysis, explaining an event usually involves explaining its cause, and the analysis of the relationship between the cause and effect of events is essential to several formations of theory (i.e. processes, conjectures, models, frameworks, or body of knowledge) [45]. Therefore, in this research the cause-effect analysis concept was adopted so as to help identify, examine, and understand the relationship between the core phenomena underlying the execution of collaboration dependent tasks during enterprise architecture creation. In addition, existing literature on enterprise architecture creation (e.g. in categories A, B, and C that was discussed in section 2.2) was used as a starting point for analyzing the cause-effect and conditional relations in enterprise architecture creation. The adoption of this concept in this research is discussed in chapter 4.

3.9.2 Generic Decision Making Process

Simon [118] defined the following as the three key phases that constitute all tasks associated with decision making (and problem solving).

1. Intelligence phase, this entails examining a situation or (problem) environment in order to identify conditions or scenarios that call for decision making or intervention or problem solving action.

2. Design phase, this entails devising or formulating possible courses of action or possible decision alternatives for solving the identified problem or for improving the examined environment.

3. Choice phase, this entails choosing a particular course of action or decision alternative from those identified or formulated.

Section 3.2 explains why enterprise architecture creation is a CDM task. Thus, Simon's generic decision making process was adopted along with the cause-effect analysis concept, in order to rationally structure the activities required for the execution of collaboration dependent tasks during enterprise architecture creation. Chapters 4 – 6 discuss how this process was adopted in this research.

3.9.3 Joint Decision Making Theory

According to [107], there are four broad approaches to decision making, i.e. (1) decision analysis – "*a prescription of how an analytically inclined individual should and could make wise decisions*", (2) behavioral decision making – "*a description of the psychology of how ordinary individuals do make decisions*", (3) game theory – "*a normative approach of how groups of ultra-smart individuals should make separate interactive decisions*", and (4) negotiation analysis – "*an approach of how groups of reasonably bright individuals should and could make joint, collaborative decisions*". The suitable approach in this research is negotiation analysis (also referred to as the Joint Decision Making or the CDM theory). This is because the CDM theory aims at yielding *joint decisions* and *joint payoffs* for all actors involved [107]. Moreover, since game theory aims at maximizing individual pay offs for each player involved [107], it is not given priority in this research. Chapters 4 – 6 discuss how the CDM theory was adopted in this research.

3.10 Summary on Selected Approaches

This chapter has presented core approaches that were selected for adoption in this research. All adopted approaches (i.e. the core and supplementary ones) are listed below with respect to the three ways in which CDM can be supported during the execution of collaboration dependent tasks. These three ways were introduced in section 1.4.

Task Structuring and Execution Support. Selected approaches to support both task structuring and execution in this research are Collaboration Engineering and SSM. Collaboration Engineering is selected with special emphasis on using groupware (computer based systems) and paper-based tools. In the computer-based tools, emphasis is put on EMSs. This is because EMSs address both the social and technological aspects required in meetings, whereby they allow group members to socially interact and they provide the technological support required to support the social interactions [78]. Other groupware instances are not chosen in this research because they mainly address the technological aspects in meetings, but hardly address the social aspects that occur in meetings. In the paper-based tools (e.g. pens, papers, flip charts, stickers, markers etc), we adopt techniques of problem structuring and rational thinking that are provided in SSM. We provide explicit facilitation procedures for using these paper-based tools by adopting the thinkLet technique of Collaboration Engineering. Details on this are discussed in chapter 6.

In this research, we first adopted approaches that support task structuring and task execution, but need arose to additionally adopt approaches that specifically support either task structuring or task execution in collaborative problem solving and decision making. This is because sometimes adopting approaches that support both task structuring and task execution requires that there is an explicit definition of the goal/aim of a given macro task. Therefore, it may be vital to first adopt approaches in the task structuring category, so as to first provide some sort of structural format to the macro task at hand. Thereafter, the "coarse-grained" structural format of the macro task can be decomposed (to a "fine-grained" format) using the selected approach that supports both task structuring and task execution. This is discussed and demonstrated in chapters 4 – 7. Approaches that were selected to support task structuring or task execution are listed below.

Task Structuring Support. Selected approaches to specifically support the structuring of tasks to be supported by the CEADA artifact include the guidelines of theory-driven design of collaboration systems [12], the cause-effect analysis concept [45], the generic decision making process [118], and the joint decision theory [107]. The reasons for adopting these techniques are discussed in section 3.9, and chapters 4 – 5.

Task Execution Support. Selected approaches to specifically support the execution of tasks in the CEADA artifact include the committees and subcommittees technique by Raiffa et al. [107], Single Negotiating Texts (SNTs) by Roger Fisher (as discussed in Raiffa et al. [107]), take-a-panel and share-panel techniques [51], the Ishikawa diagram [56], and causal loop diagrams [128, 103]. The reasons for adopting these techniques are discussed in sections 6.2.3, 7.3.3, 7.8, and 7.9.

Chapters 4 – 6 discuss how these approaches were adopted in this research to design CEADA. Chapter 7 discusses evaluation findings regarding the use of the adopted approaches in the context of enterprise architecture creation. In the context of our research framework (see figure 2.3 in section 2.3.1), this chapter has discussed origins of core approaches (e.g. methods, tools, techniques, theories) that can be adopted to formulate a procedure of using computer-based tools and paper-based tools in meetings on enterprise architecture creation. In the context of our research goals, this chapter is an effort towards seeking ways of answering research questions (a), (c), and (d) (in section 1.5), and achieving research objectives (1), (3), and (4) in section 1.6.

Chapter 4

Solution Synthesis

Abstract. This chapter gives an orchestration of the solution delivered by this research. The solution comprises three parts, i.e. a theory on Collaborative Decision Making (CDM) in enterprise architecture creation, a synergy of collaboration dependent tasks, and a flexible procedure for executing tasks in the synergy. Since these three parts are interrelated, we provide an orchestration in form of a framework that coordinates conversations among stakeholders and architects during enterprise architecture creation. This framework is known as the architecture conversation coordination framework. This chapter also discusses the theory on CDM in enterprise architecture creation, and the roadmap of steps that were undertaken to move from the theory component of the solution to the collaboration process for enterprise architecture creation.

4.1 Chapter Overview

A Design Science project demands that the researcher seeks innovative knowledge-based ways in which a significant problem can be resolved, rather than routinely build a system (by customarily applying existing knowledge to a known problem) [49]. In chapters 2 and 3 a number of approaches and concepts were selected to be adopted and researched in this project. Therefore, this chapter provides the "*orchestration*" that guided the adoption of all the selected approaches in this research.

A Design Science artifact can appear in the shape of a construct (i.e. basic concepts that define aspects in a given domain), model (i.e. an expression of the relationships among constructs), method (i.e. procedural guidance on how to perform a given task), or instantiation (i.e. an implementation of constructs, models, or methods) [71, 49]. Figure 4.1 shows that in this research the desired artifact is CEADA, a flexible collaboration process (or method) that supports the execution of collaboration dependent tasks in enterprise architecture creation. For CEADA to achieve this, there was need to clearly define collaboration dependent tasks, key phenomena associated with executing these tasks, and interrelationships among those phenomena. The boxes in figure 4.1 represent research activities associated with building CEADA, and the solid lines with arrow heads represent information flow between two representations.

The top right corner of figure 4.1 indicates that it was vital to adopt the cause-effect analysis concept so as to examine relations among key phenomena associated with execut-

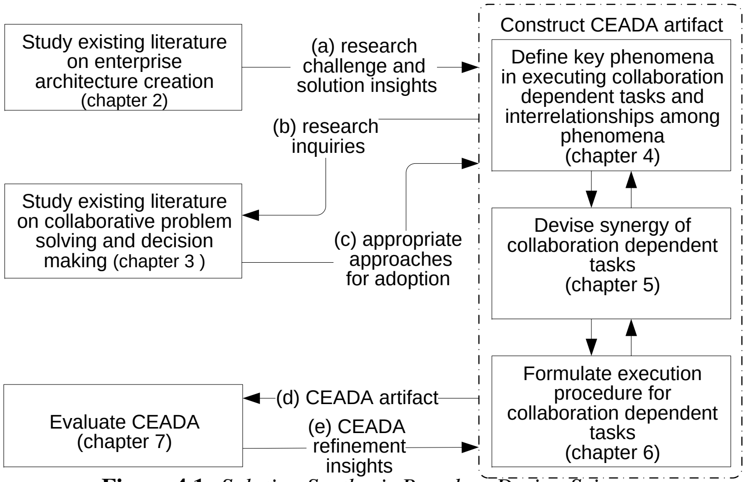

Figure 4.1: *Solution Synthesis Based on Design Science*

ing collaboration dependent tasks. This is because the knowledge of cause-effect relations among phenomena enables one to explain the occurrence of events, make predictions from (existing) theories or knowledge, and formulate theories [45]. This motivated us to devise a theory that could guide (a) the formulation of a synergy of collaboration dependent tasks, and (b) the design of CEADA. Besides, theory-driven design of artifacts can result in innovative design decisions and development of better technologies [12, 71] or solutions. For example, during the design or deployment of a collaboration system, a good theory helps one to account for the successes, failures, repeatability, and predictability of the system (or explain how technology can be used to achieve desired goals) [12].

As indicated in the right part of figure 4.1, this chapter presents a theory that defines interrelationships among key phenomena associated with executing collaboration dependent tasks. This theory is used in chapter 5 to formulate a synergy of collaboration dependent tasks, and used in chapter 6 to guide the design of a process for executing collaboration dependent tasks. The upward facing arrows in the right part of figure 4.1 indicate that the theory was refined based on findings from the evaluation of CEADA.

This chapter is structured as follows. Section 4.2 discusses the formulation of the theory on achieving Collaborative (Problem Solving and) Decision Making (CDM) in enterprise architecture creation. Section 4.3 presents a roadmap of how to use this theory to design the desired artifact. Section 4.4 shows how this theory guided the formulation of a framework for coordinating conversations that occur when executing collaboration dependent tasks during enterprise architecture creation. Section 4.5 summarizes this chapter. Some parts of this chapter are a (slightly) modified version of sections of work that appeared in [90, 87, 85].

4.2 CDM in Enterprise Architecture Creation

This section presents the steps involved in constructing a theory (section 4.2.1) and the theory on CDM in architecture creation (section 4.2.2).

4.2.1 Constructing a Theory

Constructing a theory (i.e. theorizing) involves forming scientific claims or consolidating existing knowledge or data to explain why and how effects occur [71]. A theory can be constructed in form of a *'cause-and-effect'* model, or a specific composition of statements (shaped as axioms and propositions) that coherently account for variations in the effects or phenomena of interest in a given domain [12]. An axiom *"is an assumption about the nature of reality (or some mechanism that could affect the phenomenon of interest)"*, while a proposition *"is a functional statement of cause and effect"* (that connects two constructs or concepts) and must be *"logically true if the assumption*" on which it is based *"holds"* ([12], page 575). Thus, a theory can be perceived as a set of either formal constructs (e.g. those in semantic data models) or informal constructs (e.g. consensus, satisfaction) that describe phenomena and incidences as they occur in a domain [71].

Briggs [12] discusses steps involved in rigorously designing a theory that is intended to guide the design of a collaboration system, and Gregor [45] discusses structural components of a theory. Based on their discussions we have formulated figure 4.2.

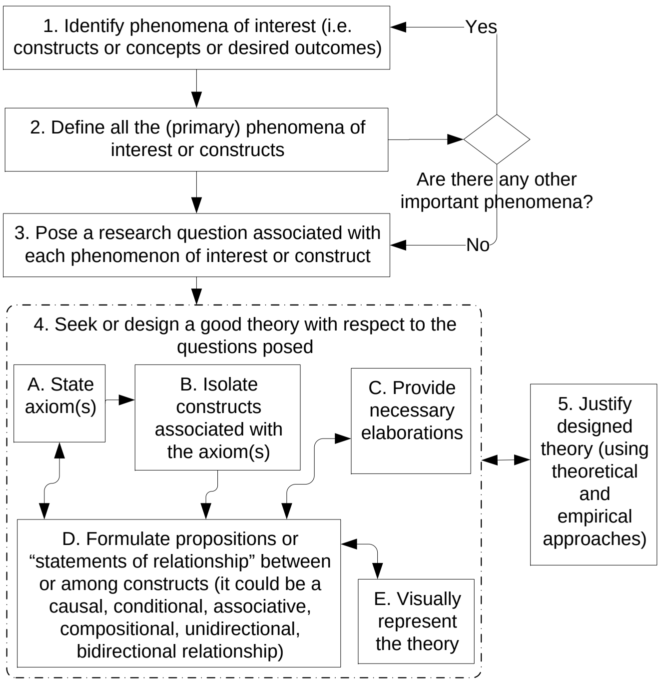

Figure 4.2: *Steps in Theory Formulation* (this model has been formulated based on the discussion in [12, 45])

In figure 4.2, the boxes represent steps undertaken to formulate a theory, and the lines with arrow heads represent information flow between steps. Basing on [12, 45], figure 4.2 shows that designing a theory starts with clearly identifying and defining the primary phenomena of interest (i.e. constructs or desired effects or outcomes) in a given domain and ends with the visual representation of the theory using various ways. Box C in step 4 of figure 4.2 represents a task we have added to the theory formulation procedure, i.e. the task of providing *elaborations*. An elaboration is an explanation that is associated with a given axiom and proposition. Following the steps in figure 4.2, the theory on CDM in enterprise architecture creation was formulated as discussed in section 4.2.2 below.

4.2.2 Theory on CDM in Architecture Creation

A theory can be visually represented using mathematical notations, symbolic logic, diagrams, tables, pictures, or models [45]. Herein the theory on CDM in enterprise architecture creation is visually represented using a model (see figure 4.3). The model in figure 4.3 is an orchestration of notions that explain how CDM can be achieved in enterprise architecture creation. Earlier versions of this model (see appendix B) were refined based on findings from the evaluation of CEADA artifact (this is discussed in chapter 7). Thus, the model in figure 4.3 has undergone three refinement iterations (that were reported in [90, 87, 85]).

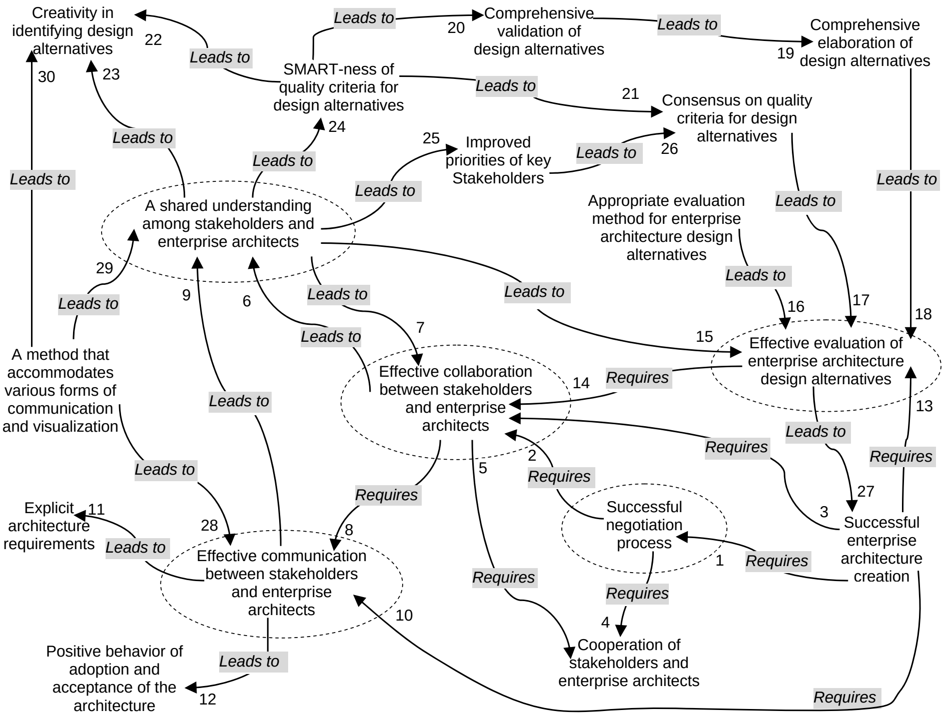

Figure 4.3: *Theory on CDM in Enterprise Architecture Creation*

The theory in figure 4.3 shows the phenomena associated with achieving CDM in architecture creation, and the relations among those phenomena. From chapters 2 and 3 we identified the phenomena of interest shown in figure 4.3. In figure 4.3, the primary phenomena have been highlighted using circles with dashed edges. The arrows in figure 4.3 represent relations between phenomena. The relations among phenomena are causal, conditional, and sequential. A causal relation between p and q means that an increase in

p leads to an increase in q, while a conditional relation between p and q means that p is a necessary prerequisite for the existence or realization or success of q (this is derived from the discussion in section 7.3.3). A sequential relation results from a chain of at least two casual and/or conditional relations among phenomena. The relations shown in figure 4.3 are essentially based on existing literature, and have also been supported by the evaluation findings discussed in chapter 7.

The relations shown in figure 4.3 are numbered (for the purpose of clarity in reading and discussing the theory) and are discussed below in the form of *notions*. Each notion of the theory on CDM in enterprise architecture creation comprises an axiom, proposition, and elaboration. In this research we define axioms and propositions by adopting the definitions provided by Briggs [12] (see section 4.2.1). Thus, axiom is used to refer to an assumption (that is based on existing literature) about a given phenomenon, and a proposition is used to refer to a claim about a given phenomenon that is based on a given axiom and/or existing literature. An elaboration as defined in section 4.2.1, provides necessary details or explanations of a given axiom and/or proposition. In reading or discussing figure 4.3 we start with relation marked 1 at the bottom right corner of figure 4.3. The arrow heads in figure 4.3 show the direction in which a given relation is read. Following is a discussion of notions A – K that constitute the theory on CDM in enterprise architecture creation.

4.2.2.1 Notion A

This refers to the negotiation phenomenon in figure 4.3.

Axiom. In enterprise architecture development, negotiated solution aspects may be more appropriate than optimal solution aspects [57]. Negotiations among stakeholders and enterprise architects enable stakeholders to understand why *all* their concerns and requirements can not be satisfied by the enterprise architecture [88].

Proposition. Successful enterprise architecture creation requires a successful negotiation process (as indicated by relation marked 1 in figure 4.3). In this case successful architecture creation is perceived as acquiring stakeholders' support, commitment, and participation during architecture creation, and gaining their acceptance of the designed architecture (derived from [96]).

Elaboration. This axiom and proposition imply the need for adopting the negotiation theory (and other techniques that enhance negotiations) into enterprise architecture creation. In negotiation theory (discussed in section 3.9.3), the joint decision is not only the final decision in a given task, since negotiations involve several emerging opportunities for joint decisions that eventually lead to the final joint decision [107]. Likewise, an enterprise architecture can be perceived as a collection of joint decisions that are made through out the phases of architecture creation. For example, according to [124], output from the preliminary phase of the architecture development method is used as input in the architecture vision phase, and output from the architecture vision phase is used as input in the phases of developing domain (i.e. business, data, applications, and technology) architectures, and output from all these phases yields the ultimate enterprise architecture. Relation marked 1 in figure 4.3 is therefore a conditional relation, where successful negotiations are required for the success of enterprise architecture creation.

4.2.2.2 Notion B

This refers to the collaboration and cooperation phenomena in figure 4.3.

Axiom. Negotiations involve multiple individuals cooperating to arrive at a joint (or collaborative) decision which results in joint consequences for each individual [107]. Hence relations marked 2 and 4 in figure 4.3.

Proposition. Successful negotiation requires effective collaboration among stakeholders and enterprise architects (as indicated by relation marked 2), and successful negotiation requires the cooperation of stakeholders and enterprise architects (as indicated by relation marked 4).

Elaboration. Collaboration is when multiple individuals join their efforts to achieve a given goal [64]. This implies that relations marked 2 and 4 are conditional relations, in the sense that successful negotiations can not occur unless individuals are willing to collaborate and cooperate. From relations marked 1 and 2, it can be deduced that effective collaboration (among stakeholders and enterprise architects) is required for successful architecture creation (as indicated by relation marked 3). Relation marked 3 is also based on existing literature on enterprise architecture (e.g. [96, 105, 79, 57, 2, 3, 124, 121, 41]) which recommends that during enterprise architecture creation, enterprise architects need to work collaboratively with organizational stakeholders. Moreover, maximum effectiveness of the architecture function is attainable if stakeholders efficiently collaborate towards a shared goal [105].

4.2.2.3 Notion C

This refers to the collaboration phenomenon in figure 4.3.

Axiom. Cooperativeness is an individual's trait, since cooperation is when an individual renders his or her (expected) effort to a group result without intentionally frustrating the efforts of other individuals [64].

Proposition. Effective collaboration among stakeholders and enterprise architects requires the cooperation of individual stakeholders and enterprise architects (as indicated by relation marked 5 in figure 4.3).

Elaboration. Relation marked 5 is conditional. Stakeholders' cooperation is vital for the success of the architecture project because they provide the resources that are required in architecture development, determine the requirements and constraints of the architecture, influence others, and make decisions [96].

4.2.2.4 Notion D

This refers to the shared understanding phenomenon in figure 4.3.

Axiom. In a collaborative environment people purposely "*spend as much time understanding what they are doing as actually doing it*", with the aim of "*creating a shared understanding that didn't exist before*" [116]. Thus, we can define "shared understanding of problem (as-is) and solution (to-be) aspects among stakeholders" as a situation which occurs when stakeholders become aware of the validity/invalidity of their own concerns and requirements, with respect to the concerns and requirements of other stakeholders and the short and long term goals of the enterprise. It is then expected that in a fair or force-free environment, the probability of acquiring shared and supported goals is higher when stakeholders collaborate [64].

Proposition. Effective collaboration creates a shared understanding of the as-is (i.e. current or problem situation) and to-be (i.e. desired situation) aspects of the organization among stakeholders and enterprise architects (as indicated by relation marked 6 in figure 4.3).

Elaboration. Since a shared understanding is a basis for achieving effective collaboration [105], relation marked 7 means that shared understanding among stakeholders and architects will result in effective and efficient collaboration. This is because stakeholders' commitment increases as they gain shared understanding of the as-is and to-be aspects [57]. In addition, the lack of shared goals and expectations between stakeholders and architects is the source of project failures in many cases [124]. Thus, relation marked 6 is a conditional relation, while relation marked 7 is a causal relation.

4.2.2.5 Notion E

This refers to the communication and shared understanding phenomena in figure 4.3.

Axiom. Effective collaboration requires information sharing among actors [33], yet information is shared through communication. There are various *calls* for effective communication in enterprise architecture development in e.g. [57, 124, 141, 41, 123, 110] (see discussion in section 2.2). In addition, discussions or conversations enable a group to effectively use the resources each individual contributes to the meeting and to create a high level of motivation among group members, so as to secure a group decision on the solution to the problem and certainly implement it [28]. Hence relations marked 8 to 12 in figure 4.3.

Proposition. Effective collaboration between stakeholders and architects involves effective communication among stakeholders and enterprise architects (as indicated by relation marked 8). This effective communication in turn leads to a shared understanding among collaborating stakeholders (as indicated by relation marked 9). Thus, successful architecture creation requires effective communication between stakeholders and enterprise architects (as indicated by relation marked 10).

Elaboration. According to Janssen and Cresswell [57], effective communication eliminates ambiguities and this results in explicit requirements for the architecture (as indicated by relation marked 11) as well as positively influencing the acceptance and adoption of the architecture (as indicated by relation marked 12). It is vital for architects to communicate critical and actionable information and to collaborate with willing stakeholders (who value the architecture concept), as this will help to build relationships that will yield long term and mutually beneficial results that encourage adoption of architecture throughout the organization [79, 110]. Thus, relations marked 8 and 10 in figure 4.3 are conditional in the sense that effective communication is vital for effective collaboration and successful architecture creation (respectively), while relations marked 9, 11, and 12 are causal.

4.2.2.6 Notion F

This refers to the evaluation of design alternatives phenomenon in figure 4.3.

Axiom. To address stakeholders' concerns and requirements, the architect develops architecture views that show the trade-offs required to resolve conflicting concerns [124]. Such trade-offs are clarified through evaluation of (solution and design) alternatives [96]. Moreover, satisfactory solutions are sought and obtained through evaluating possible (design) alternatives or courses of action [118, 119].

Proposition. Successful architecture creation requires effective evaluation of architecture design alternatives (as indicated by relation marked 13), and effective evaluation of alternatives leads to successful architecture creation (as indicated by relation marked 27). Hence sequential relation 13 – 27 in figure 4.3.

Elaboration. Satisfactory solutions can be in form of high level solutions or low level unit components of the high level solution. During architecture creation, there are design alternatives for each of the architecture components. For example, alternative objects or aspects in models representing particular organization scenarios or domains. Therefore, architecture creation involves evaluating these alternatives and selecting satisfactory (and sometimes optimal) ones. This implies that relation marked 13 is conditional.

In addition, relation marked 16 in figure 4.3 means that using an appropriate evaluation method for enterprise architecture design alternatives leads to effective evaluation of those alternatives. The type of problem determines the evaluation method that is used. According to [38], evaluation problems are categorized into three (1) choice problems, which involve *"selecting of a subset of actions, as small as possible, in such a way that a single action may be finally chosen"*, (2) ranking problems, which involve *"ranking of all the actions belonging to a given set of actions from the best to the worst"*, (3) sorting problems, which involve first defining a set of categories depending on some typical features, and then *"assigning each action to one of the pre-defined categories"*. Evaluating enterprise architecture design alternatives can be classified as a "sorting-ranking-choice" problem. This is because at least one of the three problems is encountered when defining or creating elements of the enterprise architecture. For example, defining architecture principles invokes a ranking problem, defining architecture requirements invokes a sorting problem and a ranking problem, creating architecture vision invokes all problem types (i.e. sorting, ranking, and choice). Other than the evaluation method used, there are other factors that enhance the evaluation of design alternatives (see relations marked 15, 17, and 18). This explains why relation marked 27 in figure 4.3 is causal.

4.2.2.7 Notion G

This refers to the collaboration and evaluation of design alternatives phenomena in figure 4.3.

Axiom. For (complex) organizational problems it can be difficult for one individual to possess all the required skills for understanding and foreseeing all implications of a given decision or course of action [18, 64, 95], and therefore the best decision requires combining expertise of people from different disciplines or domains [64].

Proposition. Effective evaluation of architecture design alternatives requires effective collaboration between stakeholders and enterprise architects (as indicated by relation marked 14 in figure 4.3).

Elaboration. See elaboration of notion H.

4.2.2.8 Notion H

This refers to the consensus phenomenon in figure 4.3.

Axiom. It has been reported that the commitment of stakeholders increases as they acquire a shared understanding [57] or a shared goal [64]. This implies that achieving a shared understanding directly improves the priorities of stakeholders, and this consequently results in consensus on quality criteria for design alternatives [85].

Proposition. A shared understanding among stakeholders leads to an improvement in their priorities (as indicated by relation marked 25 in figure 4.3), and an improvement in stakeholders' priorities leads to consensus on quality criteria for design alternatives (as indicated by relation marked 26 in figure 4.3).

Elaboration. This axiom and proposition can be explained using the following example. Results obtained after ranking of alternatives (by a stakeholder) using some evaluation criteria, are often consistent with the stakeholder's objectives and preferences [39]. Consequently, if stakeholders have reached consensus on quality criteria for evaluating alternatives, this will lead to effective evaluation of alternatives (as indicated by relation marked 17 in figure 4.3). Hence sequential relation 25 – 26 – 17 in figure 4.3. Sequential relation 25 – 26 – 17 implies relation marked 15 in figure 4.3. Relation marked 15 means that if stakeholders have acquired a shared understanding of the as-is and to-be contexts of the organization, then they can effectively evaluate architecture design alternatives. Relations 15, 17, 25, and 26 are causal.

4.2.2.9 Notion I

This refers to the consensus phenomenon in figure 4.3.

Axiom. Relation marked 24 in figure 4.3 means that if stakeholders have acquired a shared understanding of the as-is and to-be organization contexts, then they can define SMART (i.e. Specific, Measurable, Achievable, Realistic, and Time bound) quality criteria for design alternatives.

Proposition. If quality criteria for architecture design alternatives are SMART, then it is possible that stakeholders will reach consensus on these criteria (as indicated by relation marked 21 in figure 4.3). Hence sequential relations 24 – 21 in figure 4.3.

Elaboration. Sequential relation 24 – 21 – 17 in figure 4.3 also implies relation marked 15.

4.2.2.10 Notion J

This refers to the creativity phenomenon in figure 4.3.

Axiom. If quality criteria for design alternatives are SMART, then this leads to creativity in identifying (possible and relevant) architecture design alternatives (as indicated by relation marked 22 in figure 4.3). Sequential relation 24 – 22 in figure 4.3 implies relation marked 23. Besides, creativity in formulating solution strategies and new alternatives is one of the core components of the negotiation theory [107].

Proposition. If stakeholders have acquired a shared understanding (of the as-is and to-be organization contexts), then this leads to creativity in identifying architecture design alternatives (as indicated by relation marked 23 in figure 4.3).

Elaboration. Identifying design alternatives is not enough, there is need to validate and elaborate them. Thus, relation marked 20 in figure 4.3 means that the SMART-ness of quality criteria for design alternatives leads to comprehensive validation of design alternatives. Relations marked 19 in figure 4.3 means that comprehensive validation of design alternatives leads to comprehensive elaboration of design alternatives, which in turn leads to effective evaluation of design alternatives (as indicated by relation marked 18 in figure 4.3).

4.2.2.11 Notion K

This refers to the shared understanding and communication phenomena in figure 4.3.

Axiom. Often the matters entrusted to be handled by a group are too critical for a single individual [28]. Thus, members of the group will need to communicate and express their views in ways they are familiar with.

Proposition. In enterprise architecture creation, a method with features that accommodate various forms of communication and visualization will lead to effective communication between stakeholders and architects (as indicated by relation marked 28 in figure 4.3), and a shared understanding among stakeholders and architects (as indicated by relation marked 29 in figure 4.3).

Elaboration. A method with features that accommodate various forms of communication and visualization will encourage creativity among stakeholders (as indicated by relation marked 30 in figure 4.3). Relations marked 28, 29, and 30 are causal relations.

4.2.2.12 Core Notion

Major conclusions from the theory in figure 4.3 include the following sequential relations: 1 – 2 – 6 – 15 – 27, 1 – 2 – 6 – 25 – 26 – 17, and 6 – 7 – 8 – 9. From these sequential relations, the core notion of the theory is derived, i.e. *the main parameters for Collaborative Evaluation of Enterprise Architecture Design Alternatives (CEADA) are effective collaboration, communication, negotiation, and shared understanding among enterprise architects and organizational stakeholders*.

4.3 Theory-to-Process Roadmap

Theoretical assertions provide an implied perception of reality, and can be partially validated if they are practically applied by adopting Design Science to test them through designing and evaluating artifacts based on them [71]. Thus, from the notions of the formulated theory (in section 4.2.2), it is possible to make predictions that suggest ways in which the desired artifact (i.e. CEADA) can be designed so as to support execution of collaboration dependent tasks. Figure 4.4 gives an overview of how this was done.

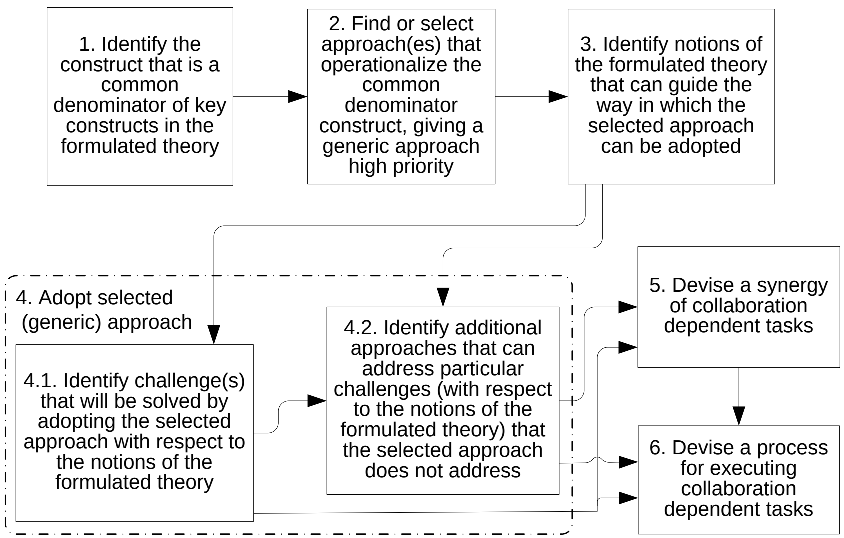

Figure 4.4: *Roadmap from the Theory to the Process*

Figure 4.4 has been formulated to show the steps that were undertaken to move from the theory presented in section 4.2.2 to the synergy of collaboration dependent tasks (discussed in chapter 5) and to the design of CEADA (discussed in chapter 6). In figure 4.4, the boxes represent the steps that were undertaken, the lines with arrow heads represent the direction of flow from one step to another.

Following step 1 of the theory-to-process roadmap in figure 4.4, the key constructs in the formulated theory are effective communication, shared understanding, effective collaboration, successful negotiations, and evaluation of design alternatives (see highlighted phenomena in figure 4.3). Among these key constructs, effective communication seems to be a common denominator. This claim is based on relations marked 8, 9, 10, and sequential relations 2 – 8, 9 – 15, and 9 – 23 in figure 4.3.

Following step 2 of the theory-to-process roadmap in figure 4.4, there is need to choose, from existing literature, an approach (e.g. a method, framework, technique, tool) that operationalizes the common denominator construct. If more than one approach is found, it is better to determine the scope of each and then give high priority to the one that is generic or more accommodative. This is because if a generic or holistic approach is adopted, it may invoke the adoption of other approaches that deal with particular aspects of the construct under consideration (see section 4.4 for details of how this was done). For a theory-driven adoption of these approaches, step 3 of the theory-to-process roadmap in figure 4.4 demands that the notion(s) associated with the common denominator construct are applied. Section 4.4 provides details of how this was done.

Step 4 of the theory-to-process roadmap in figure 4.4 raises the need to identify research challenges that will be solved by adopting the selected approach with respect to notions in the formulated theory. Herein research challenges extracted from literature and those extracted from survey findings were discussed in chapter 2, and are re-examined in chapter 5 for the purpose of identifying approaches that address them with respect to the notions in the formulated theory. The purpose of step 4 in the theory-to-process roadmap is to ensure that the requirements for the desired solution actually address the research challenges. Steps 5 and 6 of the theory-to-process roadmap in figure 4.4 involve defining collaboration dependent tasks and devising support for their execution. Chapters 5 and 6 give a detailed discussion on how steps 5 and 6 of the roadmap were undertaken.

4.4 Synthesis

This section discusses how steps 2 and 3 of the theory-to-process roadmap in figure 4.4 were carried out in order to obtain a synthesis towards addressing the research problem. The synthesis is a framework for coordinating conversations that transpire during the execution of collaboration dependent tasks in enterprise architecture creation. A framework helps to coordinate and provide a formal structure of the thinking processes that the group will undergo to achieve its purposes, to reduce coordination loss (by keeping everyone focused on the same subject at the same time), and to reduce conceptual loss [107].

Although architecture creation is a CDM task (as discussed in section 3.2), the "division of labor" among stakeholders during the execution of collaboration dependent tasks is necessary. This is because (some) stakeholders have tight work schedules that may affect their participation in the execution of collaboration dependent tasks. Section 2.3 highlights the need for insights into how labor can be divided during the execution of collaboration dependent tasks. Dividing labor implies the need to properly coordinate the resultant sub-efforts and outputs that should coherently contribute to the desired outcome.

Usually proper coordination of tasks executed by a group of actors enhances communication and collaboration among actors [33]. Thus, concerted division of labor among stakeholders during execution of collaboration dependent tasks calls for proper coordination of tasks (their output and the actors involved) and effective communication. This still emphasizes effective communication as our common denominator construct. Following steps 2 and 3 of the theory-to-process roadmap in figure 4.4, we now proceed below to discuss the approach we adopted to operationalize the communication construct.

Members of a group produce and reproduce various types of interpersonal communication (i.e. information exchange) until they converge on some final substance, which is taken as the group decision [28]. In system development this communication can be perceived as a set of conversations in which knowledge about the intended system (and its development) is created and shared among actors [104]. For conversation or communication support, two holistic approaches were identified, i.e. the guidelines for communicating enterprise architectures defined by Proper et al. [123], and the VPEC-T[1] communication framework by Green and Bate [44]. Basing on step 2 of the theory-to-process roadmap in figure 4.4, first priority is given to the former. This is because the former (a) is closely associated with enterprise architectures, (b) it could be used along with the latter, and (c) it encourages and accommodates the adoption of other approaches that support the operationalization of the other key constructs in this research. Following is a discussion of how the selected approach was adopted.

Proper et al. [104] discuss the guidelines for formulating conversation strategies, selecting architectural knowledge goals, and selecting conversation techniques for communicating architectural models. These guidelines have been adopted in this research, to develop a conceptual framework for coordinating all (sub) conversations and tasks that occur when labor is divided during the execution of collaboration dependent tasks in architecture creation. Our conversation coordination framework or mechanism for the architecture creation conversation is shown in figure 4.5. The three inner boxes in figure 4.5 represent components of the coordination framework of the architecture creation conversation. The top part of each inner box shows the name of each component and the chapter where each component is discussed. The upward facing arrows between the inner boxes in figure 4.5 show how components in the framework support each other. The arrows outside the outer box in figure 4.5 show the factors affecting the architecture creation conversation.

Architecture creation conversations are affected by several situational factors [104] which are denoted as SF_j in the outermost left and right parts of figure 4.5, where $j = \{1, 2, ..., n\}$. In addition, prior to the conversation it is vital to determine the architectural knowledge goals that the conversations will aim to achieve, i.e. creating new knowledge, agreeing to it, or committing to it [104]. A question arises of the kind of knowledge that will be created, agreed on, or committed to during the conversation. Step 3 of the theory-to-process roadmap (in figure 4.4) suggests that the notions of the formulated theory are used to guide the adoption of the selected approach. Accordingly, from notion A of the theory on CDM in architecture creation, it can be noted that the products that are required from the architecture creation process are specified prior to the commencement of the architecture creation conversation. This implies that the knowledge goals or states that architecture creation conversations generally endeavor to attain, can be perceived as the

[1] VPEC-T stands for Values Policies Events Content Trust [44], and was earlier discussed in section 2.2.3).

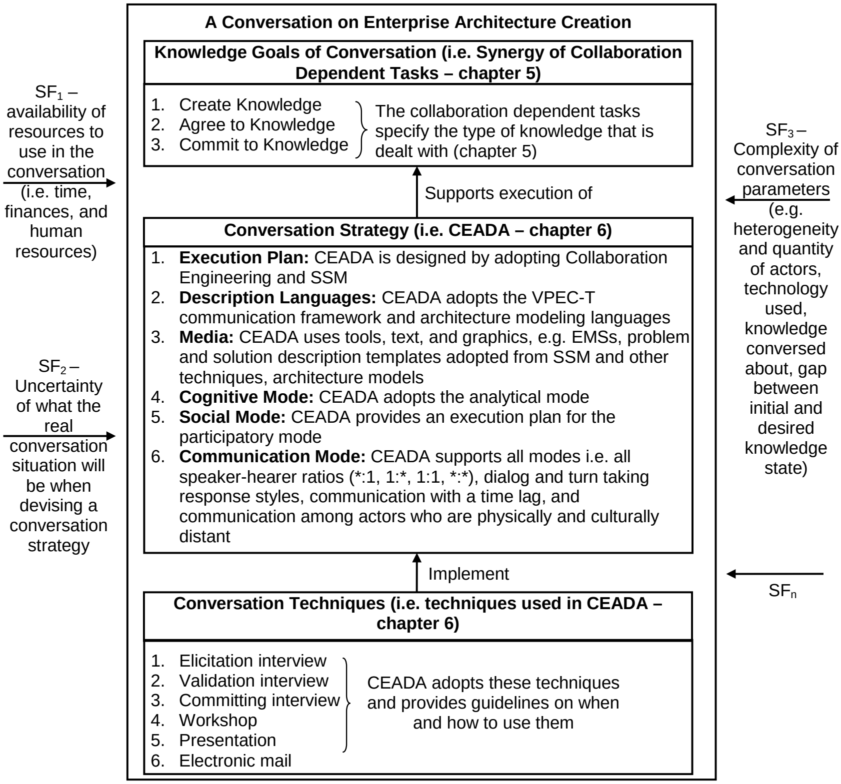

Figure 4.5: *Coordination Framework for Architecture Creation Conversation (*this model has been formulated based on the discussion in [104])

deliverables of collaboration dependent tasks and architect-specific tasks. Thus, as shown in the top part of figure 4.5, in this research knowledge goals of the conversation are pointers to collaboration dependent tasks. These are discussed in chapter 5.

Furthermore, to achieve the architectural knowledge goals, a conversation should follow a strategy [104]. As shown in the middle part of figure 4.5, in this research such a strategy can be perceived as CEADA, since it can enable architects and stakeholders to achieve the knowledge goals of architecture creation conversations through executing collaboration dependent tasks.

According to Proper et al. [104], any conversation strategy should articulate the following aspects.

1. *An execution plan of the conversation.* This shows the execution order of sub conversations that will achieve sub goals that contribute to achieving the main goal [104]. All notions of the formulated theory give clues of what the execution plan of the architecture creation conversation should entail, but clues on the execution order are only implicitly represented by the sequences in the theory. Thus, following step 3 of the theory-to-process roadmap shown in figure 4.4, there was need to adopt other approaches that can give insight into the execution order of the architecture

creation conversation. As shown in figure 4.5, these approaches include Collaboration Engineering, and Soft Systems Methodology (SSM). The adoption of these approaches to obtain the execution plan (i.e. CEADA) is guided by the notions of the formulated theory. Details of how this was done are provided in chapters 5 and 6.

2. *The description languages used in the conversation.* This defines the language or vocabulary that will be used when describing aspects in the conversation [104]. The conversation involves stakeholders (who are often business-oriented experts) and enterprise architects (who are often ICT-oriented experts). Architects describe the architecture conversation in form of architecture models that are drawn using any of the various (architecture) modeling languages. Since effective communication between these two groups is often a problem, the VPEC-T framework [44] was adopted (as shown in figure 4.5) to enable proper communication of business and ICT related aspects during the architecture creation conversation. Details of how this was done are provided in chapter 6.

3. *The type of media used in the conversation.* This defines media or tools or objects that will be used during the conversations [104]. Notion K, for example, was followed to adopt approaches that provide various forms of media that enable proper communication and encourage the creation of a shared understanding. Figure 4.5 shows the approaches that were adopted to enable CEADA to use various types of media to describe, store, and deliver information or data required in (or resulting from) the architecture creation conversation. Details of how this was done are provided in chapter 6.

4. *The cognitive mode in the conversation.* This shows how actors will gather and process knowledge during the conversation – it may be analytical (with support for managing complexity by abstracting information so as to reach a deeper shared understanding); or experimental (with support for experimenting ideas using prototypes or other techniques so as to reduce uncertainties) [104]. Figure 4.5 shows that CEADA adopts the analytical mode of knowledge gathering and processing. Although the experimental mode is also vital, its adoption was beyond the scope of this research. Details of the guiding axioms, propositions, and elaborations, as well as adopted approaches for enabling the analytical cognitive mode are provided in chapter 6.

5. *The social mode in the conversation.* This shows how system development actors will collaborate with business actors during the conversation – it may be (a) expert-driven (where the development team uses their own expertise and interviews with business actors to produce descriptions, and then delivers them to business actors for approval), or (b) participatory driven (where the development team produces descriptions in close cooperation with business actors using workshops) [104]. Figure 4.5 shows that CEADA adopts both the participatory and expert-driven modes. CEADA provides the execution plan of the participatory driven mode and the interview aspects in the expert-driven mode. This is because technical aspects that the development team focuses on (in the expert-driven mode) are richly available

in literature (e.g. [67, 124]). Approaches that should be adopted to enable the participatory driven mode include the collaboration support, negotiation support approaches, support for creativity, support for collaborative evaluation of alternatives, support for communication and shared understanding. Details of the guiding axioms, propositions, and elaborations, as well as adopted approaches for enabling the participatory driven mode are provided in chapter 6.

6. *The communication mode in the conversation.* This shows the basic patterns of communication that will be used in the conversation, i.e. speaker-hearer ratio (which may be *:1, 1:*, 1:1, *:*), the response style (which may be dialog and turn taking if an answer is expected from the hearer), communication time lag between speaking and hearing, and the locality or physical and cultural distance between actors [104]. The modes considered in this research are shown in figure 4.5. Approaches that were adopted to enable these communication modes include those for collaboration support and communication support. Details of these are provided in chapter 6.

Chapter 5 discusses details of a synergy of knowledge goals of the architecture creation conversation. Chapter 6 discusses details of an explicit and flexible conversation strategy, that comprises an execution plan or agenda of the architecture creation conversation, the description languages, type of media, cognitive mode, social mode, and communication mode used in the conversation. Chapters 7 – 8 discuss evaluation findings on the execution plan, and its associated description languages, media, cognitive mode, social mode, and communication mode. Section 4.5 gives an overview of deliverables from this chapter and from the research in general.

4.5 Summary on Solution Synthesis

This chapter has provided an overview of the solution synthesis delivered by this research by following Design Science. The solution synthesis comprises three aspects. First, a theory that provides an orchestration of the phenomena (and their relationships) that are associated with executing collaboration dependent tasks so as to achieve CDM in enterprise architecture creation (discussed in section 4.2). Second, a theory-to-process roadmap (discussed in section 4.3) that was followed to move from the formulated theory to the desired artifact (i.e. CEADA). Third, a coordination framework for conversations on enterprise architecture creation (discussed in section 4.4). The architecture creation conversation coordination framework, with respect to the theory on CDM in architecture creation, enabled us to adopt other relevant approaches in a methodical and coordinated way to develop CEADA. In our architecture creation conversation coordination framework, CEADA is perceived as a conversation strategy that comprises an execution plan, description languages, media, cognitive mode, social mode, communication mode, and conversation techniques that can support architecture creation conversations. CEADA, as a conversation strategy, intends to achieve certain (knowledge) goals in architecture creation. In chapter 5 we discuss a synergy of such goals.

Chapter 5

Collaboration Dependent Tasks

Abstract. This chapter discusses a synergy of tasks that are collaboration dependent in enterprise architecture creation. The synergy is designed by adopting selected approaches that support task structuring, with respect to notions of the theory on Collaborative Decision Making (CDM) in enterprise architecture creation. The synergy is mainly based on the generic decision making process by Herbert A. Simon and the multi-level thinking technique by Peter Checkland.

5.1 Chapter Overview

In chapter 4 we discussed the theory on Collaborative Decision Making (CDM) in architecture creation, a roadmap of the steps we took to move from the formulated theory to the design of CEADA, and a framework for coordinating conversations that transpire during architecture creation. The conversation coordination framework comprises three components, i.e. the knowledge goals of architecture creation conversations, the conversation strategy, and the conversation techniques. The knowledge goals component defines *what* the architecture creation conversations endeavors to achieve, while the conversation strategy and techniques define *how* the architecture creation conversation is conducted. Chapter 6 covers the latter, and this chapter covers the former. Therefore, this chapter discusses *what* needs to be done during the architecture creation conversations in order to achieve CDM in enterprise architecture creation. In doing so we perceive the knowledge goals component of our conversation coordination framework as the *synergy of collaboration dependent tasks*. Although different architecture projects may have different knowledge goals, we assume that achieving CDM in architecture creation generally involves some common goals or tasks. We present a synergy of such tasks in this chapter.

In figure 5.1 we show the focus of this chapter with respect to the preceding and subsequent chapters. Boxes (a) – (g) in the top part of figure 5.1 represent deliverables of chapters 2 – 6, while the arrows show how the deliverables of these chapters are interrelated. Boxes (h) – (k) in the bottom part of figure 5.1 represent the research questions that were presented in section 1.5, and the dashed arrows represent an association between a given research question and the box showing information where answers of the research question are discussed.

The top part of figure 5.1 shows that formulating the synergy of collaboration depen-

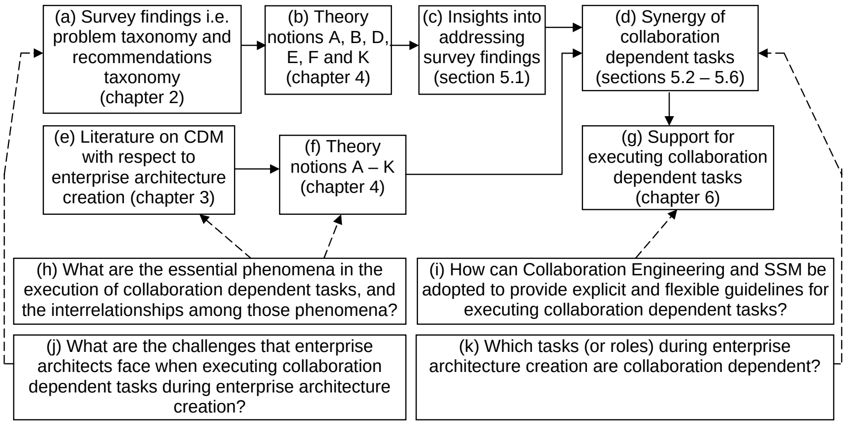

Figure 5.1: *Focus of Chapter 5*

dent tasks was done in two complementary ways. The first way is represented by boxes (e) – (f) – (d) in figure 5.1. Boxes (e) – (f) – (d) show that literature on enterprise architecture creation (in chapter 2) and on CDM (in chapter 3) was reviewed, and this enabled us to devise the orchestration of key phenomena associated with achieving CDM in architecture creation. This provided insights into the theory on CDM in architecture creation (discussed in chapter 4), which guided the adoption of relevant approaches that informed the formulation of the synergy of collaboration dependent tasks (see discussion in section 5.3). The second way in which the synergy was formulated is represented by boxes (a) – (b) – (c) – (d) in the top part of figure 5.1. These boxes show that survey findings in chapter 2 were re-examined with respect to notions of the theory on CDM in architecture creation, in order to determine how the challenges and recommendations that were reported by architects could be addressed. Thus, survey findings also provided insights into the formulation of the synergy of collaboration dependent tasks, and the adoption of other relevant approaches in this research (see discussion in section 5.2).

In section 5.2 we present insights (based on CDM literature and the theory for CDM in architecture creation) into addressing issues in the survey findings. Section 5.3 discusses the adoption of approaches used to formulate the synergy of collaboration dependent tasks. Sections 5.4 – 5.7 discuss the synergy constituents, and section 5.8 summarizes the chapter. Some parts of this chapter are a (slightly) modified version of sections of work in [90, 86, 85, 88].

5.2 Insights into Addressing Survey Findings

This section gives high level guidelines or suggestions on how to address survey findings (that were presented in section 2.3.3). As shown in columns 4 and 5 of table 5.1, these guidelines are based on CDM literature and on the notions of the theory on CDM in enterprise architecture creation. From column 4 of table 5.1, we show that survey findings can be addressed by skillfully adopting techniques that support three key aspects. These include effective collaboration (see rows 4 – 7 in table 5.1), shared understanding (see row 3 in table 5.1), and effective communication (see row 2 in table 5.1). Sections 5.2.1 – 5.2.3 provide details on these aspects.

Table 5.1: *Insights into Addressing Survey Findings*

<table>
<tr><th>#</th><th>Problem category from the survey</th><th>Recommendation category from the survey</th><th>Insights into addressing challenges and recommendations from the survey with respect to existing literature on CDM</th><th>Solution insights based on the theory on CDM in architecture creation</th></tr>
<tr><td>1</td><td>Ineffective communication</td><td>Communicate clearly and regularly</td><td>Aim at creating a common and understandable vocabulary for communication among actors</td><td>Notion E of the theory</td></tr>
<tr><td>2</td><td>Lack of a shared understanding and shared vision or strategy</td><td>Explicitly define purpose of enterprise architecture creation</td><td>Deploy or adopt techniques for enabling the creation of a shared understanding of as-is and to-be contexts of an enterprise</td><td>Notions D, E, and H of the theory</td></tr>
<tr><td>3</td><td>Social complexity</td><td>Collaborate with the right people</td><td>(a) Use effective collaboration techniques, (b) use short group sessions, and (c) devise ways in which interview sessions can be used to supplement group sessions</td><td>Notions A and B of the theory</td></tr>
<tr><td>4</td><td>Lack of a clear decision making process or unit in the organization and architecture governance</td><td rowspan="2">Ensure establishment of a clear decision making process and governance framework</td><td rowspan="2">(a) Find out all key decision makers in the organization, (b) define clear roles of each stakeholder in the interview sessions and group sessions prior to scheduling the sessions, and (c) analyze the as-is situation and to-be situation so as to identify and involve the current or possible or future problem owners</td><td rowspan="2">Notion D of the theory</td></tr>
<tr><td>5</td><td>Lack of long term planning</td></tr>
<tr><td>6</td><td>Lack of supporting tools and techniques for executing collaboration dependent tasks</td><td rowspan="2">Other</td><td rowspan="2">Aim at generally addressing weaknesses of methods currently used in practice to support execution of collaboration dependent tasks</td><td rowspan="2">Notions F and K of the theory</td></tr>
<tr><td>7</td><td>Other</td></tr>
</table>

5.2.1 Effective Collaboration

The problems in rows 4 – 7 in table 5.1 (i.e. social complexity, lack of long term planning, lack of a clear decision making process, and lack of supporting tools and techniques) partly call for deployment of techniques that enable effective collaboration into architecture creation. This argument is inspired by the following views.

Row 7 of table 5.1 shows that no recommendations were given from the survey for the problem of lack of supporting tools and techniques. However, in the survey findings several methods were reported that are currently used to support collaborative work between stakeholders and architects (see section 2.3.3). Therefore, the problem of lack of supporting tools and techniques (listed in row 7 of table 5.1) implies the need to address weaknesses of methods currently used in practice to support execution of collaboration dependent tasks. For example, among the methods reported, interviews and workshops are the most commonly used methods (see chapter 2, figure 2.5). From figure 2.5 it can also be noted that the strengths of using well prepared and facilitated workshops can help one to overcome the weaknesses of using only interview sessions. Also, some weaknesses of using only workshop sessions can be partly overcome by using supplementary interview sessions, and by undertaking other measures that are discussed below. The following are suggestions of how some weaknesses (presented in section 2.3.3) of using only workshop sessions can be dealt with.

Adopt means for detailed information elicitation. There is need to deploy techniques for eliciting detailed information from workshops in order to overcome the reported weakness of workshops producing insufficiently detailed information and informal results (see section 2.3.3). This can be done by conducting interviews that build on output from workshops, or conducting workshops that build on output from interviews, and then seeking formal approval of workshop results. Approaches for achieving this already exist and need to be creatively adopted in enterprise architecture creation. For example, Vreede et al. [129] developed a collaboration process that supports two workshop sessions, where the first session gathers general concepts on the usability of a software application, and the second session deals with a detailed analysis of concepts from the first session. Also Checkland [22] presents the *multilevel thinking* concept which enables problem solvers or owners to think hierarchically or in layers, such that they can thoroughly answer questions of whether, why, what, how etc regarding a problem situation. Therefore, in this research we adopt these concepts (see sections 5.3.1, 6.2.1, and 6.4) in order to address the above mentioned problems of using workshops.

Adopt means that support participants' anonymity. There is need to deploy Electronic Meeting Systems (EMSs) to overcome the reported weakness of workshops lacking anonymity (see section 2.3.3). This is because one of the key advantages of EMSs is their support for anonymity of participants in group sessions during tasks of brainstorming, evaluation, voting, and choice (see e.g. [14, 16, 129, 95]). In addition, focused and structured deliberation in a group can be enabled by deploying EMSs, since they reduce distractions and cognitive overheads involved in communication [18]. More details on EMSs are discussed in section 3.5.2. Thus, in this research we adopt EMSs in order to address the anonymity problem of using workshops (see section 6.2.1).

Adopt a sustainable way of executing collaboration dependent tasks. This helps to overcome other reported weaknesses of using workshops e.g. their success depending on skills of professional facilitators, the time consuming process of preparing for workshops and processing their results, or the inability to stay focused on the agenda (see section 2.3.3). In Briggs et al. [15, 14, 16] Collaboration Engineering is reported to be a sustainable way of deriving value from collaboration technologies, because it supports the design of processes that are (1) transferable, i.e. with a reduced conceptual load for practitioners so that they only have to learn the functionality of a collaboration technology (but not the intensions thereof), (2) predictable, i.e. where different practitioners can execute the processes and get similar or predictable results, and (3) repeatable, i.e. where the processes can be reused to minimize development time for new similar processes.

Such collaboration processes have been designed for tasks like testing usability of software applications [129], strategic decision making in multi organizational collaborations [11], incident response planning [61], organizational policy making [83], designing evolutionary systems [70]. Similarly this research has explored the development of a (repeatable, predictable, or transferable) collaboration process for enterprise architects to successfully execute by themselves. With such a process, the preparation time for workshops may be less, since what will be required is to customize the collaboration process so that it suits the situation of a given organization. Thereby, the success of a workshop does not only depend on the presence of a professional facilitator. Such a process is vital because it can enable effective use of workshops in large enterprises, thereby architects are spared from conducting several interviews as they endeavor to reach all relevant stakeholders in an architecture creation initiative. A collaboration process can also be designed in such a way that workshop stakeholders stay focused on the agenda, and are restricted from sharp diversions. For example, in Bragge et al. [11] a collaboration process was designed in a way that it helped stakeholders to stay focused during a strategic decision making workshop. Therefore, in this research we adopt Collaboration Engineering (see sections 6.2.1 and 6.4) to develop a repeatable collaboration process for architecture creation, in order to address the above mentioned problems of using only workshop sessions.

Adopt techniques that address social complexity issues. Row 4 in table 5.1 shows that deploying effective collaboration techniques in workshops may partly minimize the social complexity problem, which if not addressed can frustrate the above suggested efforts. For example, Nunamaker et al. [95] report that effective use of collaboration techniques helps to address issues such as lack of focus in the group meetings, domination of some participants, fear of speaking, making premature decisions, misunderstandings. In this research we attempt to address some of the social complexity issues by adopting collaboration techniques such as thinkLets and other techniques that support rational thinking (see sections 6.2.1 – 6.2.3).

Devise means that enable complementary use of interviews and workshops. Row 4 in table 5.1 also shows that overcoming the challenge of some stakeholders having insufficient time for participating in group sessions may require scheduling short group sessions, and then supplementing their output with output from interview sessions. This could work in situations where stakeholders have low priority for participating in group sessions. Basing on notions D, E, and H of the theory on CDM in architecture creation (in section 4.2.2), flexible ways of encouraging stakeholder participation may change their priorities in the long run. This is because effective collaboration results in a shared understanding among stakeholders (and helps to create a shared vision), which eventually leads to an improvement in stakeholders' priorities (see notion H in section 4.2.2). However, these attempts may work if the 'insufficient time' issue is genuine, since in the survey it was reported that some stakeholders use absenteeism as one of their tactics of playing politics. If this is the case, then guidelines for managing political issues during architecture creation are given in Spewak [121]. The scope of this research excludes addressing organization politics.

5.2.2 Effective Communication

In row 2 of table 5.1, the communication problem implies the need for stakeholders and architects to use a common and understandable vocabulary which articulates the business goals, reasons for creating the architecture, linkages between the architecture and other organization frameworks, and short-term and long-term benefits of the architecture. On addressing the communication problem, section 4.4 presents the framework that has been formulated to enable coordinated conversations or communication during enterprise architecture creation. The framework also shows the description languages that were selected for adoption in CEADA, the communication media, and the adopted communication modes. Sections 5.3 – 5.7 discuss *what* is communicated during enterprise architecture creation, while section 6.4 discusses *how* it is communicated.

5.2.3 Shared Understanding

Implementing the above suggestions on enabling effective collaboration and effective communication (see examples in sections 5.2.1 and 5.2.2) helps to create a shared understanding of the baseline and target aspects of an enterprise among stakeholders and architects. This assumption is based on notions D, E, and H of the theory on CDM in architecture creation (see section 4.2.2).

The suggestions discussed above (in sections 5.2.1 and 5.2.2) justify the relevance of the coordination framework for the architecture creation conversations that is discussed in section 4.4. This is because the implementation or realization of the above suggestions raises the need to categorize, structure, and synergize them. This section has categorized the above suggestions (on addressing problems and recommendations that were elicited from the survey) into those associated with deploying approaches that support effective collaboration, creation of a shared understanding, and effective communication. Section 5.3 then proceeds to focus on structuring and synergizing suggestions that constitute these three broad categories.

5.3 Synergy of Collaboration Dependent Tasks

In section 4.3 we presented the roadmap or steps we undertook to move from the theory on CDM in architecture creation (in section 4.2.2), to the synergy of collaboration dependent tasks (in this section), and to the execution support for these tasks (in chapter 6).

The section now discusses how steps 4 and 5 of the theory-to-process roadmap (in figure 4.4) were carried out to identify approaches that were adopted to structure and synergize suggestions in section 5.2 and predictions from the theory on CDM in architecture creation. With respect to the coordination framework for architecture creation conversations (in section 4.4), the resultant synergy in this section serves as the set of knowledge goals that architecture creation conversations aspire to achieve. With respect to the research objectives in section 1.6, this section presents activities that can be collectively referred to as collaboration dependent tasks in architecture creation.

Classical approaches or views that were found to support the structuring and synergizing of implications (from the survey findings and the theory on CDM in architecture creation) are the generic decision making process by Simon [118], the decision-making group concept by DeSanctis and Gallupe [28], and the multilevel thinking concept by Checkland [22]. According to Simon [118], all types of decision making tasks can generally be structured to involve three phases, i.e. intelligence, design, and choice (see left part of figure 5.2). These phases are defined in section 3.9.2. In addition, DeSanctis and Gallupe define a decision-making group to consist of two or more people who attempt to *jointly detect* a problem, *elaborate the nature* of the problem, *generate possible* solutions, *evaluate potential* solutions, and *formulate strategies* for implementing (appropriate) solutions. The middle part of figure 5.2 shows how this concept of a decision-making group relates to the generic concept of decision making. The right part of figure 5.2 shows the type of organizational stakeholders who need to work with enterprise architects when enterprise architecture creation is undertaken as a group decision making initiative.

In this research, the phases of the generic decision making process were adopted with respect to the responsibilities of a decision making group, so as to create a structure and synergy of predictions from the theory on CDM in architecture creation and the suggestions for addressing issues in the survey findings. This was done in the following two ways.

First, predictions were made based on notions in the theory on CDM in architecture creation. The theory helps one to make predictions of the conditions/aspects that have to be addressed before other conditions/aspects can be addressed. For instance, from no-

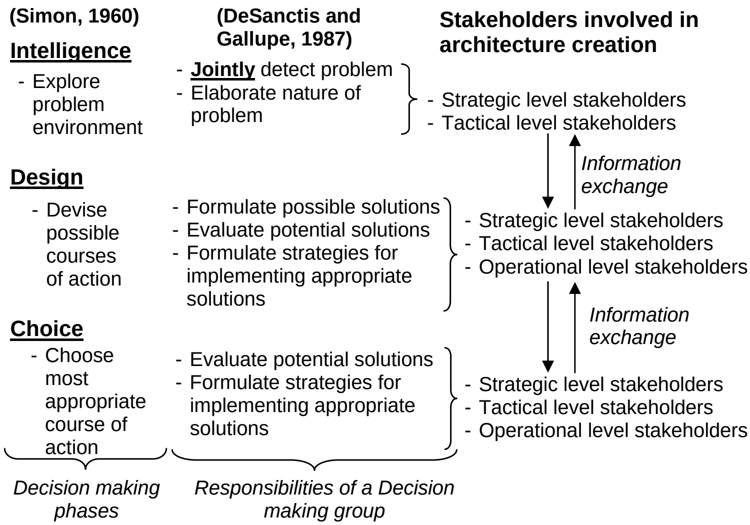

Figure 5.2: *Decision Making Phases and Tasks*

tions C, B, D, J, H, and A, we predict that "*achieving CDM in enterprise architecture creation requires enterprise architects and stakeholders to cooperate, with the aim of gaining shared understanding of the baseline and target situations of the organization, identifying and devising possible design alternatives for realizing the target situation, evaluating the possible impacts of these design alternatives, and selecting (and agreeing on) the design alternative that is appropriate*". Also, from notions H and I of the theory we predict that "*since key stakeholders have diverse concerns and views, if they first acquire a shared conceptualization and understanding (of enterprise aspects relevant to architecture development), this will effectively guide the determination of common and explicit criteria for evaluating enterprise architecture design alternatives, the identification and validation of possible design alternatives, the evaluation of such alternatives, and the selection of appropriate ones*". Other predictions from the theory are given in sections 5.4 – 5.7.

Second, the suggestions on addressing survey findings (see section 5.2) were put into consideration. Those suggestions imply two key aspects. The first implication is that there is need to divide the architecture creation conversation into short structured (interview and group) sessions, in which approaches (for enabling effective collaboration, detailed information gathering or problem analysis, shared understanding, negotiations etc) can be used to support the execution of collaboration dependent tasks. The second implication is that there is need to ensure that the structure of the architecture creation conversation is a communication plan in itself. This helps to ensure that there is regular and clear communication throughout the execution of collaboration dependent tasks. Developing a communication plan is vital in enterprise architecture development [124, 41]. For the structure of a conversation to simultaneously serve as a communication plan, it needs to show what should be communicated before, during, and after execution of various collaboration dependent tasks. More details on this are discussed in sections 5.4 – 5.7.

Following these implications and predictions, we formulated a model that shows the synergy of collaboration dependent tasks (see figure 5.3). Steps in figure 5.3 were further decomposed into activities in tables 5.2 – 5.4 (in sections 5.4 – 5.7). Thus, figure 5.3 can be perceived as a coarse-grained form of the synergy of collaboration dependent tasks, while tables 5.2 – 5.4 can be perceived as constituents of a fine-grained model of the synergy. Earlier versions of models showing the synergy of collaboration dependent tasks (see appendix B) were evaluated, and evaluation findings were used to refine and validate them (see discussion in chapter 7). In general figure 5.3 and tables 5.2 – 5.4 have undergone three refinement iterations (see [85, 86, 90]). Below we discuss figure 5.3, and in sections 5.4 – 5.7 we discuss tabular models of its decomposed form. The production life cycle of these models is thoroughly discussed in [85, 86].

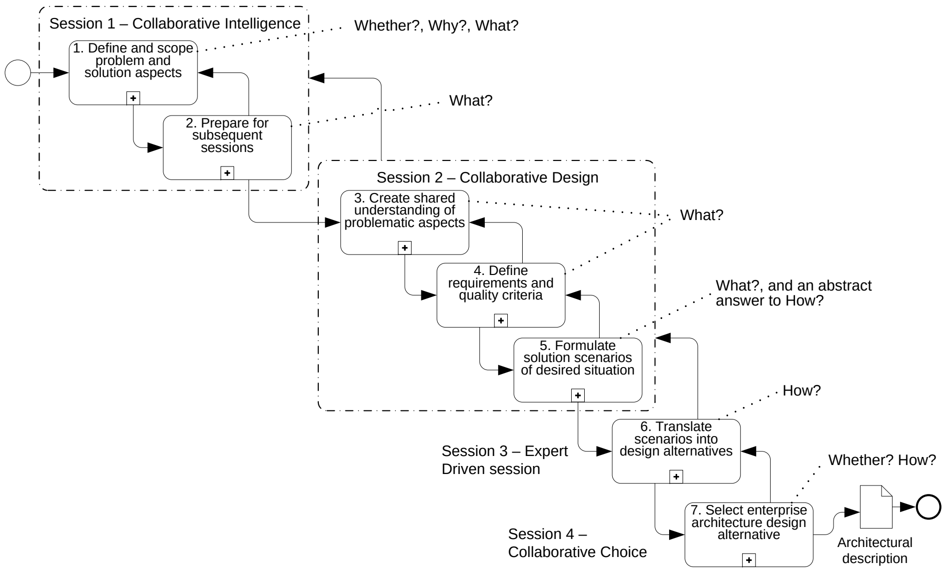

Figure 5.3: *Synergy of Collaboration Dependent Tasks*

In figure 5.3 the round cornered boxes represent the seven steps that constitute the synergy, while the arrows represent information exchange between steps. The dashed boxes represent a group of steps or tasks in the synergy that make up a given session in the architecture creation conversations. Figure 5.3 is a non-linear synergy that structures the enterprise architecture creation conversation into four sessions. A well structured decision making schema should have nonlinear prescriptions, allowing feedback loops at every stage to earlier stages to enable participants to get deeper understanding of the problem and/or desired situation [107]. Thus, in figure 5.3 the backward facing arrows at the top of each box indicate feedback loops between steps in the synergy and between sessions in the synergy.

Sessions 1, 2, and 4 are collaborative in the sense that enterprise architects ensure thorough stakeholder participation or involvement and interactions in these three sessions. Session 3 is essentially expert driven, and it may require the experts/practitioners (i.e. enterprise architects) to collaborate among themselves during the execution of tasks involved in translating the formulated scenarios into architecture design alternatives. However, collaboration among architects at step 6 in figure 5.3 is beyond the scope of this research.

The synergy shown in figure 5.3 and tables 5.2 – 5.4 defines *what* can be done in order to achieve CDM in conversations on enterprise architecture creation. Chapter 6 discusses *how* the tasks in figure 5.3 and tables 5.2 – 5.4 can be executed.

5.3.1 Underlying Intentions in the Synergy

Human conversations are significantly affected by the confusion that sprouts from the failure to properly organize thoughts and expressions [22]. Thus, the formulation of figure 5.3 and tables 5.2 – 5.4 is an attempt towards having an explicit and flexible structure of conversations on creating enterprise architecture. Moreover, structured thinking should cater for feedback loops, because *"unexpected insights in the course of doing analysis may be the impetus for breakthroughs, accidents may be more important than planned events, and disappointments may lead to successes"* [107] (page 398). The synergy in figure 5.3 is flexible and non-linear, in the sense that it caters for feedback loops between steps, between sessions, and between or among activities in each step. Feedback loops among activities in each step or session are clearer in the fine-grained format of the synergy (see tables 5.2 – 5.4 in sections 5.4 – 5.4).

In figure 5.3, session 1 is a derivative of Simon's intelligence phase, session 2 is a derivative of his intelligence phase and design phase, session 3 is a derivative of his design phase, and session 4 is a derivative of his choice phase. The grouping of steps in each session is based on the responsibilities of a decision making group by [28] (see figure 5.2), and the multi-level thinking concept of Checkland [22].

Multi-level thinking involves thinking in levels (or layers or hierarchies), and it enables actors or decision makers to purposely distinguish the '*whether*', the '*what*', and the '*how*' [22]. Thus, in figure 5.3, session 1 addresses the *whether* level of thinking and also addresses (to an abstract extent) the *what* level of thinking about the baseline and target aspects during the enterprise architecture creation conversation. In session 2 of figure 5.3, steps 3 and 4 address details of the *what* level of thinking. Step 4 also addresses (to an abstract extent) the *how* level of thinking about the baseline and target aspects during the architecture creation conversation. Session 3 addresses the details of the *how* level, while session 4 involves discussing or debating aspects associated with the *how* level of thinking in the architecture creation conversation. Session 4 also involves, to some extent, the *whether* level of thinking, since there is need to choose an appropriate enterprise architecture design alternative. This structuring is made more explicit in tables 5.2 – 5.4, which decompose steps in figure 5.3, into explicit tasks. Like figure 5.3, the decomposition of tasks in tables 5.2 – 5.4 was based on the notions of the theory on CDM in enterprise architecture creation (see section 4.2.2), the suggestions on addressing survey findings (see section 5.2), and findings from the evaluation of CEADA (see section 7.3.3).

5.3.2 Constituent Sessions

Sections 5.4 – 5.7 discuss intentions of sessions and steps in figure 5.3, and the tasks or activities involved in each session or step (in tables 5.2 – 5.4).

5.4 Collaborative Intelligence

This session comprises steps 1 and 2 of the synergy in figure 5.3. It intends to enable enterprise architects and stakeholders to determine and analyze major problems in the baseline context of the enterprise and determine key aspects of the solution or desired context of the enterprise. Table 5.2 shows that step 1 of the synergy in figure 5.3 is decomposed into activities A.1.0 – A.1.9, and step 2 is decomposed into activities A.2.1 – A.2.3. Below we give an overview of *what* these activities involve. However, details of *how* these activities are executed are provided in section 6.4.1.

Table 5.2: *Activities in Collaborative Intelligence Session*

Activity Identifier #	Decomposition of Collaboration Dependent Tasks in steps 1 and 2 of the synergy in figure 5.3 (Collaborative Intelligence Session)
A.1.0	Communicate purpose of the session
A.1.1	Define organization processes and problematic aspects or challenges
A.1.1.1	Define processes, projects, programs, and services/products of the organization
A.1.1.2	Define the major problematic aspects in the organization
A.1.2	Define the scope of the organization problem
A.1.3	Determine possible business solution alternatives
A.1.4	Determine internal constraints associated with the possible business solution alternatives
A.1.4.1	Reaffirm key principles associated with the problems and/or possible business solution alternatives
A.1.4.2	Specify existing information on business strategy and business goals
A.1.5	Determine external constraints associated with the possible business solution alternatives
A.1.6	Choose the most appropriate business solution alternative
A.1.7	Agree on the purpose of the enterprise architecture in implementing the chosen business solution alternative
A.1.8	Determine high level solution specifications and scope of the enterprise architecture
A.1.8.1	Determine high level solution specifications of the chosen business solution alternative
A.1.8.2	Determine scope of the enterprise architecture creation effort
A.1.9	Determine key stakeholders and their roles in the architecture creation effort
A.2.1	Design the organization's architecture creation roadmap
A.2.2	Prepare execution plan for subsequent collaborative sessions
A.2.3	Schedule subsequent collaborative sessions

Activities A.1.0 – A.1.9 in table 5.2. In these activities, enterprise architects and senior management (i.e. strategic level and/or tactical level stakeholders) define the organization problem and its scope, determine the desired solution and the internal and external constraints associated with it, define the purpose of the architecture effort, and select decision makers and members of the architecture board of the enterprise. Some of these activities were included in the synergy after the first evaluation iteration of the models representing the synergy (see section 7.3.3). Examples include A.1.2, A.1.3, A.1.4.2, A.1.5, A.1.6, 1.1.7, A.1.8. Other activities were inspired by literature on enterprise architecture creation (e.g. [67, 96, 124]) and by implications of survey findings. Examples of such activities include A.1.0, A.1.1.1, A.1.1.2, A.1.5, A.1.6, A.1.7, A.1.8, A.1.9.

Activity A.1.7 involves specifying and agreeing on what the architecture results will be used for, and the problems that will be solved by creating the architecture. In section 1.2.3 the four key purposes of architecture results were discussed, thus in A.1.7 stakeholders get to choose and agree on the purpose that applies to their needs. In addition, activity A.1.9 involves specifying the list of problem owners, which comprises stakeholders who are consulted regarding matters on the problem situation, and is also a pointer to the type of solution scenarios that have to be formulated in the collaborative design session. This is because an exhaustive understanding of the problem owners in an organization helps in the identification of the systems or solutions required to solve the problematic issues in the organization [22]. Since an organization problem situation can affect various stakeholders, it is vital to identify them and understand their powers and interest in the situation [32].

Activity A.2.1. This involves designing the organization's architecture creation roadmap. In doing so, the organizations' architecture maturity level is first determined. According to [27], an organization is at (a) architecture maturity level 0 if it does not have any architecture programme, (b) at level 1 if it has an informal ongoing IT architecture program with ad hoc and localized processes, but has no unified architecture process, (c) at level 2 if it is implementing its architecture, (d) at level 3 if it has fully established its architecture, (e) at level 4 if it is maintaining the architecture, and (f) at level 5 if it is continuously improving its architecture. From these levels, it is evident that architecture creation activities occur in organizations at architecture maturity level 0 or 1, but collaboration dependent tasks occur at levels 0, 1, 4, and 5. Thus, if an organization's architecture maturity level is recognized, then it is possible to appropriately determine the procedure an organization will follow in its architecture development effort [96]. This is why it is vital to start the architecture creation conversation with the collaborative intelligence session, so as to gain insights into the organization's baseline information. For example, through discussions on the completed and ongoing projects and programmes (in activity A.1.1.1), information is obtained that can be used to determine the architecture maturity level of the organization. Knowing this information at the start helps the architect to prepare the important tools for the subsequent architecture creation sessions.

Activity A.2.2. In this activity, enterprise architects liaise with stakeholders (selected in activity A.1.9) to prepare an execution plan for the architecture creation conversations. In this activity, the architect determines the skills or expertise that the group will need in order to define baseline and target aspects in the subsequent sessions. It is vital that only needed stakeholders are invited and given an opportunity to offer their ideas about the purpose of a given session, because group members are often motivated to achieve a purpose that they helped to define [107].

Activity A.2.3. This involves scheduling subsequent sessions of the conversation in which output from activities A.1.1 – A.1.8.2 is elaborated by all stakeholders who were selected (in activity A.1.9) to join the architecture creation conversation. In A.2.3 the architect also communicates to the relevant stakeholders information such as the purpose of subsequent sessions, their individual roles, and tentative schedules for the sessions. Explicit communication of the purpose of the meeting prior to the meeting helps stakeholders to individually prepare useful contributions and make any necessary consultations that will enrich the meeting discussions [107].

With respect to the suggestions on addressing survey findings (see section 5.2), the intention of steps and activities in this session of the synergy is to ensure that the problems of lack of long term planning and lack of a clear decision making process are addressed. The lack of long term planning implies the need for a thorough analysis of the problem situation. A comprehensive analysis of the organization's problem or situation helps to identify current, possible, or future problem owners [22]. If the organization problem is explicit, then the purpose of creating the architecture also becomes explicit and key business and IT stakeholders (i.e. problem owners and key decision makers) can be identified and their roles defined prior to scheduling the collaborative sessions.

In addition, if key decision makers are specified or members that constitute the architecture board are identified (e.g. in activity A.1.9), this helps to address the problem of lack of a clear decision making process that was reported in the survey findings (see section 5.2). It may also help to overcome an impasse that may occur in group sessions when variability among participants is too high during execution of activities that involve evaluation and choice. In such incidences, opinions of key decision makers or members of the architecture board are given highest priority. In addition, survey findings report the need for ensuring early and good collaboration with stakeholders, where the "early" implies the necessity of effective collaboration with stakeholders when analyzing the as-is organization situation. Although involving more people may result in increased ideas and expertise, it is advised that inviting only people whose presence or participation is significant helps to eliminate some problems during a group effort [107]. Thus, determining problem owners and key stakeholders explicitly reveals the key people needed in the subsequent architecture creation activities.

5.5 Collaborative Design

This session comprises steps 3, 4, and 5 of the synergy in figure 5.3. It intends to ensure support for creating a shared understanding of the problem situation and a shared vision of the desired situation, among stakeholders and architects. Table 5.5 shows that step 3 of the synergy in figure 5.3 is decomposed into activities A.3.0 – A.3.3, step 4 is decomposed into activities A.4.0 – A.4.6, and step 5 is decomposed into activities A.5.1 – A.5.8. Below we give an overview of *what* these activities involve. However, details of *how* these activities are executed are provided in section 6.4.2.

Activities A.3.0 – A.3.3 in table 5.3. In these activities, enterprise architects and stakeholders elaborate and perform a detailed analysis of aspects describing the organization problem and its scope (that were defined in the collaborative intelligence session). This helps to create a shared understanding of those aspects among the operational level stakeholders (e.g. problem owners, subject matter experts) and tactical level stakeholders who did not take part in collaborative intelligence session of the conversation. Therefore, while the intention of the collaborative intelligence session is to create an understanding and vision that is shared by top management (as recommended in the survey findings in section 2.3.3), this collaborative design session intends to ensure that the understanding and vision of the problem (and solution) aspects is also shared by other levels of stakeholders. The relevance and implications of this are discussed below.

5.5.1 Shared Understanding of Baseline and Target Aspects

Agility is a key requirement in several business operations, but often hindered by organization stakeholders being uninformed about enterprise aspects (such as their own products, services, capabilities) and lacking a common understanding and governance of their data resources [96]. Stakeholders need to understand aspects related to data and control flow, as well as decisions that will affect the organization's overall performance [60]. The architecture development process helps to raise stakeholders' awareness of business objectives and information flow [59]. However, achieving this awareness during enterprise architecting is not automatic. The architecture process should be '*open*' in the sense

Table 5.3: *Activities in Collaborative Design*

Activity Identifier #	Decomposition of Collaboration Dependent Tasks in steps 3, 4, and 5 of the synergy in figure 5.3 (Collaborative Design Session)
A.3.0	Communicate purpose of the session
A.3.1	Define concerns about (or elaborate) problems that were defined in the collaborative intelligence session
A.3.2	Clarify and organize concerns about (and additional issues to) the problem aspects
A.3.3	Validate and agree on concerns about (and additional issues to) the problem aspects
A.4.0	Communicate solution/desired aspects in the target situation that were defined in collaborative intelligence module
A.4.1	Define business requirements that the enterprise architecture must fulfill
A.4.2	Clarify and categorize business requirements by type
A.4.3	Validate and agree on the requirements for the enterprise architecture
A.4.4	Define quality criteria (or quality assurance principles) with respect to achieving the business requirements
A.4.5	Clarify and categorize quality criteria by type
A.4.6	Evaluate, discuss, validate and agree on quality criteria
A.5.1	Define names of transformation process(es) required to achieve the business requirements
A.5.2	Clarify and organize names of required transformation process(es)
A.5.3	Elaborate business requirements
A.5.4	Clarify and organize elaborated aspects on the business requirements
A.5.5	Sketch solution scenarios of the solution/desired or target situation
A.5.6	Analyze and refine each formulated solution scenario of the desired situation
A.5.7	Validate solution scenarios of the desired situation
A.5.8	Agree on solution scenarios for the desired situation

that participation of stakeholders is encouraged [2, 3]. This openness calls for effective collaboration between architects and organizational stakeholders. From notion D of the theory on CDM in architecture creation (see section 4.2.2), we see that effective collaboration between stakeholders and architects during enterprise architecting enhances a shared conceptualization and understanding of key enterprise aspects among stakeholders. In addition, if architects also acquire a good understanding of the goals of the stakeholders, their collaboration with stakeholders can be effective [105].

Moreover, enterprise architecting requires all involved actors to speak a common and identical language, and to have a shared understanding of what the architecture is supposed to do [2]. A common vocabulary is a prerequisite to proper communication (see notion K of the theory on CDM in architecture creation). Proper communication helps stakeholders to acquire a shared conceptualization and understanding about (a) the baseline or as-is situation, (b) the target or to-be situation, and (c) any constraints that should be met by the architecture [96]. These three constitute the organization's "*problem and solution aspects*" as used in figure 5.3 and tables 5.2 and 5.3.

Furthermore, creating a shared understanding involves sharing knowledge, sharing meaning about the knowledge, mutual learning (people learning from each other to advance their knowledge and the group knowledge), and understanding of mutual differences or conflicts [62]. Thus, in the context of architecture modeling, encouraging open modeling, sharing models, and frequent communication with stakeholders can enable the architect to steadily eliminate the different implicit views that individual stakeholders have regarding the intended system [79]. Also, notion H of the theory on CDM in architecture creation motivates the need to create a shared understanding of the baseline and a shared vision of the target contexts of the organization. These aspects were considered in the decomposition of tasks presented in table 5.3.

Output of activities A.3.1 – A.3.3 (i.e. valid concerns of stakeholders and the relative importance of those concerns) is used by architects to perform a tradeoff analysis of design alternatives of the enterprise architecture (see section 5.6).

5.5.2 Defining Requirements for the Enterprise Architecture

Steps 4 and 5 of the synergy in figure 5.3 aim at ensuring support for creating a shared vision of the target context of the organization among stakeholders and architects. The relevance and implications of this are discussed below.

Designing a system (e.g. an enterprise architecture) involves determining its requirements and devising feasible specifications with respect to those requirements [37]. Thus, in activities A.4.0 – A.4.6 in table 5.3 stakeholders and architects define business requirements and quality criteria that the enterprise architecture must fulfill. These activities involve the following specific aspects.

Activities A.4.1 – A.4.3 in table 5.3. Given that each organization stakeholder pursues specific objectives (depending on his/her role in the architecture function, organization level at which (s)he operates, and the aspect area (s)he focuses on), there are extensive and potentially conflicting stakeholders' expectations that are hard to satisfactorily address [105]. Thus, identifying and validating business requirements involves defining functionalities that the organization needs to have in order to achieve its business strategy and goals, and fulfill stakeholders' concerns with respect to the external and internal constraints.

Activities A.4.4 – A.4.6 in table 5.3. When designing the architecture there are various ways of addressing a set of (related) concerns and requirements. This implies that quality criteria (for evaluating enterprise architecture design alternatives) may vary across organizations depending on the organization's mission, vision, strategy, and goals. This therefore, calls for enterprise architects and stakeholders to collaboratively identify, evaluate, and agree on acceptable quality criteria that will be used during the evaluation of design alternatives of an organization's architecture. Yet this is possible if a shared conceptualization and understanding of the organization's problem and solution aspects has been achieved (see notions H and I of the theory on CDM in architecture creation).

In addition, decision making demands that one first evaluates possible courses of action in order to choose a satisficing one [118, 119]. Therefore, in A.4.4 – A.4.6, stakeholders need to define quality criteria that will be used to evaluate possible enterprise architecture design alternatives, or define quality assurance principles that the enterprise architecture will adhere to.

5.5.3 Formulating Solution Scenarios for the Architecture

Activities A.5.1 – A.5.8 in table 5.3 intend to help stakeholders and architects to acquire a shared understanding and a shared vision of the desired solution situation. This is done through formulating solution scenarios that must be considered in the enterprise architecture. The relevance and implications of this are discussed below.

In the endeavor to comprehensively define requirements and quality criteria, solution scenarios that the desired enterprise architecture must address need to be formulated. Solution scenarios are textual and graphical descriptions of the desired organization situation, showing (possible) ways through which the desired situation or event (or business requirement) can be achieved. Solution scenarios therefore show the different directions in which the enterprise can be transformed in order to achieve the desired business objectives and operations. Solution scenarios can be represented using models, because explicit models tend to enhance a shared conceptualization and understanding (among stakeholders and enterprise architects) of the aspects regarding the desired solution. This shared conceptualization and understanding then results in refinement of the requirements and quality criteria that the architecture must fulfill. Solution scenarios can also be perceived as detailed definitions of requirements that the enterprise architecture must address. Thus, they offer a somewhat detailed and understandable way in which stakeholders define aspects of the desired solution.

There are two reasons for collaborating with key tactical level and operational level stakeholders during the formulation of solution scenarios.

1. Collaboration of actors yields creativity during problem solving [25]. From notion J of the theory on CDM in architecture creation (see section 4.2.2), it can be noted that creativity and a shared understanding of problem and solution aspects are vital when identifying design alternatives or formulating solution scenarios.

2. Commitment of actors to a new course of action gradually evolves during the intelligence and design phases of the generic decision making process [118]. Therefore, since the step of formulating solution scenarios (in figure 5.3 and table 5.3) is derived from the design phase of the generic decision making process, involving tactical and operational level stakeholders at this step is likely to gradually build commitment, consensus, and a sense of ownership among them. Building consensus among participants involves various forms of reasoning or collaboration, i.e. generating ideas, converging ideas, organizing ideas, and evaluating ideas [130]. In addition, acceptance, support, ownership of CDM results can be attained through involving stakeholders in the decision making process [107].

Formulating solution scenarios involves *identifying*, *elaborating*, and *validating* possible ways through which the (business) requirements can be operationalized so as to achieve the business strategy and goals. Identifying solution scenarios involves brainstorming on possible ways to achieve business requirements or the desired solution. For example, stakeholders can specify aspects such as ways in which their enterprise will differentiate itself from competitors (and how), or specify incidences where it prefers a business model of optimal operations and cost [124].

Elaborating solution scenarios involves adding relevant details to the scenarios so that they can be properly assessed, in order to iron out any redundancies and ambiguities. Validating solution scenarios involves investigating or evaluating their feasibility and determining their possible impacts. Validating solution scenarios is most likely to be affected by the availability of information on various organization aspects. For example, the lack of knowledge and misunderstanding of particular features and information from a system (e.g. an enterprise) or its environment, limits the verification and validation of (enterprise) model(s) [21]. This explains why stakeholders and enterprise architects need to effectively collaborate (and to have a shared understanding of problem and solution aspects) during the formulation of solution scenarios. For example, determining possible implications of the as-is and to-be business capabilities on the technology capabilities of the organization helps to create an initial picture of the IT capabilities that are relevant to support the target architecture vision [124]. Also, the coherence of all solution scenarios for the desired state is verified, and stakeholders choose the most appropriate solution scenarios for the desired situation.

With respect to the suggestions on addressing survey findings (see section 5.2), the intention of the collaborative design session is to ensure that the problem of lack of a shared understanding and shared vision is addressed. Architects recommended that it is vital to effectively collaborate with the right stakeholders during architecture creation. Although in this chapter we do not answer the question of how this can be done (a question to be answered in chapter 6), this section attempts to answer the question of what to do when collaborating with stakeholders.

In addition, the challenge of lack of documented information about the organization (as reported in the survey findings in section 2.3.3) calls for the use of techniques that can enable stakeholders to collaboratively define the as-is situation. Besides, the need to clearly link the architecture function to other frameworks in the organization (as reported in the survey findings in section 2.3.3), demands for effective collaboration with stakeholders in order to gather sufficient information on the existing frameworks. This is partly catered for in the activities of the collaborative intelligence session, and fully catered for in the activities of this collaborative design session. Furthermore, since effective collaboration helps to enhance learning in groups [95], activities defined in this session intend to partly overcome the reported challenge of some stakeholders being unqualified for tasks assigned to them or being unable to imagine new situations (see survey findings in section 2.3.3).

In general solution scenarios as used in this synergy, can be perceived as informal representations of Architecture Building Blocks (ABBs). ABBs are the capabilities an organization requires in order to be able to execute its business strategy [124]. In order to implement these capabilities or solution scenarios, they are subsequently translated into enterprise architecture design alternatives, as shown in figure 5.4 and discussed in section 5.6.

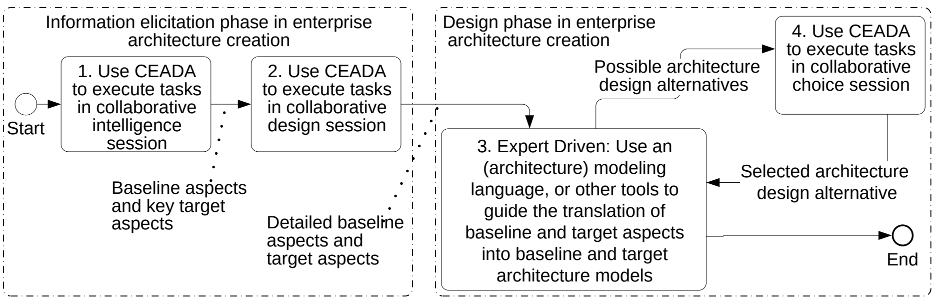

Figure 5.4: *Scope of Collaborative Tasks Covered in this Research*

The boxes with dashed borderlines in figure 5.4 show that enterprise architecture creation generally involves the knowledge elicitation or information gathering phase and the design phase. Figure 5.4 shows which sessions in the synergy of collaboration dependent tasks are in each phase of architecture creation. The arrows in figure 5.4 show deliverables expected from each session in the synergy. Figure 5.4 also shows that this research is interested in tasks that make up the collaborative intelligence, collaborative design, and collaborative choice. Box marked 3 in figure 5.4 represents the expert driven session. The expert driven session is beyond the scope of this research. This is because it essentially involves architectural work such as, architects selecting reference models, architectural patterns, tools and techniques for presenting the baseline and target business, data, applications, and technology architectures [124]. Section 5.6 elaborates this.

5.6 Expert Driven Session

This session is represented by step 6 of the synergy in figure 5.3, which involves determining technical architectural details of how to implement the solution scenarios of the desired organization situation. This session is essentially expert-driven. Since various enterprise architecture development approaches (e.g. [67, 124] richly support and inform the execution of tasks in this session (see section 2.2.3), tasks in this session are beyond the scope of this research. As shown in the box 3 in figure 5.4, in this session architects embark on designing an enterprise architecture that addresses stakeholders' concerns and requirements that are portrayed in the solution scenarios of the target situation.

In the translation of solution scenarios into an enterprise architecture, architecture design alternatives arise, i.e. the alternative ways in which the solution scenarios can be implemented. Enterprise architecture design alternatives can be identified at different phases of architecture development, depending on the architecture framework used in the organization. For example, with TOGAF ADM an enterprise architecture comprises four major types of architectures, i.e. business, data, applications, and technology architectures [124]. Thus, enterprise architecture design alternatives can be encountered at the phase of creating an architecture vision (i.e. TOGAF's phase A which is concerned with a high level view of all the four types of architectures), or at the phases of creating each of these four types of architectures.

With respect to suggestions on addressing survey findings (see section 5.2), the intention of this session is to ensure that architects have ample time to (a) design an enterprise architecture that is linked to all frameworks in the organization, and (b) translate the essentials, advantages, and disadvantages of possible design alternatives for the enterprise architecture into a language that stakeholders understand. In an enterprise architecture, vague concepts should be translated to a sufficiently detailed and understandable level such that the architecture is understandable by stakeholders [57]. Likewise, architecture models (or their possible design alternatives) need to be presented and elaborated in an understandable way so as to be properly evaluated by stakeholders.

The resultant enterprise architecture design alternatives from this expert-driven session can be perceived as Solution Building Blocks (SBBs). SBBs are the components, i.e. processes, data, application software, and technology that are used to implement the required capabilities or ABBs in an enterprise. Thus, architecture design alternatives in this research are equivalent to SBBs as used in architecture approaches. Also, as highlighted in the preceding section, solution scenarios in this research are equivalent to ABBs as used in architecture approaches.

5.7 Collaborative Choice

This session is represented by step 7 of the synergy in figure 5.3, which intends to ensure that stakeholders and architects collaboratively evaluate possible enterprise architecture design alternatives and choose the appropriate one. Table 5.4 shows that step 7 of the synergy in figure 5.3 is decomposed into activities A.7.0 – A.7.4. Below we give an overview of *what* these activities involve, but details of *how* these activities are executed are provided in section 6.4.3.

Table 5.4: *Activities in Collaborative Choice*

Activity Identifier #	Decomposition of Collaboration Dependent Tasks in step 7 of the synergy in figure 5.3 (Collaborative Choice Session)
A.7.0	Communicate purpose of the session
A.7.1	Discuss positive and negative implications of possible architecture design alternatives (or architecture views) for each solution scenario that was formulated in the collaborative design session
A.7.2	Discuss positive and negative implications of each enterprise architecture design alternative (i.e. a combination of the various architecture views that represent the solution scenarios)
A.7.3	Evaluate and discuss enterprise architecture design alternatives
A.7.4	Agree on the most appropriate enterprise architecture design alternative

The internal drive for an organization to adopt the enterprise architecture practice is to effectively execute its strategy and optimize its operations [67, 59]. Optimal or satisfactory solutions or operations can be sought through considering and evaluating alternatives [118]. Thus, during enterprise architecture creation there is need to evaluate enterprise architecture design alternatives that are formulated and validated in the expert driven session. Evaluating enterprise architecture design alternatives involves assessing the appropriateness of each valid architecture design alternative, with respect to predefined quality criteria or requirements (that were defined in activities A.4.1 – A.4.6) using a given evaluation method. The appropriateness of a design alternative can also be determined by assessing its possible impact(s) on various organization aspects.

In various incidences, the issue is not the formulation of a "*perfect or most elegant*" architecture, but the formulation of the "*most adaptable*" architecture that accommodates future changes [29]. However, achieving the most adaptable enterprise architecture requires a collaborative effort and most of all during the evaluation of architecture design alternatives. This is because some decisions can be too complex for an individual to understand all implications [64] regarding each alternative or course of action. Hence the need for a collaborative effort during the evaluation of design alternatives. Even then, it is difficult to satisfy all stakeholders' concerns [105]. Thus, from notion A of the theory on CDM in architecture creation (see section 4.2.2), there is need to discuss the design alternatives, negotiate tradeoffs, and then select a *satisficing*[1] enterprise architecture design alternative. In this case we consider an enterprise architecture design alternative to be satisficing (or appropriate) if it accommodates (key) concerns and requirements, satisfies evaluation quality criteria, and is feasible with respect to the organization's resources.

Enterprise architecture products include tangible and intangible products such as principles, models of views, intermediate results used to develop the enterprise architecture

[1] From satisfice, i.e. a *"good enough"* decision or solution to a problem whose *best* or *maximized* solution is unknown (or unattainable) due to the complexity in real world business environments ([119], page 27 – 28).

models, the evaluation of alternative solutions, shared understanding, shared agreement, and commitment among stakeholders [96]. Thus, with respect to survey findings (in section 5.2), this session intends to ensure that stakeholders (a) participate in the completion of the architecture creation stage, (b) get a sense of ownership of the products of the architecture creation conversation, and (c) possibly become motivated to implement the architecture.

5.8 Summary on Collaboration Dependent Tasks

This chapter has discussed the synergy of collaboration dependent tasks, which is motivated by (a) literature on CDM and enterprise architecture creation, (b) findings from the exploratory survey that was conducted among architects, and (c) notions from the theory on CDM in architecture creation. The discussions in this chapter have dealt with *collaboration dependent tasks*, i.e. activities whose successful execution depends on effective collaboration between stakeholders and architects during enterprise architecture creation. The synergy of these tasks communicates *what* should be done in order to achieve CDM in architecture creation conversations. Details of *how* to execute the activities that constitute the synergy are given in chapter 6.

Chapter 6

CEADA

Abstract. This chapter presents CEADA, a clear and flexible process for guiding and supporting the execution of collaboration dependent tasks in enterprise architecture creation. CEADA is mainly based on Collaboration Engineering and SSM. Other techniques that were relevant in designing CEADA include the Ishikawa diagram, labour division techniques (e.g. committees and subcommittees, take-a-panel and share-a-panel), among others. The situational parameters in CEADA that account for its flexibility are also discussed in this chapter.

6.1 Chapter Overview

In Design Science rigorous construction of an artifact involves properly applying existing foundational approaches when designing the artifact, and effectively describing it so that it can be deployed to solve (or seize) an important problem (or opportunity) [49]. This chapter discusses CEADA, a flexible process that provides details of *how* tasks discussed in chapter 5 can be executed. Thus, the major focus of this chapter is to provide a detailed operational viewpoint on executing collaboration dependent tasks, so as to achieve Collaborative Decision Making (CDM) in enterprise architecture creation.

With respect to the theory-to-process roadmap (in section 4.3), this chapter is triggered by the need to adopt approaches that can be used to devise a detailed operational outlook (on executing collaboration dependent tasks) that is based on the theory on CDM in architecture creation (in section 4.2.2). Also, with respect to the coordination framework for the architecture creation conversations (in section 4.4), this chapter discusses the design of the *conversation strategy* that can be used to support enterprise architecture creation conversations. This conversation strategy and its implementation techniques are constituents of CEADA, the resultant artifact from this research.

This chapter is organized as follows. Sections 6.2 and 6.3 discuss the adoption of approaches that inform the design of CEADA. Section 6.4 discusses the design of CEADA and section 6.5 discusses the set of selected thinkLets in CEADA's thinkLet layer. Section 6.6 shows the situational specificity of CEADA and discusses ways through which it can be customized to support execution of collaboration dependent tasks when creating an enterprise architecture for a given organization. Section 6.7 summarizes the chapter. Some parts of this chapter are a (slightly) modified version of sections of work in [91, 92, 90, 88, 85].

6.2 Underlying Approaches of CEADA

In Design Science it is vital that the construction procedure of an artifact is transparent, and this can be attained by drawing ideas from practical problems or opportunities and existing theories, artifacts, analogies and metaphors [55]. Accordingly, in addition to the theory discussed in chapter 4 and the synergy of collaboration dependent tasks discussed in chapter 5, figure 6.1 shows the major approaches that were adopted to design CEADA. CEADA generally intends to support the execution of tasks discussed in chapter 5. Figure 6.1 also shows the major reason that inspired the selection of each of the approaches (a detailed discussion of these reasons is first provided in sections 2.2.3, 3.7, and 3.8, and is now continued in this section). Following figure 6.1, section 6.2.1 discusses the adoption of Collaboration Engineering in enterprise architecture creation, section 6.2.2 discusses the adoption of SSM in enterprise architecture creation, and section 6.2.3 discusses the adoption of other techniques in enterprise architecture creation.

6.2.1 Adoption of Collaboration Engineering

This section discusses how the Collaboration Engineering design approach was adopted to design CEADA (a general overview of Collaboration Engineering is discussed in section 3.7). According to [62, 130], the procedure of developing a collaboration process generally involves seven steps, i.e. task diagnosis, task decomposition, thinkLet choice, agenda building, design evaluation and validation, and documentation. Following is a discussion of how these steps were executed to design CEADA.

6.2.1.1 Task Diagnosis

This step involves determining the goal and deliverable(s) of a collaboration process [62, 130]. In this research the main goal of CEADA was to support the execution of collaboration dependent tasks during conversations on enterprise architecture creation (see sections 1.4 and 1.6). Accordingly, the intended deliverable was an appropriate enterprise architecture that is based on concepts that are agreed on, shared, and owned by (key) stakeholders of an enterprise.

6.2.1.2 Task Decomposition

This step involves determining the basic activities for achieving the goal and the deliverable(s) of a collaboration process [62, 130]. In this research the main goal of CEADA was first decomposed into specific short term goals which constitute the synergy of collaboration dependent tasks (discussed in chapter 5). These short term goals/tasks were defined by following notions of the theory on CDM in enterprise architecture creation, and by drawing implications from findings of the exploratory survey that we conducted among architects (see section 5.2). These goals/tasks were further decomposed into basic activities that should be executed in order to achieve CDM during architecture creation (sections 5.3 – 5.8). Figure 6.2 gives an overview of the way in which basic activities and deliverables of CEADA were derived. Boxes 1 to 7 in figure 6.2 represent constituents of the research artifact, the cylinder represents a collection of approaches (i.e. methods, tools, techniques) that have been adopted in the formulation of the research artifact. The downward facing arrows show information exchange between components of the artifact.

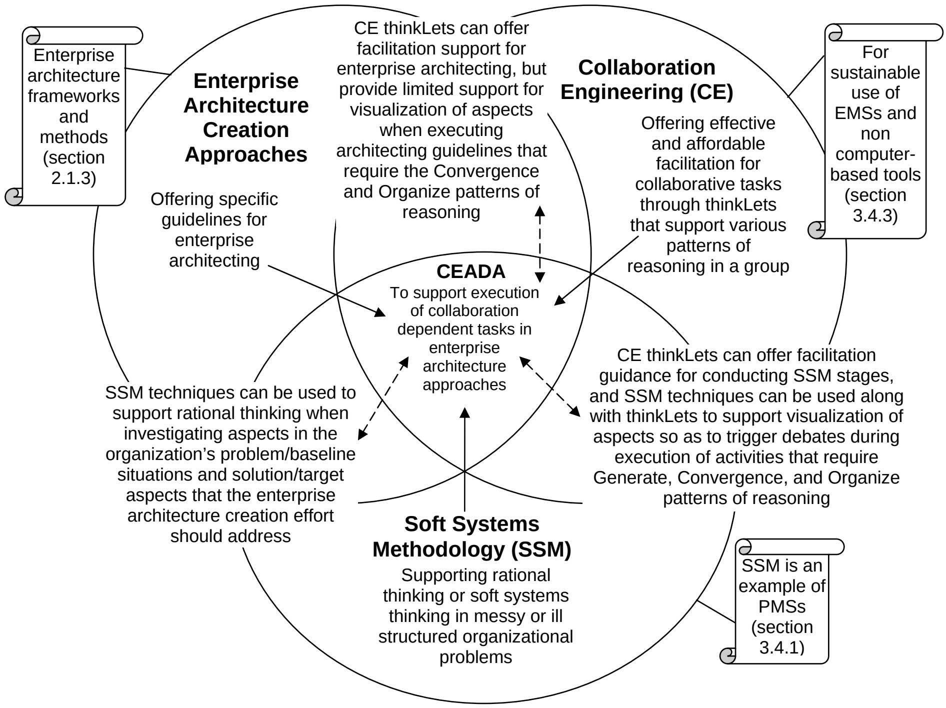

Figure 6.1: *Key Underlying Approaches in the Design of CEADA*

The upward facing arrows show that refinements in the bottom components of the solution imply refinements in the top components of the solution.

Box 1 in the top part of figure 6.2 shows that we first formulated the theory on CDM in enterprise architecture creation (as discussed in chapter 4). Thereafter, as shown in boxes 2 and 3 the middle part of figure 6.2, we formulated the synergy of collaboration dependent tasks (as discussed in chapter 5). Then, as shown in box 4 in the middle part of figure 6.2, we formulated the activity layer of CEADA. The reason for this theory-based decomposition of CEADA activities is motivated by the call for (a) designing artifacts with an understanding of how or why they will work [49, 71], and (b) ensuring a *conscious* and *harmonious* design of collaboration processes [131, 12]. In an era where organizations strive to sustainably enrich their business environments with groupware (which apparently exists in various flavors and originates from various perspectives), need arises to *consciously* and *harmoniously* design collaboration processes [131]. Thus, it was vital to derive the basic activities of CEADA from the synergy of collaboration dependent tasks (in chapter 5) and the theory on CDM in enterprise architecture creation (in chapter 4).

At the task decomposition step of the Collaboration Engineering design approach, the basic activities that constitute the process layer are assigned suitable patterns of collaboration or reasoning that a group must undergo so as to achieve the desired deliverables of each activity [62, 130]. Below we provide an overview of how this was done.

The process layer of CEADA. As shown in boxes 2 and 3 in figure 6.2, the process layer of CEADA first appears in form of a coarse grained model showing the synergy of

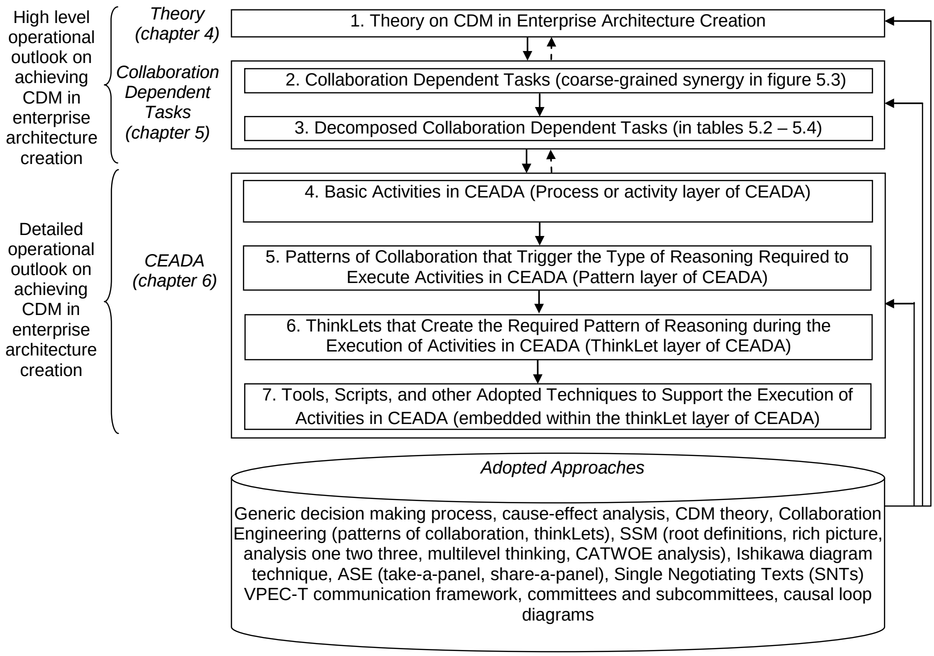

Figure 6.2: *General Composition of the Research Solution*

collaboration dependent tasks (discussed in section 5.3, figure 5.3). The steps in figure 5.3 were then decomposed into specific tasks (see section 5.3, tables 5.2 – 5.4). Box 3 in the middle part of figure 6.2 shows that these tasks were further decomposed into basic activities and deliverables. This is indicated by the down-facing arrows that link boxes 2 and 3 in figure 6.2. Decomposing the specific tasks into basic activities resulted in a fine grained model of the process layer of CEADA, which is represented in section 6.4 (by column 2 of tables 6.3 – 6.5 and then by figures 6.17 – 6.19). The down-facing arrows in the middle part of figure 6.2 also indicate that the process layer of CEADA influences the constituents of the pattern layer of CEADA.

The pattern layer of CEADA. To form the pattern layer of CEADA, each activity in the process layer was assigned the required pattern(s) of collaboration or reasoning that would enable stakeholders and architects to execute the activity and obtain its deliverable(s). The pattern layer of CEADA is represented in section 6.4 (by column 3 of tables 6.3 – 6.5 and then by figures 6.17 – 6.19). The down-facing arrows in the middle part of figure 6.2 indicate that the pattern layer of CEADA influences the constituents of the thinkLet layer of CEADA.

6.2.1.3 ThinkLet Choice

This step of the Collaboration Engineering design approach involves *matching* each basic activity in a collaboration process with a suitable thinkLet that will support its realization [62, 130]. The matching of thinkLets and the basic activities is based on some criteria, e.g. the pattern of reasoning that is assigned to an activity, the purpose of a given thinkLet, or conditions for using a given thinkLet. For example, the left part of figure 6.3 shows variations in patterns of collaboration, implying that the existence of any of these variations in the pattern layer of CEADA, influences the selection of thinkLets that constitute the thinkLet layer of CEADA. Other details on the selection criteria of thinkLets were discussed in section 3.7.

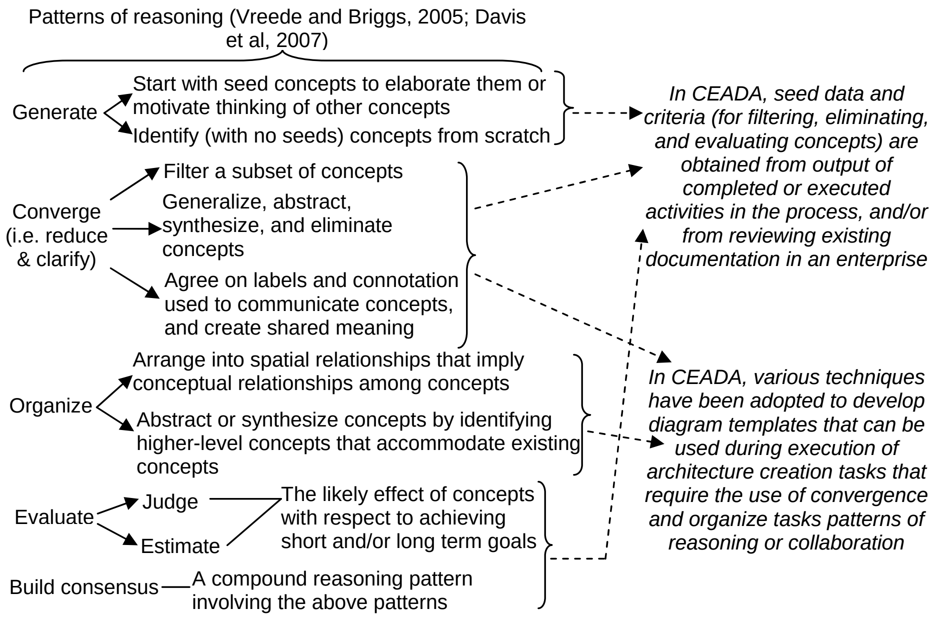

Figure 6.3: *Variations in Patterns of Collaboration* (this model has been formulated based on the discussion in [130, 26])

The thinkLet layer of CEADA. To form CEADA's thinkLet layer, thinkLets were selected that can appropriately support the pattern and process layers of CEADA. The thinkLet layer is represented in section 6.4 (by column 4 of tables 6.3 – 6.5 and then by figures 6.17 – 6.19). Box 6 in the middle part of figure 6.2 indicates that the thinkLet layer of CEADA influences the adoption of other techniques that can address some problematic issues that occur during the execution of collaboration dependent tasks. Box 7 in figure 6.2 shows that the adoption of other techniques influences the adoption of various tools and formulation of scripts that can be used to create the required patterns of reasoning during the execution of CEADA activities. Sections 6.2.2 and 6.2.3 discuss the adoption of other techniques that have been appended to the thinkLet layer of CEADA, and the adopted tools .

6.2.1.4 Agenda Building

This step of the Collaboration Engineering design approach involves preparing all information required for validating a collaboration process, and (graphically) representing it in a facilitation process model [62, 130]. A facilitation process model is essentially an agenda or logical flow chart showing activities that constitute a given collaboration process [62]. The agenda of a collaboration process can also be presented in a tabular format

[62]. In this research, due to the numerous basic activities that constitute the process layer of CEADA, it was found suitable to present the flow of basic activities in CEADA using both the tabular format and the facilitation process model format (see section 6.4, tables 6.3 – 6.5 and figures 6.17 – 6.19). The detailed design of a collaboration process is represented using a thinkLets notation model [130]. Section 6.4 and appendix C present the thinkLets notation model of CEADA.

6.2.1.5 Design Evaluation and Validation

This step of the Collaboration Engineering design approach involves using walkthroughs, pilot testing, simulation, and expert evaluation to validate and evaluate the collaboration process [62, 130]. As indicated by the upward facing dashed arrows in the middle part of figure 6.2, models describing the process, tasks, and theory components of the research solution have undergone refinements based on evaluation findings that are discussed in chapter 7. The upward facing dashed arrows in the middle part of figure 6.2 indicate the way CEADA models were refined. For example, the evaluation of CEADA revealed refinements that had to be done in its thinkLet layer, pattern layer, and process layer. This in turn resulted in validating aspects in the tasks and theory components of the research solution. In other words, refinement of a lower component in figure 6.2 implied the need for refinement in the upper component in figure 6.2. Herein, a detailed account of the evaluation of the design of CEADA is discussed in chapter 7.

6.2.1.6 Documentation

This step of the Collaboration Engineering design approach involves keeping record of the procedure undertaken to develop a collaboration process [62, 130]. Herein the design procedure of CEADA has been provided in this section, while the actual design of CEADA is discussed in section 6.4.

6.2.2 Adoption of SSM Techniques

The relevance of SSM in this research is discussed in section 3.8. SSM is a structured inquiry process that uses models as a source of questions about a problem situation [22]. This section discusses how its techniques were adopted to enrich the thinkLet layer of CEADA.

After the first field study evaluation of CEADA, need arose (as discussed in section 7.8) to seek additional support for CEADA activities that required the *reduce*, *clarify*, and *organize* patterns of reasoning. The thinkLet layer of the version of CEADA that was used in the first field study evaluation (see appendix B) offered effective support for activities that required stakeholders to (a) brainstorm and prioritize concerns and requirements for the architecture, and (b) perform a multi-criteria evaluation of possible architecture design alternatives. However, it offered inadequate support for stirring vigorous discussions during the execution of activities that required converging and organizing problem and solution aspects that resulted from brainstorming activities (section 7.8 elaborates this).

In addition, Vreede and Briggs [130] reported that Collaboration Engineering research widely addressed issues encountered in the generate, evaluate, and build consensus patterns of reasoning, but more research was needed to address issues encountered in the converge and organize patterns of reasoning. As indicated in figure 6.1, this research attempts to partly address these issues (in the context of architecture creation) by adopting SSM techniques to incite vigorous discussions during the execution of activities that require converge and organize patterns of reasoning. Through such discussions, stakeholders can acquire a shared understanding and shared vision of problem and solution aspects during the execution of architecture creation activities that involve the converge and organize patterns of reasoning.

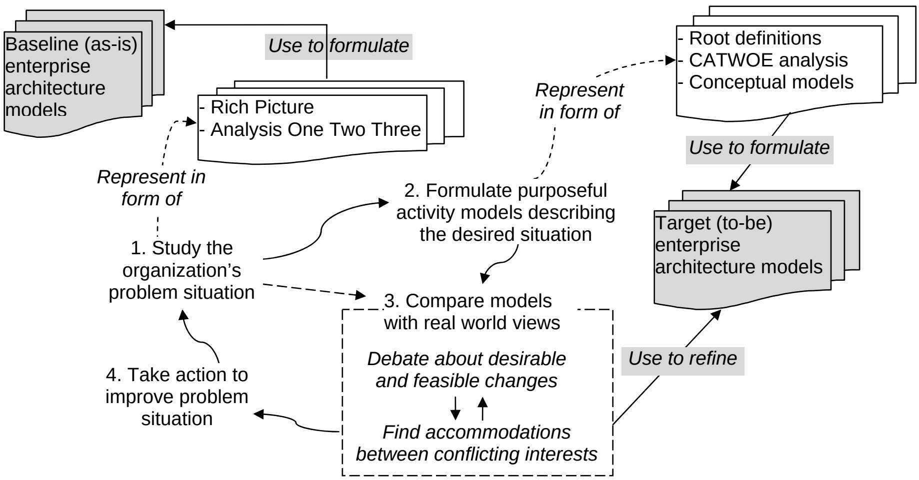

Figure 6.4: *SSM in Enterprise Architecture Creation* (this model has been formulated based on the discussion in [22, 53])

Figure 6.4 shows the relevance of stages 1 – 3 of SSM in enterprise architecture creation. It indicates that the Rich Picture and Analysis One Two Three techniques at stage 1 of SSM are adopted in CEADA as techniques for gathering information that is used to formulate baseline architecture models (see section 6.4.1). It also indicates that the Root Definitions and CATWOE analysis (at stage 2 of SSM) and purposeful conceptual or activity models (at stage 3 of SSM) are adopted in CEADA as techniques for gathering information that is used to formulate target architecture models (see section 6.4.2). This mode of adopting SSM techniques was motivated by (a) their function, and (b) viewing SSM stages in the context of the generic decision making process by Simon [118]. Figure 6.5 provides a view of SSM stages with respect to (i) the phases of the generic decision making process (discussed in section 5.3), and (ii) the coarse grained model of the synergy of collaboration dependent tasks (section 5.3, figure 5.3).

Figure 6.5 shows that activities in stages 1 – 3 of SSM reflect the three phases of Simon's generic decision making process. Where activities in stage 1 of SSM relate to the intelligence phase of Simon's process, activities in stages 2 and 3(a) relate to the design phase of Simon's process, and activity 3(b) relates to the choice phase of Simon's process. From the bottom part of figure 6.5, if the Rich Picture and Analysis One Two Three are found relevant at steps 1 – 3 of the synergy, then that means these techniques can be vital in the formulation of baseline architecture models. This is because steps 1 – 3 of the synergy are concerned with defining aspects in the baseline situation of the enterprise and some aspects in the target situation of the enterprise. The bottom part of figure 6.5 also shows that Root Definitions, CATWOE analysis, activity models are

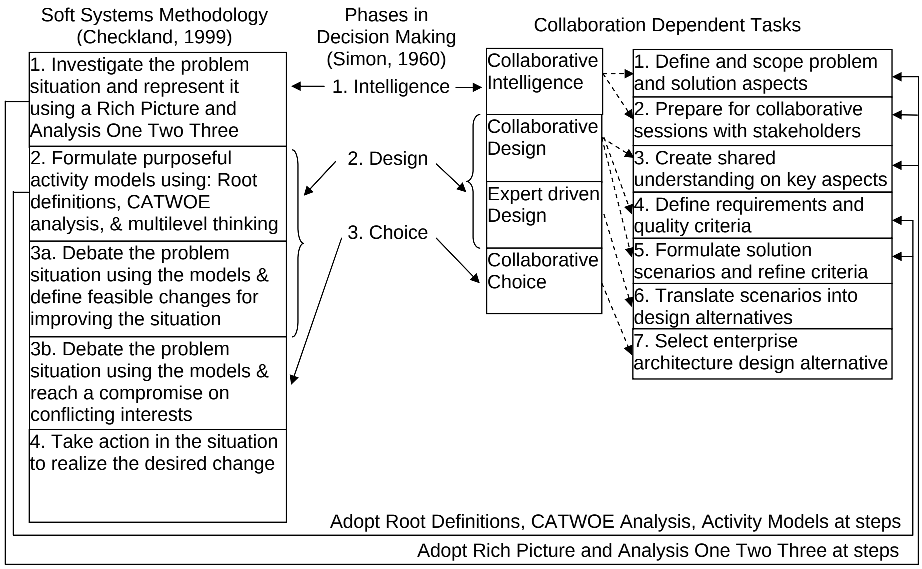

Figure 6.5: *SSM, Decision Making, Collaboration Dependent Tasks*

applicable at steps 4 and 5 of the synergy. This means that these techniques can be vital in the formulation of target architecture models. This is because steps 4 and 5 of the CEADA requirements are concerned with defining the target situation of the enterprise. However, CEADA adopts these techniques in a flexible way in the sense that, a technique assigned to be used for gathering information about the target situation, may be found appropriate to gather information about the baseline situation, e.g. the purposeful conceptual model technique. Following is a discussion of how each SSM technique was adopted.

6.2.2.1 Rich Pictures in CEADA

According to Checkland [22], a Rich Picture is a representation of aspects (that are gathered from e.g. semi-structured interviews) about a problem situation in a way that encourages holistic and exploratory thinking about the situation. This technique was adopted in CEADA and used to formulate an informal or cartoon-like representation of the general operations (or the main activities or processes) and people (or actors) within an organization. A Rich Picture model can be formulated for the entire organization or for each department therein. These (informal) models can help stakeholders to have an overview of the activities executed in their enterprise, the people involved, and the problems faced.

In figure 6.6 there are six key symbols that we have chosen to be used during CEADA sessions to formulate a Rich Picture that shows the as-is situation of an organization. These symbols can also be used to sketch a Rich Picture of the desired situation. In figure 6.6 a face-like symbol and accompanying text represents various complexities of people, e.g. individual person, a department, a committee, a community. One symbol is used to refer to various complexities of something in order to abstract information and avoid an overcrowded Rich Picture. The more details one enters in a Rich Picture, the more congested and unreadable it becomes. Besides, the level of detail in a Rich Picture

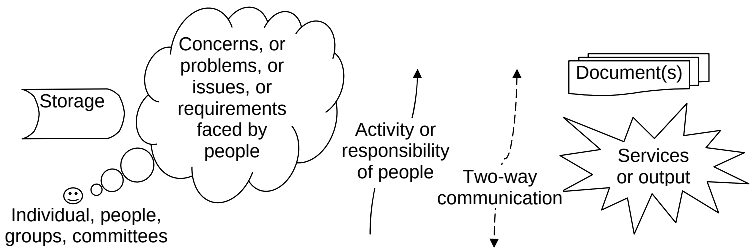

Figure 6.6: *Symbols to use in CEADA Sessions to Draw a Rich Picture*

depends on the problem solver [22]. Thus, to avoid an overcrowded or congested Rich Picture and to enable shared understanding about the major problem(s) faced, some details are left out and information is represented in an abstract way (for example, see appendix D – figures D.1, D.2, and D.3). This makes the Rich Picture more of a high level view of the existing and/or desired situation.

The dotted lines (in the selected symbols in figure 6.6) represent two-way communication, while the un-dotted lines represent responsibilities of people, the stars represent the services offered by an organization, and the cloud call-out represents problems faced by people associated with the organization. Section 6.4.1 provides more information on when and how the symbols in figure 6.6 are used to draw a Rich Picture of an enterprise.

Limitations of Rich Pictures in CEADA. From the evaluation of CEADA (discussed in section 7.9), it was noted that although Rich picture is adopted in CEADA to gather baseline information, it can not be used to represent details of operational processes in an organization. Therefore, using Rich Pictures alone to gather baseline information makes it time consuming for the architect to formulate baseline architecture models, as (s)he will have to gather additional information in order to make the baseline models complete. Hence the need to adopt other techniques along with the Rich Picture, that can help gather detailed information of processes and problems in an enterprise. For example, the formulated diagram template in figure 6.7, and other templates in section 6.2.3 (e.g. figures 6.8, 6.9).

6.2.2.2 Analysis One Two Three in CEADA

Analysis One Two Three involves assessing the problem situation with the aim of (a) identifying the correct list of possible problem owners (which is a pointer to the relevant systems for improving the situation), and (b) finding out the social (i.e. roles or norms or values) and political factors in the situation [22]. Group processes are vital because most problem situations affect several types of stakeholders, and this implies the need to identify and involve these stakeholders and determine their power and interest in the situation at hand [32]. Thus, the Analysis One Two Three technique has been adopted to formulate templates for gathering and organizing information on key stakeholders in an architecture creation effort and their roles, and social and political factors that may affect the architecture creation effort. This information is useful during the formulation of both the baseline and target architectures of an organization. The diagram template designed for performing Analysis One Two Three is provided in section 6.2.3. Section 6.4.1 provides more information on when and how Analysis One Two Three is done during CEADA sessions.

6.2.2.3 Root Definitions, CATWOE Analysis, Activity Models in CEADA

According to Checkland [22], Root Definitions are short phrases formulated in the form of "Do P by Q in order to contribute towards achieving R", so as to answer the questions of (or influence thinking in terms of): "*what to do* (i.e. P)", "*how to do it* (i.e. Q)", and "*why do it* (i.e. R)". This technique was adopted in CEADA and used in the following two ways.

- To formulate *data capture functions or formats* that are used when executing CEADA activities that involve brainstorming (or that require generate pattern of reasoning). A basic data capture function in CEADA takes the form of:
  {*name or type or category of required aspect*} = {*details of aspect*}

- To formulate a diagram template that is used to classify (i.e. categorize and organize) brainstormed requirements that the architecture must address. The diagram template designed for *requirements classification* is provided in section 6.2.3 (figure 6.11).

Each Root Definition can be assessed by undergoing a CATWOE analysis, which essentially involves determining **C**ustomers (or beneficiaries) associated with aspects in the Root Definition, **A**ctors who will realize the transformation proposed in each Root Definition, **T**ransformation process(es) that are to be implemented in order to realize each Root Definition, **W**orld views that justify the significance of the transformation proposed in each Root Definition, **O**wner(s) that will control the proposed transformation, and **E**nvironmental or external factors that are likely to affect the proposed transformation [22]. This technique has been adopted in CEADA to enable stakeholders elaborate the requirements for the architecture. In the adoption of this technique, we have represented aspects on **C**ustomers, **A**ctors, **W**orld views, **O**wner(s), **E**nvironmental or external factors using the fives sides or edges of the pentagon in figure 6.7. The **T**ransformation aspect is indicated in the top most inner corner of the pentagon (see figure 6.7).

In addition, a purposeful activity model is an assembly of the transformation processes described in the Root Definitions, and their associated CATWOE analysis aspects [22]. The activity models technique was adopted in CEADA to be flexibly used to graphically define scenarios of both the baseline and target situations of the enterprise. Figure 6.7 shows the requirements elaboration and scenarios formulation diagram template that has been formulated to be used to represent existing processes in an organization's baseline situation, and/or the required transformation processes that the organization must implement or execute so as to achieve a given requirement or goal (target situation). The formulation of figure 6.7 was inspired by the activity models presented in [53]. The diagram template in figure 6.7 also shows how the above CATWOE aspects of SSM can be used to assess the requirements that the architecture must address. Sections 6.4.1 and 6.4.2 provide more information on when and how to use the data capture functions, the requirements classification diagram template, and the requirements elaboration and scenarios formulation diagram template during CEADA sessions.

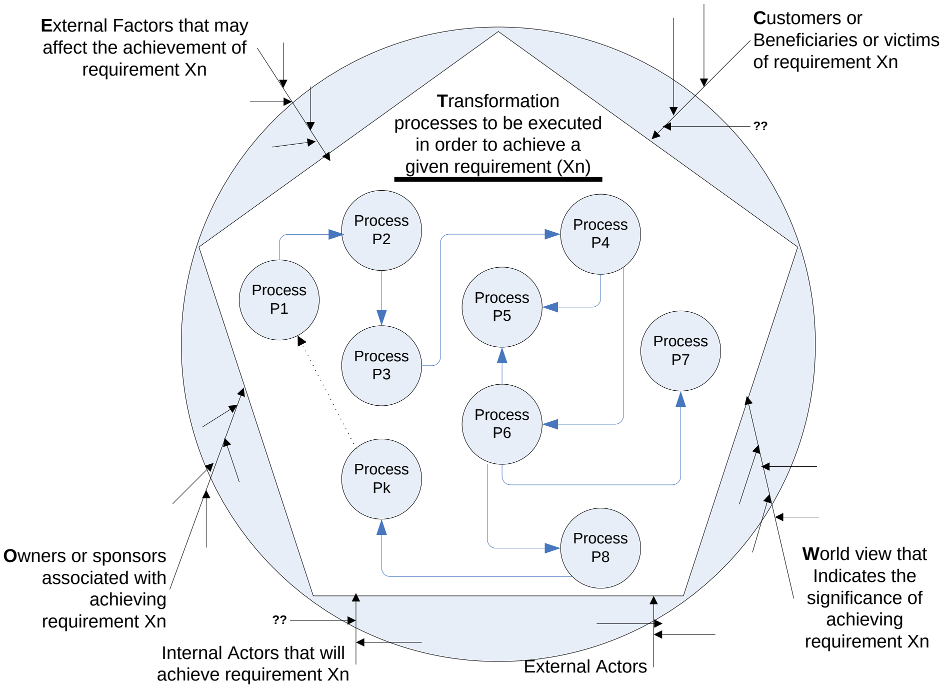

Figure 6.7: *Requirements Elaboration and Scenarios Formulation Template*

6.2.3 Adoption of Other Approaches

The adoption of SSM led to the adoption of other techniques. For example, at the problem investigation stage of SSM, one is encouraged to use other techniques (rather than only the Rich Picture and Analysis One Two Three) to investigate the problem situation [53]. This motivated us to adopt additional approaches so as to enhance or enable the creation of a shared understanding of aspects among stakeholders and architects by providing support for proper communication, increased visualization of ideas, lively discussions, and interactive work during CEADA sessions. For this cause, the following techniques were adopted, i.e. Ishikawa diagram technique of quality control [56], causal loop diagram technique of System Dynamics [128], the pyramid concept that relates the core aspects of an enterprise architecture [67], and the main purposes of an enterprise architecture [96]. Other approaches that were adopted in the design of CEADA include take-a-panel, share-a-panel [51, 20], committees, subcommittees, Single Negotiating Text (SNT) techniques [107], and VPEC-T [44]. Following is a discussion on why and how these techniques were adopted in the thinkLet layer of CEADA.

6.2.3.1 Ishikawa Diagram Technique in CEADA

When factors associated with a problem situation are numerous, a cause-and-effect (also known as fishbone or Ishikawa) diagram helps to organize them into causes and effects, and reveal mutual relationships that exist in the problem situation [56]. Although this Ishikawa diagram started out as a quality control tool in manufacturing processes, it is now being used to enable thinking about mutual relations among aspects in various types of tasks. In CEADA the Ishikawa diagram technique was adopted to formulate five templates that can be used during execution of CEADA activities to enable stakeholders to categorize, organize, and discuss aspects. The following formulated templates also enhance visualization of relations that exist among aspects.

Diagram template for process attributes. This was formulated to support the capturing and classification of information on an organization's operational processes or programs or projects (and their attributes) in the baseline or target situations (see figure 6.8). In figure 6.8 we have three levels of arrows. Level I arrow runs from the left part to the right part of figure 6.8 (it is only one arrow in the middle or spine part of figure 6.8). Level II arrows are the ones connecting to the level I arrow. For example, figure 6.8 has six level II arrows labeled inflows, outflows, beneficiaries, existing projects, internal and external actors. Level III arrows are the ones connecting to the level II arrows. For example, the blank template in figure 6.8 shows 24 level III arrows. However, the number of level III arrows varies depending on the number of organization aspects that describe the information required in the template. Thus, stakeholders populate level III arrows with information on values of the six attributes in figure 6.8.

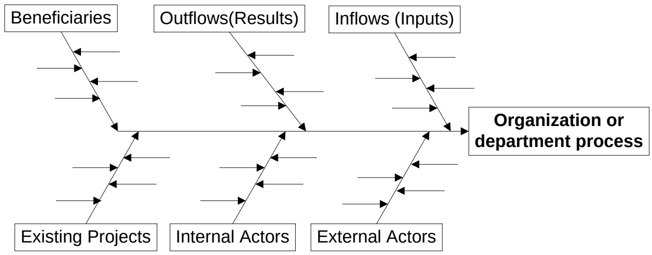

Figure 6.8: *Diagram Template for Process Attributes*

The limitation of this diagram template (in figure 6.8) is that it does not portray the details of scenarios or events that trigger the particular information inflows, information outflows, and processes in the enterprise. This challenge is overcome by using both the diagram template for process attributes in figure 6.8 (to provide a high level view of the processes and their attributes) and the scenarios formulation diagram template in figure 6.7 (to capture a detailed sequence of scenarios or events in the existing or desired situations). For example, see appendix D, figures D.3 and D.8.

Diagram template for problem analysis. This was formulated to support the capturing of problem aspects, classification of aspects into problems and their (root) causes, and comprehensive analysis of problems encountered in the baseline situation of an enterprise (see figure 6.9).

Diagram template for Analysis One Two Three. This was formulated to support the capturing and classification of aspects associated with problem and solution owners, cultural factors, and political factors in the problem situation (see figure 6.10). The Analysis One Two Three technique was discussed in section 6.2.2.

Diagram template for requirements classification. This was formulated to support the classification of aspects associated with (business) requirements of the desired or target situation that the enterprise architecture must address (see figure 6.10). The structuring of requirements in figure 6.11 is based on the Root Definition technique by Checkland

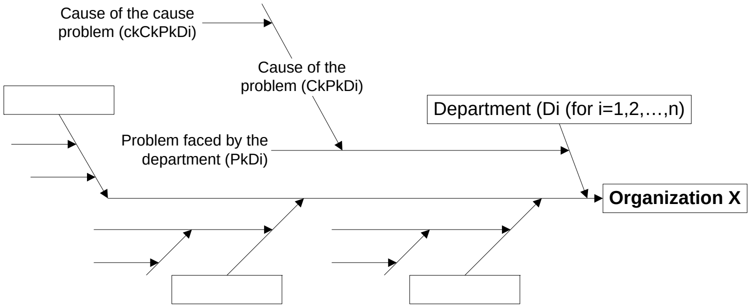

Figure 6.9: *Diagram Template for Problem Analysis*

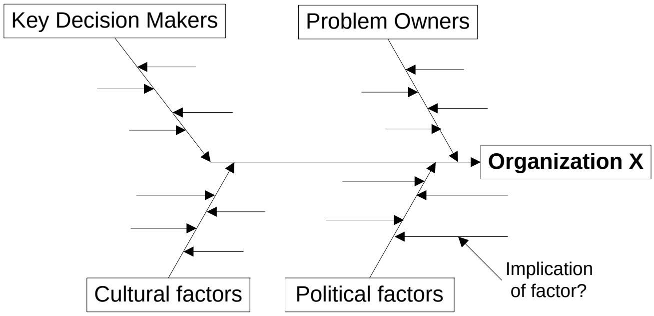

Figure 6.10: *Diagram Template for Analysis One Two Three*

[22] (discussed in section 6.2.2). Thus, figure 6.11 shows that any business requirement comprises three parts, i.e. *what* should be done, *how* it should be done, and *why* it should be done. The how component of the business requirement is elaborated using the solution scenarios formulation template (i.e. figure 6.7 that was discussed in section 6.2.2).

Diagram template for constraints classification. This was formulated to support the classification of internal and external constraints of the desired or target situation that the enterprise architecture must consider (see figure 6.12). Internal constraints are derived from the organizations principles, while external constraints from the laws or principles declared by regulatory bodies.

In order to produce a useful illustration of factors and their relationships on an Ishikawa diagram, it is vital to have a detailed understanding of those factors [56]. This justifies why in CEADA, there is a brainstorming session prior to populating these diagram templates with data. Thereafter, stakeholders are encouraged to collaboratively organize the brainstormed aspects or information by populating the formulated diagram templates. The templates prompt stakeholders to think about the required data, use the generated data to populate the diagram template, and then debate about the populated diagram. Thus, with diagram templates, the knowledge of formulating the diagram is indirectly provided, which prevents participants from wasting time thinking of how they can represent or categorize their ideas. In addition, CEADA (discussed in section 6.4) provides questions that the facilitator (who in this case is the architect himself or herself) asks. These questions are also indirectly already embedded or represented in the diagram templates. Thereby,

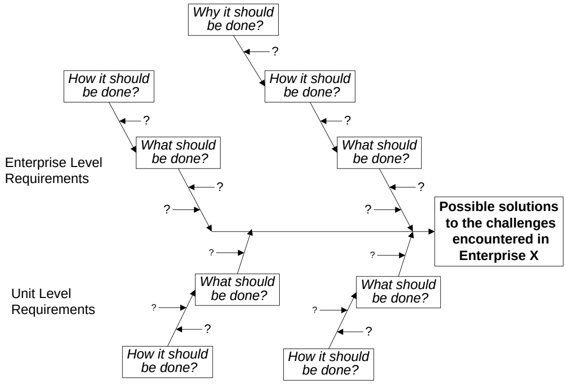

Figure 6.11: *Diagram Template for Requirements Classification*

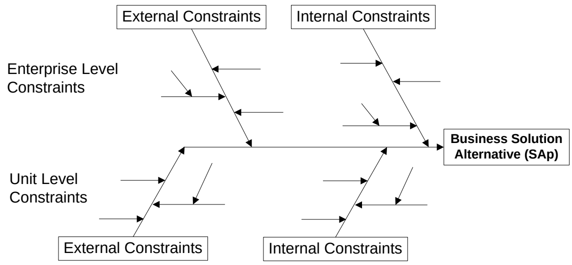

Figure 6.12: *Diagram Template for Constraints Classification*

the diagram templates serve as *compound questions*. Sections 6.4.1 and 6.4.2 provide more details on when and how to use the five formulated diagram templates.

6.2.3.2 Causal Loop Diagram Technique in CEADA

With the Ishikawa diagram, similar causes are sometimes repeated on the diagram, some small causes may not be examined, and it is difficult to show that a particular cause is a combination of factors [56]. Some of these challenges were experienced during the evaluation of CEADA in two large organizations (see chapter 7). In some incidences it was difficult to explicitly represent a *compound cause* (i.e. a cause that is a combination of other causes) or a *nested* cause (i.e. a cause that is embedded within a compound cause), let alone feedback loops in the problem situation.

However, with a causal loop diagram it is possible to acquire a wider perspective and understanding of the structure of a system investigated (in this case an enterprise), and to identify feedback loops within that system [103]. Thus, to address the challenge of using the Ishikawa-based diagram template for problem analysis, the causal loop diagram technique was adopted. It is vital to note that the use of the causal loop diagram in CEADA depends on the problem situation. For example, in CEADA the causal loop diagram is invoked in incidences where stakeholders and architects would like to avoid repetitive representation of causes or want to represent any identified nested or compound causes, or feedback loops in the problem situation.

In such incidences the Ishikawa-based diagram template for problem analysis is first used in the preliminary gathering and organization of aspects on causes and, effects in the baseline situation, and then the populated diagram is analyzed to identify repeated, nested, or compound causes, and any possibilities of feedback loops. Thereafter, the enterprise architect uses aspects presented in the populated diagram to formulate a causal loop diagram, so as to remove repeated causes and explicitly represent repeated, nested, or compound causes and feedback loops. The analysis of both the populated Ishikawa-based diagram for problem analysis and the resultant causal loop diagram helps stakeholders and architects to increase their understanding of the problem situation. This then provides a basis for them to make a decision on how to address the core enterprise problem(s). Section 6.4.1 provides more details on when to use the causal loop diagram.

6.2.3.3 Committees, Subcommittees, Take-a-Panel, Share-a-Panel

After an experiment and field study evaluation of CEADA, it was found vital to divide stakeholders into small groups during execution of some activities in the process layer of CEADA (see sections 7.7 and 7.8). In the refinement of CEADA, this was addressed by adopting (a) the technique of *committees* and *subcommittees* by Raiffa et al. [107] and (b) the techniques of *take-a-panel* and *share-a-panel* of the Accelerated Solutions Environment (ASE) approach.

Committees and subcommittees. The *divide and conquer* principle helps one to use group labor efficiently by breaking down an activity into discrete thinking (sub) tasks that can be subcontracted to subgroups or parent committees and subcommittees [107]. In CEADA we adopt this technique so as to enable simultaneous and coherent execution of some activities. Each subcommittee should be given an explicit (sub) goal, expected product, and expected time frame of achieving the sub goal [107]. The execution plan of CEADA provides details of sub goals that are given to subgroups (called divisions) and expected products, but does not provide time frame because this varies depending on the enterprise situation and availability of stakeholders in a given division type (see section 6.4).

Take-a-panel and share-a-panel. Group sessions supported by ASE (see sections 2.3.3 and 7.3.3) involve short sessions of divided subgroups referred to as take-a-panel and share-a-panel. Take-a-panel means dividing participants into small groups (i.e. panels), so that they solve a given problem and learn new skills (within a short session), whereas share-a-panel means giving each participant an opportunity or turn (after a take-a-panel session has ended) to explain his or her own ideas to members in his or her subgroup (or panel) [51]. In CEADA we adopted the take-a-panel and share-a-panel techniques so as to define task(s) that are performed within a given subgroup or subcommittee.

Criteria used when forming subcommittees are (a) the nature of the task and its deliverables and (b) the qualities of group members, e.g. their ability in problem solving and decision making, expertise, and interests [107]. These guidelines were adopted and used to define the following four ways of dividing stakeholders during execution of activities in CEADA sessions.

1. *Governance-driven division.* This means that the required type of stakeholders that enterprise architects need to collaborate with in order to accomplish a given task are senior management or line of business managers, or key decision makers in the organization. These can be regarded as strategic and/or tactical level stakeholders.

2. *Specialization-driven division.* This means that executing a given CEADA activity requires enterprise architects to ensure that participating stakeholders are divided into small groups based on their units of specialization or departments within the organization. In this case the number of departments or units in the organization determines the number of subgroups that architects work with in a given activity.

3. *Task-driven division.* This means that executing a given CEADA activity, requires enterprise architects to ensure that participating stakeholders are (randomly) divided into small groups, whereby each small group is assigned a sub activity that contributes to a main goal of a given activity or session. In this case the number of sub activities that make up a given activity determine the number of subgroups that architects work with. In addition, there is no special way that determines a stakeholder's membership to a given subgroup. The dissemination of tasks also involves negotiation and agreement among stakeholders because people have various types of interests, e.g. a group satisfied with working on a given task is likely to perform better than a dissatisfied group [107].

4. *Interest-driven division.* This means that if successful execution of a given CEADA activity requires stakeholders to be divided into small groups (where each subgroup is assigned a sub activity that contributes to the main activity), then enterprise architects give stakeholders the free will of deciding which subgroup (or sub task) he or she would like to join (or work on). In this case a stakeholder's membership to a given subgroup depends on his/her interest. In addition, the number of sub activities that make up a given activity determine the number of subgroups that architects work with.

It is vital to note that task-driven and interest-driven divisions can be used as substitutes for the specialization-driven division in situations where stakeholders in an organization are few in number, or when some departments are represented by one person in a given CEADA session. This is mostly encountered in the collaborative design session (see section 6.4.2). This can happen due to factors that range from time (i.e. some stakeholders having insufficient time to attend group sessions), culture, expertise, governance, to even political factors (see sections 7.6.1 and 7.6.2). These divisions help to (a) make better use of stakeholders' time (see sections 7.6.1 and 7.6.2), (b) enable detailed assessment of aspects, and (c) enhance communication, shared understanding, and homogeneity within subgroups (see sections 7.7 – 7.9).

In addition, the choice of whether to use task-driven division or interest-driven division depends on the cultural and political factors in the organization. In some business environments task-driven division may sabotage successful execution of a given activity, while interest-driven division would have appropriately supported the execution of the activity. This is one of the reasons why there is need to first use the diagram template for Analysis One Two Three (so as to understand cultural and political factors) prior to determining the way stakeholders will be divided when executing some CEADA activities. In [107] it is noted that fishbowl environments deter negotiations because they remove the privacy of the negotiating parties. Thus, the use of these four flavors of dividing stakeholders during execution of some CEADA activities helps to avoid executing CEADA in a fishbowl environment. Section 6.4.1 shows when and how the governance-driven division is used, whereas sections 6.4.2 and 6.4.3 show when and how specialization-driven, task-driven, and interest-driven divisions are used.

6.2.3.4 Single Negotiating Text (SNT) in CEADA

Building from scratch a package or solution that is acceptable to negotiating parties can be problematic, but an SNT can be developed and treated as a preliminary package that is to be criticized by the parties and then iteratively modified by the mediator with respect to the criticisms, until conflicts are resolved [107]. In CEADA this technique was adopted to support the formulation of models that represent the target situation of an enterprise. For example, enterprise architects can first populate the scenarios formulation template (figure 6.7), requirements classification template (figure 6.11), and constraints classification template (figure 6.12) with data that shows how stakeholders' problems can be addressed or how the desired situation can be attained. Thereafter, they can use the populated diagram templates as preliminary conceptual models of the target situation, and perceive them as SNTs that can help to mediate conflicts among stakeholders when defining requirements for the enterprise architecture.

When using SNTs, it is vital that the mediators who draft the SNT are familiar with the (problem) situation of the negotiating parties and the issues of divergence among the parties [107]. This is why in CEADA we first seek a shared understanding (among stakeholders and architects) about the baseline situation and gather some information about the target situation (see section 6.4.1). Thereafter, the gathered information is used to populate the diagram templates mentioned above, so that the resultant models are used as SNTs during negotiations on requirements and solution scenarios that the architecture must address. These models, serving as SNTs, are open to (vigorous) criticisms from stakeholders, and are iteratively refined by architects based on stakeholders' criticisms and discussions. After these models have been agreed upon by stakeholders, they are then used to formulate architecture models for the target situation (which show possible ways in which the valid stakeholders' concerns and requirements are addressed in the desired situation). The architecture models are again perceived as detailed SNTs that have to be reviewed and agreed on by stakeholders. Sections 6.4.2 and 6.4.3 provide details of when and how models are used as SNTs during the execution of CEADA activities.

6.2.3.5 Values Policies Event Content Trust (VPEC-T) Framework

VPEC-T is a thinking framework for ensuring proper communication between business and IT professionals, whereby business professionals ably define business requirements for a desired solution and IT professionals respond by providing an appropriate solution that can be gradually improved [44]. This framework is entirely concerned with communication that transpires during the development of Information Systems. In this research we adopt it (as shown in table 6.1) in the context of creating an enterprise architecture.

In CEADA, concepts of the VPEC-T framework have been used (along with concepts from enterprise architecture approaches like TOGAF [124]) to formulate questions that are treated as topics of interest or discussion during the execution of CEADA activities. With the adopted VPEC-T concepts, questions were phrased in a vocabulary that is understandable to both business and IT professionals. In addition, IT professionals can translate the responses provided by business professionals into architecture design choices (as indicated in column 3 of table 6.1). The values and policies dimensions of VPEC-T are adopted in CEADA's collaborative intelligence session (see section 6.4.1). The event

Table 6.1: *Adoption of VPEC-T in Architecture Creation (Based on [44])*

VPECT language dimension	How each dimension describes aspects related to enterprise architecture	How each dimension provides guidance to an enterprise architect	Resultant benefit of each dimension
Values	They define an organization's principles and goals	(S)he can aim at addressing part of or full landscape of values of an organization, so as to align the architecture with business practices and desired business outcomes	Discussing values helps to identify and resolve any conflicts among them
Policies	They define specific practices and guidelines that the architecture must address	(S)he can know the requirements for compliance with policies, aim at addressing part of or full landscape of policies, aligns architecture with business practices, show traceability from text-based rule to readily implementable rule in the architecture	Discussing policies helps to identify and resolve any conflicts among them
Events	They define vital milestones or set off points that spark off changes in states of organization processes	(S)he can use the set off points as nodes that integrate various systems within the architecture, or as control nodes in the architecture	Discussing these helps to reveal event information useful for internal and external integration, auditing and business reporting, and information reuse
Content	This defines the core aspects of the desired business outcome in a way that is familiar to the business domain	(S)he can know the core business aspects, and internal and external business exchanges that the architecture must address	Discussing content helps to capture all relevant internal and external information exchanges of the organization
Trust	This defines existing trust and mistrust relationships, opportunities for building trust, and risks associated with the trust relationships	(S)he can know the regulatory control needs and devise risk measures (to deal with risks arising from trust relationships), that the architecture must consider	Discussing trust and mistrust relationships helps to directly deal with threats to trust and to remove barriers to IT adoption

and content dimensions of VPEC-T are adopted in CEADA's collaborative design session (see section 6.4.1). The trust dimension of VPEC-T is adopted in all sessions of CEADA. Section 6.4 provides details of activities that are executed based on questions or topics of discussion that are derived from these concepts.

6.2.3.6 Holistic Data Capture Pyramid and Architecture Purpose Template

A pyramid (in [67]) and a regular trapezoid (in [96]) are used to provide some sort of visualization of the core organization aspects from which an enterprise architecture is derived. These representations have been adopted to formulate a template, herein referred to as the *holistic data capture pyramid*, that gives an overview of all aspects that the enterprise architecture creation conversation covers (see figure 6.13). The holistic data capture pyramid shown in figure 6.13 provides a shared holistic view and understanding of data that is to be gathered during architecture creation and the CEADA diagram templates that are to be used. As shown on the left and right sides of figure 6.13, once the CEADA diagram templates are populated with data, they can be plugged into the holistic data capture pyramid to provide a holistic view of all aspects considered during the architecture creation conversation.

In addition, section 1.2.3 discusses four main purposes of developing an enterprise architecture. These have been represented in figure 6.14 to help stakeholders and architects explicitly specify and agree on the main purpose that the enterprise architecture results will be used for. According to TOGAF [124], the purpose of the architecture determines the level of detail that the enterprise architect will aim at when designing the architecture. Section 6.4.1 provides details of when and how this template for specifying architecture

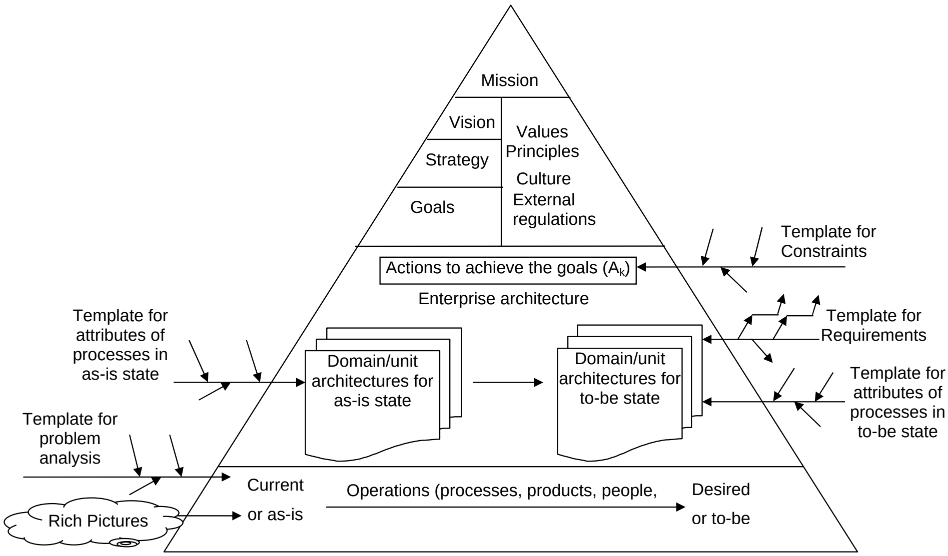

Figure 6.13: *Holistic Data Capture Pyramid (Based on [67, 96])*

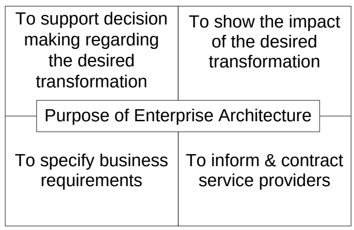

Figure 6.14: *Specifying the Purpose of the Architecture (Based on [96])*

purpose is used.

6.3 Summary of Adopted Techniques

Using a graphic representation to lay out a structure for the problem at hand frees up room in the participants' minds, can incite disagreements about the same thing at the same time, and then ways to handle the identified disagreements can be discussed [107]. Thus, in sections 6.2.2 and 6.2.3 we have discussed techniques that were adopted to formulate diagram templates that can be embedded in the thinkLet layer of CEADA to enable graphic representations of aspects during the architecture creation conversation. Table 6.2 provides a summary of the techniques adopted, why they were adopted, and how they enrich the thinkLet layer of CEADA.

Table 6.2: *Summary of Techniques Used in the ThinkLet Layer of CEADA*

#	Technique adopted in thinkLet layer of CEADA	Why the technique was adopted	How to use the technique
1	Rich Picture	To enable visualization of aspects in the baseline situation	The thinkLet layer of CEADA provides facilitation guidance on: a) When to invoke the diagram templates derived from the adopted techniques b) How to collaboratively design the required models or populate the diagram templates c) When and how to incite discussions about aspects represented in the models or diagram templates
2	Analysis One	To enable a detailed analysis of problem and solution owners	
3	Analysis Two	To enable a detailed analysis of cultural factors that may shape (or should be considered in) the architecture creation effort	
4	Analysis Three	To determine political factors that may shape or affect the architecture creation effort	
5	Root Definition	To formulate a structured way of capturing required information and defining and classifying requirements for the architecture	
6	CATWOE analysis	To elaborate (business) requirements for the architecture	
7	Activity models	To formulate scenarios in form of conceptual models showing processes or ways of operation in the baseline and target situations	
8	Ishikawa diagram	To categorize, organize, and elaborate brainstormed problem and solution aspects, trigger questions, or invoke discussions	
9	Causal loop diagram	To elaborate the nature of the problem by explicitly representing nested causes (and avoiding repetitive presentation of causes) and feedback loops in the problem situation	
10	Committees, subcommittees, take-a-panel, share-a-panel	To be able to properly or objectively divide stakeholders into small groups so as to quickly and thoroughly execute some CEADA activities	
11	The pyramid concept that relates the core aspects of an enterprise architecture	To provide a holistic visualized view of core aspects in the enterprise architecture development effort	
12	The four main purposes of an enterprise architecture	To enable stakeholders to explicitly define and understand what the architecture results will be used for	
13	Single Negotiating texts (SNTs)	To use (partially) populated diagram templates or models to start off and enhance negotiations about the desired situation	
14	VPEC-T framework	To enhance communication among stakeholders and architects by formulating topics of discussion in a common understandable vocabulary	

Adopting techniques in table 6.2 generally yields two benefits. First, it enhances visualization of aspects when executing activities that are supported by the "converge" and "organize" patterns of reasoning during the definition of an organization's problem and solution aspects. Second, the diagram templates help to incite discussions and reasoning that reveal implicit and unknown information about the current and desired situations. More details on these benefits are discussed in section 7.9. The formulated structured or question-triggering diagram templates can be used in interview sessions and group sessions (or when reviewing organization documentation) to gather information for creating baseline and target architecture models. Advantages and disadvantages of using each of these adopted techniques are discussed in sections 7.7 – 7.9. Details of when and how to use each of the adopted techniques are discussed in section 6.4 below.

6.4 CEADA Modules

This section discusses detailed operational guidelines for executing collaboration dependent tasks during enterprise architecture creation. In other words, it provides details of *how* to execute the collaboration dependent tasks discussed in chapter 5 by using the techniques adopted in the preceding sections. Chapter 5 presents *what* should be done to achieve CDM during architecture creation and *why it* should be done, and this section presents *how it* should be done (see figure 6.15). Thus, this section shows *when* and *how* to use the formulated diagram templates and other adopted techniques and concepts (in sections 6.2.2 and 6.2.3) during the conversations on architecture creation. These details are presented in three modules that constitute CEADA, i.e. collaborative intelligence, collaborative design, and collaborative choice. The design of these modules is presented in three formats, i.e. tabular, facilitation process model, and thinkLet notation model (see the right part of figure 6.15). These formats are discussed below.

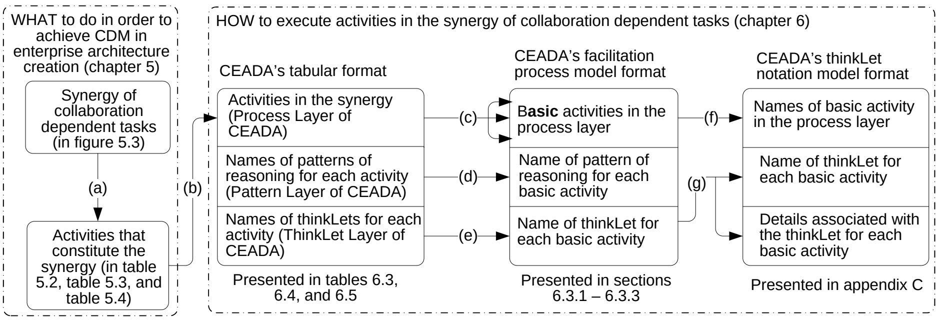

Figure 6.15: *Aspects Represented in Each Format of CEADA Design*

CEADA's tabular format. This provides an overview of the process layer, pattern layer, and thinkLet layer of each CEADA module. As shown in figure 6.15, CEADA's design in tabular format is presented in tables 6.3, 6.4, and 6.5 (see sections 6.4.1, 6.4.2, and 6.4.3 respectively). In figure 6.15 the boxes represent key aspects of deliverables of chapters 5 and 6. The arrows labeled (a) – (g) link aspects that overlap in these deliverables (or those that are related in some way). For example, arrow marked (a) in the left part of figure 6.15 shows that the synergy discussed in chapter 5 is made up of various activities presented in tables 5.2 – 5.4. Also, arrow marked (b) shows that activities presented in tables 5.2 – 5.4 (in chapter 5) form the process layer that is represented in the tabular format of CEADA's design.

CEADA's facilitation process model format. This provides a graphical and logical flow of activities and thinkLets [62, 130] that constitute CEADA. Arrow marked (c) in the middle part of figure 6.15 shows that activities in the process layer of the tabular design of CEADA are further decomposed into *basic* activities to cater for (1) the brainstorming of aspects associated with a given activity, (2) the convergence on brainstormed aspects, and (3) the evaluation and agreement on converged aspects. These basic activities (or subactivities) are represented in the facilitation process model and thinkLet notation model of CEADA. Arrow marked (d) in the middle part of figure 6.15 shows that the selected patterns of reasoning in the pattern layer of CEADA's tabular format are the ones used in the facilitation process model of CEADA. Arrow marked (e) in figure 6.15 shows that the selected thinkLets in the thinkLet layer of CEADA's tabular format are the ones used in the facilitation process model of CEADA. CEADA's facilitation process model is presented in figures 6.17 – 6.19. The notations or building patterns used in figures 6.17 – 6.19 were adopted from [130], as shown in figure 6.16.

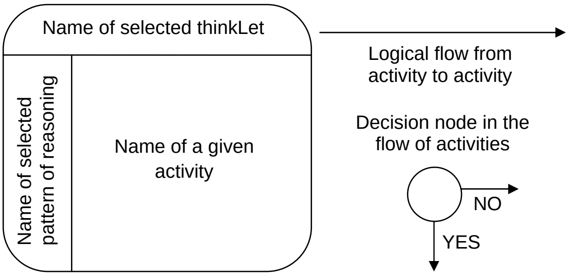

Figure 6.16: *Notations used in Formulating a Facilitation Process Model (Source: Vreede and Briggs [130])*

CEADA's thinkLet notation model format. This provides a detailed view of the process layer and thinkLet layer of CEADA modules (see appendix C). The thinkLet notation of CEADA offers execution details of activities such as the tools used, inputs, facilitation notes, outputs. Arrow marked (f) in the right part of figure 6.15 shows that the basic activities in the facilitation process model are the ones used in the thinkLet notation model of CEADA. Arrow marked (g) in the right part of figure 6.15 shows that the thinkLets in the facilitation process model are the ones used in the thinkLet notation model of CEADA and details about those thinkLets are also provided. CEADA's thinkLet notation model is presented in appendix C (figures C.1 – C.19). Guidelines for formulating figures C.1 – C.19 were adopted from [130].

In the context of the framework for coordinating conversations on enterprise architecture creation (discussed in section 4.4), the tabular format is a summarized execution plan of the conversation on enterprise architecture creation, while the facilitation process model format and the thinkLet notation model format offer detailed views of the execution plan. These formats used to represent CEADA's design do not imply linearity in its execution. Instead, they imply (to a large extent) that input required to execute a given activity may be output from the preceding activities. Thus, output for some activities is vital input for executing other activities. For example, in section 5.4 it was noted that CEADA is applicable in enterprises with architecture maturity level 0 or level 1. Recognizing an organization's architecture maturity level requires output from executing some activities in the collaborative intelligence session (see section 5.4). Also, the way CEADA is executed in enterprises with architecture maturity level 0 may (slightly) differ from the way it is executed in enterprises with architecture maturity level 1. However, in both cases the execution of CEADA starts with the collaborative intelligence session, which is discussed below.

6.4.1 Collaborative Intelligence Module

The aim of this module is to determine the key aspects of the organization's problem situation and the desired situation, and to make preparations for subsequent sessions of the architecture creation conversation. This module originates from figure 5.3 and table 5.4 in chapter 5, in the sense that the activities in table 5.4 of chapter 5 are the ones used in the activity layer of table 6.3 (section 6.2.1 provides details of this mapping). Table 6.3 shows patterns of reasoning and thinkLets assigned to each activity in the collaborative intelligence session of CEADA. Details of each activity in the process layer of table 6.3 are provided in the facilitation process model of CEADA (see figures 6.17 and 6.18), and details of each thinkLet in table 6.3 are provided in the thinkLet notation model of CEADA (see appendix C, figures C.1 –C.10).

Table 6.3: *Collaborative Intelligence Module*

Activity #	Process layer (or Activity layer)	Pattern layer	ThinkLet layer
A.1.0	Communicate purpose of the session	-	-
A.1.1	Define organization processes and problematic aspects or challenges		
A.1.1.1	Define processes, projects, programs, and services/products of the organization	Generate, Converge, Organize	LeafHopper, FastHarvest
A.1.1.2	Define the major problematic aspects in the organization	Generate, Converge, Organize, Build consensus	FreeBrainstorm, FastHarvest, LeafHopper, Concentration, StrawPoll, CrowBar
A.1.2	Define the scope of the organization problem	Generate, Converge, Organize, Build consensus	LeafHopper, Concentration, StrawPoll, CrowBar
A.1.3	Determine possible business solution alternatives	Generate, Converge, Organize	FreeBrainstorm, Concentration, ReviewReflect
A.1.4	Determine internal constraints associated with the possible business solution alternatives		
A.1.4.1	Reaffirm key principles associated with the problems and/or possible business solution alternatives	Generate, Converge, Organize	LeafHopper, Concentration ReviewReflect
A.1.4.2	Specify existing information on business strategy and business goals	Generate, Converge, Organize, Evaluate, Build consensus	LeafHopper, Concentration ReviewReflect, StrawPoll, CrowBar
A.1.5	Determine external constraints associated with the possible business solution alternatives	Generate, Converge, Organize	DealersChoice, Concentration, ReviewReflect
A.1.6	Choose the most appropriate business solution alternative	Evaluate, Build consensus	StrawPoll, CrowBar
A.1.7	Agree on the purpose of the enterprise architecture in implementing the chosen business solution alternative	Evaluate, Build consensus	StrawPoll, CrowBar
A.1.8.	Determine high level solution specifications and scope of the enterprise architecture		
A.1.8.1	Determine high level solution specifications of the chosen business solution alternative	Generate, Converge, Evaluate, Build Consensus	LeafHopper, FastHarvest, StrawPoll, CrowBar
A.1.8.2	Determine scope of the enterprise architecture creation effort	Generate, Converge, Organize	LeafHopper, Concentration, StrawPoll, CrowBar
A.1.9	Determine key stakeholders and their roles in the architecture creation effort	Generate, Converge, Build Consensus	LeafHopper, Concentration, StrawPoll, CrowBar
A.2.1	Design the organization's architecture creation roadmap	-	-
A.2.2	Prepare execution plan for subsequent collaborative sessions	-	-
A.2.3	Schedule subsequent collaborative sessions	-	-

With respect to the framework for coordinating conversations on architecture creation (see section 4.4), following is a discussion of the social mode, communication mode, execution plan, description languages, type of media, and cognitive mode of the collaborative intelligence session of architecture creation conversations.

6.4.1.1 Social and Communication Modes in Collaborative Intelligence

Social mode Used in this Module. From the architecture creation coordination framework (in section 4.4), the social mode in this module is both participatory and expert-driven. In the participatory social mode of this module, the governance-driven division is invoked. Governance-driven division (discussed in section 6.2.3) calls for and ensures participation of strategic and/or tactical level stakeholders in the execution of CEADA activities. An enterprise architect invokes a governance-driven division to execute activities A.1.0 –

A.1.9 of table 6.3. In activities A.2.1 – A.2.3 of table 6.3, the architect (as the expert in this case) first invokes an expert-driven mode to prepare a roadmap for architecture creation activities, customize diagram templates, and prepare schedules. Thereafter, the architect invokes a governance-driven division to seek approval of the prepared roadmap, templates, and schedules.

Communication Mode Used in this Module. Collaborative intelligence module can be executed using group sessions or workshops with stakeholders in the governance-driven division category (i.e. strategic and/or tactical level stakeholders), group sessions with a subset of these stakeholders, interview sessions with these stakeholders, or a combination of interviews and (sub)group sessions. Thus, the communication modes among stakeholders and architects during execution of CEADA activities can be 1:1, 1:*, *:1 (which occurs when a representative of a subgroup communicates results of his/her subgroup to an architect), and *:* (which occurs when a representative of a subgroup communicates results to the whole group). These communication modes are derived from [104]. Interview sessions are particularly considered here because in some enterprises it may not be possible to conduct group sessions due to organization politics, or when stakeholders completely fail to get time to attend the group sessions.

6.4.1.2 Execution Plan of Collaborative Intelligence Module

Table 6.3 can be perceived as the execution plan of the collaborative intelligence module of CEADA. It shows activities that constitute the collaborative intelligence module, the patterns of reasoning assigned to each activity, and the thinkLets chosen to support the execution of each activity. Although some activities may have the same set of patterns of reasoning assigned to them, the set of thinkLets assigned to them may be different. For example, see rows A.1.1.1, A.1.3, and A.1.4.1 of table 6.3. This is because each pattern of reasoning (or a variation of it) may be achieved using various thinkLets [14, 16, 129], and so one has to select the most appropriate thinkLet to support a given activity.

Activities A.1.0 – A.1.9 in table 6.3. Some activities in table 6.3 were further decomposed into basic activities that cater for (1) the gathering of information (from stakeholders) on the topic of interest or theme of an activity, (2) the converging or classification of gathered information, and (3) the seeking of stakeholders' consensus on information. For example, CEADA's facilitation process model in figure 6.17 shows that activity A.1.1.1 in table 6.3 was decomposed into basic activities A.1.1.1.1 and A.1.1.1.2. Figure 6.17 also shows that A.1.1.2 was decomposed into basic activities A.1.1.2.1 – A.1.1.2.5.

Column 4 of table 6.3 shows the set of thinkLets assigned to each activity in CEADA's collaborative intelligence session. Figures 6.17 and 6.18 show particular thinkLets assigned to the *basic activities* that constitute a given activity in table 6.3. Details of each thinkLet in table 6.3 or figures 6.17 and 6.18 are provided in CEADA's thinkLet notation model in appendix C (figures C.1 –C.10). Reasons why the selected thinkLets in table 6.3 were chosen are discussed in section 6.5. CEADA's thinkLet notation model also provides details of when and how each adopted technique in this module is used.

An agenda needs to be flexible in the sense that it can be rethought and refined as group members understand their problems better [107]. Thus, ad hoc activities can be added to table 6.3 during the execution of CEADA, or some activities currently scheduled under the collaborative design module (in section 6.4.2) can be executed in this module if need arises. For example, activities A.3.1 – A.3.4 in the collaborative design module can be executed along with activities A.1.1 – A.1.2 in this module.

Activities A.2.1 – A.2.3 in table 6.3. These activities require no thinkLet support but use output from activities A.1.1 – A.1.9. For activity A.2.1, architecture approaches (such as TOGAF ADM) provide guidelines for devising a roadmap of enterprise architecture development. For example, during roadmap design it is vital to determine whether the time period articulated for the architecture effort makes sense in terms of practicality and resources [124]. For this to be achieved, output from A.1.1 – A.1.9 is vital input. Also, any complexities that arise when planning the architecture effort may result in refining (or negotiating) output from A.1.8.2 (i.e. the scope of the architecture effort).

A.2.1 also involves assessing output from A.1.1 – A.1.9 so as to fully populate the diagram template for Analysis One Two Three with data on the organization's cultural aspects (which are extracted from, e.g., A.1.4.1) and the organization's political factors that the architect identifies or observes through interacting with stakeholders. Understanding these factors helps the architect(s) to properly schedule activities in the architecture creation roadmap or to customize CEADA's activities that constitute the collaborative intelligence, collaborative design, and collaborative choice modules. Also, in A.2.1 architects work with the chosen key decision makers (i.e. output of A.1.9.3) to acquire formal approval of output from A.1.1 – A.2.1. This helps to solve the problem of lack of formal results from workshops, which was reported in the survey findings (in section 2.3.3).

A.2.2 involves preparing or customizing diagram templates (that are to be used when executing activities in the collaborative design module) and the execution plan of the collaborative design module and collaborative choice module. This activity may also involve using output from A.1.1 – A.1.9 to formulate preliminary text or partially filled/populated diagram templates that can be used as SNTs (discussed in section 6.2.3) in the collaborative design module and collaborative choice module. Based on Raiffa et al. [107], in CEADA we define SNTs as partially or fully populated diagram templates or models that stakeholders discuss (i.e. scrutinize, comment on, approve, or disapprove) during the execution of collaboration dependent tasks. CEADA's diagram templates are discussed in sections 6.2.2 and 6.2.3, and examples include the scenarios formulation template (figure 6.7), requirements classification template (figure 6.11), constraints classification template (figure 6.12). The customized diagram templates that show the kind of information that is to be discussed in the collaborative design session are disseminated in A.2.3.

A.2.2 also involves determining, by basing on the cultural and political factors in the enterprise (i.e. output from A.1.1 – A.2.1), whether interest-driven or task-driven division will be used incase specialization-driven division is not possible. Reasons why this is important are discussed in section 6.2.3. For example, in an organization where most individuals are motivated (to be more productive) by the presence of familiar group mates or bosses that they wish to impress [107], interest-driven division and specialization-driven division would be appropriate compared to task-driven division. These concepts are discussed in section 6.2.3. In A.2.2 architects determine the divisions that will be used in the collaborative design module and collaborative choice module, while in A.3.0 architects verify with selected stakeholders if they agree with the type of division that has been selected.

In A.2.3 activities in the collaborative design module of the architecture creation conversation are scheduled. This entails communicating with all stakeholders (selected in activity A.1.9) the calendar of upcoming events in the architecture creation roadmap, communicating expectations of the architect team, finding out stakeholders' expectations on upcoming conversations on the architecture creation effort, revising the execution plan of the collaborative intelligence module and collaborative choice module to ensure that it addresses stakeholders' expectations, inviting relevant stakeholders (who are determined based on output from A.1.9) for the collaborative design module, and distributing the blank or partially populated diagram templates to the invited stakeholders.

In A.2.3 the customized execution plan for the collaborative design module and collaborative choice module also serves as a communication plan for the subsequent architecture creation activities. This is done as an effort towards overcoming the communication problem, which was reported in the survey findings (in section 2.3.3). Communication prior to the meeting can be done using memos that indicate what needs to be decided, information that could be useful for decision making, the (series of) expected tangible results, problems to be worked on or opportunities that will be explored, and activities that will be done by the group [107] as a whole and those that will be done by subgroups.

To execute the above execution plan of the collaborative intelligence module, the description languages, types of media, and cognitive mode that are used are discussed below.

6.4.1.3 Languages, Media, Cognitive Mode in Collaborative Intelligence

Description Languages Used in this Module. Topics of discussion in the CEADA execution plan are questions that were formulated basing on (a) enterprise architecture concepts (e.g. in TOGAF [124], Op't Land et al. [96], Lankhorst et al. [67]) and (b) VPEC-T [44] vocabulary (discussed in section 6.2.3). These questions and topics are given in CEADA's thinkLet notation model (see appendix C, figures C.1 – C.10). Output from the questions and topics of activities A.1.1.1 – A.1.2, A.1.4.1, and A.1.9 in table 6.3 is useful in the formulation of baseline architecture models, while output from other activities in table 6.3 is useful in the formulation of target architecture models. In addition, architecture modeling languages are used to transform output from CEADA activities into baseline and/or target architecture models. For example, in this research Business Process Modeling Notation (BPMN) [134] was used to design the baseline and target architecture models, although ArchiMate would have been the most appropriate. Examples of resultant BPMN models are provided in appendix D (e.g. figures D.12, D.10).

Type of Media Used in this Module. Text data in CEADA activities that involve brainstorming (i.e. those supported by thinkLets that create the generate pattern of reasoning) is captured in form of data capture functions (discussed in section 6.2.2), which vary depending on the type of question or topic. In addition, the diagram templates of CEADA (discussed in section 6.2.2) serve as conceptual models that are perceived as graphics-type *media* for collecting information for designing baseline and target architecture models. For example, graphics-type media used in activity A.1.1 – A.1.2 include the diagram template for process attributes, the adopted symbols of formulating a Rich Picture, and the diagram template for problem analysis. Media used in A.1.4 – A.1.5 and A.1.9 are the diagram template for constraints classification and the diagram template for Analysis One Two Three. Media used in A.1.3 and A.1.6 – A.1.8 is the diagram template for requirements classification.

The third type of media used are tools that are technology based (such as EMS software and hardware tools) and non-technology based tools (such as pens, papers ranging from sizes A4 to A0 depending on activity executed, stickers, markers, and flip charts).

Details of how these media are used are given in CEADA's thinkLet notation model (see appendix C). Also, the thinkLet notation model of CEADA is documented basing on the Meetingworks™ EMS tools and their configurations.

Cognitive Mode Used in this Module. As noted in section 4.4, the analytical cognitive mode (i.e. abstracting information to reach a shared understanding of complex aspects) [104] was adopted for CEADA activities. This was achieved by using thinkLets selected for activities that require convergence of aspects (see table 6.3) and by populating the following CEADA diagram templates with information.

At A.1.0 the holistic data capture pyramid template is invoked to help stakeholders visualize architecture development aspects. At A.1.1.1 the diagram template for process attributes and symbols for Rich Picture formulation are invoked to define operations, project and programme portfolio, and governing frameworks in the baseline situation. At A.1.2 the diagram template for problem analysis is invoked to define problematic issues in the baseline situation. At A.1.4.1 and A.1.9 the diagram template for Analysis One Two Three is invoked to determine cultural factors, problem and solution owners, and key decision makers. The diagram template for requirements classification is invoked at A.1.3 to determine possible business solution alternatives. At A.1.4 – A.1.5 and A.1.8 the diagram template for constraints classification is invoked to determine internal constraints, external constraints, and high level solution specifications for a given business solution alternative. At A.1.7 the diagram template for specifying the purpose of the architecture creation effort is invoked. Details of the use of these templates to enable analytical cognitive mode are given in CEADA's thinkLet notation model (see appendix C).

Output from activities A.1.1 – A.2.3 in table 6.3 provides a somewhat detailed view of the organization's baseline situation and high level view of the organization's desired situation. Output from the collaborative intelligence module is then elaborated and made more explicit in CEADA's collaborative design module (see section 6.4.2).

6.4.2 Collaborative Design Module

The aim of this module is to elaborate output from the collaborative intelligence module, create a shared understanding of problem and solution aspects among all stakeholders, define requirements and quality criteria that the enterprise architecture must address, and formulate solution scenarios that cater for those requirements. This module originates from figure 5.3 and table 5.5 in chapter 5, in the sense that the activities in table 5.5 are the ones used in the activity layer of table 6.4 (for details on this mapping, see discussion in section 6.2.1). Table 6.4 shows patterns of reasoning and thinkLets assigned to each activity in the collaborative design session of CEADA. Details of each activity in the process layer of table 6.4 are provided in the facilitation process model of CEADA's collaborative design module (see figure 6.19), and details of each thinkLet in table 6.4 are provided in the thinkLet notation model of CEADA (see appendix C, figures C.12 – C.18).

With respect to the framework for coordinating conversations on architecture creation (see section 4.4), following is a discussion of the social mode, communication mode, execution plan, description languages, type of media, and cognitive mode of the collaborative design session of architecture creation conversations.

Table 6.4: *Collaborative Design Module*

Activity #	Process layer (or Activity layer)	Pattern layer	ThinkLet layer
A.3.0	Communicate purpose of the session	-	-
A.3.1	Define concerns about (or elaborate) problems that were defined in the collaborative intelligence session	Generate	LeafHopper
A.3.2	Clarify and organize concerns about (and additional issues to) the problem aspects	Converge, Organize	FastHarvest
A.3.3	Validate and agree on concerns about (and additional issues to) the problem aspects	Evaluate, Build Consensus	StrawPoll, CrowBar
A.4.0	Communicate solution/desired aspects in the target situation that were defined in collaborative intelligence module	-	-
A.4.1	Define business requirements that the enterprise architecture must fulfill	Generate	FreeBrainstorm
A.4.2	Clarify and categorize business requirements by type	Converge, Organize	FastHarvest
A.4.3	Validate and agree on the requirements for the enterprise architecture	Evaluate, Build Consensus	StrawPoll, CrowBar
A.4.4	Define quality criteria (or quality assurance principles) with respect to achieving the business requirements	Generate	FreeBrainstorm
A.4.5	Clarify and categorize quality criteria by type	Converge, Organize	Concentration, ReviewReflect
A.4.6	Evaluate, discuss, validate and agree on quality criteria	Evaluate, Build Consensus	StrawPoll, CrowBar
A.5.1	Define names of transformation process(es) required to achieve the business requirements	Generate	FreeBrainstorm
A.5.2	Clarify and organize names of required transformation process(es)	Converge, Organize	FastHarvest
A.5.3	Elaborate business requirements	Generate	FreeBrainstorm
A.5.4	Clarify and organize elaborated aspects on the business requirements	Converge, Organize	FastHarvest
A.5.5	Sketch solution scenarios of the solution/desired or target situation	Generate	FreeBrainstorm
A.5.6	Analyze and refine each formulated solution scenario of the desired situation	Converge, Organize	FastHarvest
A.5.7	Validate solution scenarios of the desired situation	Organize	Concentration
A.5.8	Agree on solution scenarios for the desired situation	Evaluate, Build Consensus	StrawPoll, CrowBar

6.4.2.1 Social and Communication Modes in Collaborative Design

Social Mode Used in this Module. From the architecture creation coordination framework (in section 4.4), the social mode in this module is participatory driven. The participatory social mode of this module can be achieved by involving stakeholders (at the strategic, tactical, and operational levels) and invoking any of the four types of division that were discussed in section 6.2.3, i.e. specialization-driven, task-driven, interest-driven, and governance-driven. For example, in activities A.3.1, A.4.1, A.4.2, A.4.4, A.5.1, A.5.2 of table 6.4, the specialization-driven, task-driven, interest-driven divisions can be invoked. These divisions enable parallel execution of sub tasks that would be time consuming and difficult to execute with the whole group. However, in activities A.3.0, A.3.3, A.4.3, A.4.6, A.5.7, A.5.8 of table 6.4, a session with all participating stakeholders in one whole group can be scheduled. If this is not possible, then to get approval of the defined problem and solution aspects, the architect needs to invoke a governance-driven division in addition to the specialization-driven, task-driven, or interest-driven divisions.

Communication Mode Used in this Module. Like in the collaborative intelligence module, this module can be conducted using group sessions with (strategic level, tactical level, operational level) stakeholders, group sessions with subgroups that emerge after a given division has been invoked, interview sessions with stakeholders, or a combination of interviews and (sub)group sessions. Thus, the communication modes among stakeholders and architects during execution of CEADA activities in this module can be 1:1, 1:*, *:1, and *:*. These modes are discussed in section 6.4.1.

6.4.2.2 Execution Plan of Collaborative Design Module

Table 6.4 shows the process, pattern, and thinkLet layers of CEADA's collaborative design module. Like in the collaborative intelligence module, although some activities may have the same set of patterns of collaboration assigned to achieve them, the set of thinkLets assigned to achieve them may be different. CEADA's facilitation process model in figure 6.19 shows the logical flow of basic activities in this module.

Activities A.3.0 – A.3.3 in table 6.4 allow operational level stakeholders to share their concerns about the problem and solution aspects that were defined in the collaborative intelligence module by the strategic level and tactical level stakeholders. In some incidences, activities A.3.0 – A.3.3 can be executed prior or along with activity A.1.1.2 – A.1.2 in the collaborative intelligence module. The aim of activities A.3.1 – A.3.3 of table 6.4 is to ensure that stakeholders' concerns are validated with respect to business principles, strategy, goals, and external and internal solution constraints (i.e. output from activities A.1.4 and A.1.5 of table 6.3). Activities A.4.1 – A.4.6 in table 6.4 deal with specifying business requirements and quality criteria that the enterprise architecture must address. The requirements can be categorized according to organizational units or departments. Activities A.5.1 – A.5.8 in table 6.4 enable stakeholders and architects to formulate conceptual models that show how stakeholders' concerns and requirements can be catered for in the desired situation. Reasons why the selected thinkLets in table 6.4 were chosen are discussed in section 6.5. CEADA's thinkLet notation model also provides details of when and how each adopted technique in this module is used.

To execute activities in this module, the description languages, types of media, and cognitive mode that are used are explained below.

6.4.2.3 Languages, Media, Cognitive Mode in Collaborative Design

Description Languages Used in this Module. Like in the collaborative intelligence module, topics of discussion in this session are questions that were formulated basing on enterprise architecture concepts and the VPEC-T vocabulary. These questions and topics are given in the thinkLet notation of CEADA (see appendix C). Output from the questions and topics of A.3.1 – A.3.3 in table 6.4 is useful in the formulation of baseline architecture models, while output from A.4.1 – A.5.8 in table 6.4 is useful in the formulation of target architecture models. Also, BPMN was used to transform output from these activities into baseline and target architecture models.

Type of Media and Cognitive Mode Used in this Module. Like in the collaborative intelligence module, text data for brainstorming-related activities is captured using data capture functions. The graphics-type media used in activity A.3.1 is the Rich Picture that was formulated in the collaborative intelligence module. According to [22], a Rich Picture can be used as a starting point of an exploratory discussion with people in a problem situation. In A.3.1 Rich Picture is used to start off discussions about the baseline situation of an enterprise. Moreover, the rich picture can be used to solicit comments and views (from the problem owners) on what the main issues in the situation are, give a holistic view of the situation, and contribute to the understanding of the social and cultural aspects of the situation [22]. The (partially) populated diagram template for requirements classification from the collaborative intelligence module is invoked in A.4.1 – A.4.3. The requirements elaboration and scenarios formulation template is invoked in A.4.1 – A.4.3 and A.5.1 — A.5.8 to formulate solution scenarios for the desired situation of the organization. In A.4.4

– A.4.6 the (partially) populated diagram template for constraints classification is invoked again and further populated with data from this module. Details of how these media are used are given in CEADA's thinkLet notation model (see appendix C).

After executing the collaborative design module, enterprise architects transform the conceptual models formulated using CEADA diagram templates into baseline and target architecture models. Providing details of how this is done is beyond the scope of CEADA (as discussed in section 5.6). However, figure 6.20 shows the procedure taken to transform filled/populated diagram templates (that represent baseline and target information of an enterprise) into formal architecture models.

6.4.3 Collaborative Choice Module

The aim of this module is to select an appropriate enterprise architecture design alternative. This module originates from figure 5.3 and table 5.7 in chapter 5, in the sense that the activities in table 5.7 are the ones used in the activity layer of table 6.5 (for details on this mapping, see discussion in section 6.2.1). Table 6.5 shows how the activities in the collaborative choice session of CEADA can be executed using support from the patterns of reasoning and thinkLets assigned to each activity. Table 6.5 shows the summarized design of the collaborative choice module of CEADA, while the detailed design of this module is provided in figure 6.17 and appendix C.

Table 6.5: *Collaborative Choice Module*

Activity #	Process layer (or Activity layer)	Pattern layer	ThinkLet layer
7.0	Communicate purpose of session	-	-
7.1	Discuss positive and negative implications of possible architecture design alternatives (or architecture views) for each solution scenario that was formulated in the collaborative design module	Clarify, Organize	-
7.2	Discuss positive and negative implications of each enterprise architecture design alternative (i.e. a combination of the various architecture views that represent the solution scenarios)	Clarify, Organize	-
7.3	Evaluate and discuss enterprise architecture design alternatives	Evaluate	StrawPoll
7.4	Agree on most appropriate enterprise architecture design alternative	Evaluate, Build Consensus	StrawPoll, CrowBar

The social mode in this module is participatory driven. This is achieved by invoking the specialization-driven division and governance-driven division at activity A.7.1, and involving all (strategic level, tactical level, operational level) key stakeholders at A.7.0, A.7.2 – A.7.4. The communication mode of this module is the same as the one for the collaborative design module of CEADA (see section 6.4.2). The graphic-type media used in this module are the baseline and target architecture models for the enterprise.

Table 6.5 shows that activities A.7.1 – A.7.2 enable stakeholders to understand the positive and negative implications of possible design alternatives for each solution scenario that was chosen in the collaborative design module, with respect to the alternative ways in which the enterprise architecture as a whole can be designed. At A.7.3 – A.7.4 stakeholders use quality criteria, which were defined in the collaborative design module, to evaluate the enterprise architecture design alternatives and agree on the most appropriate one.

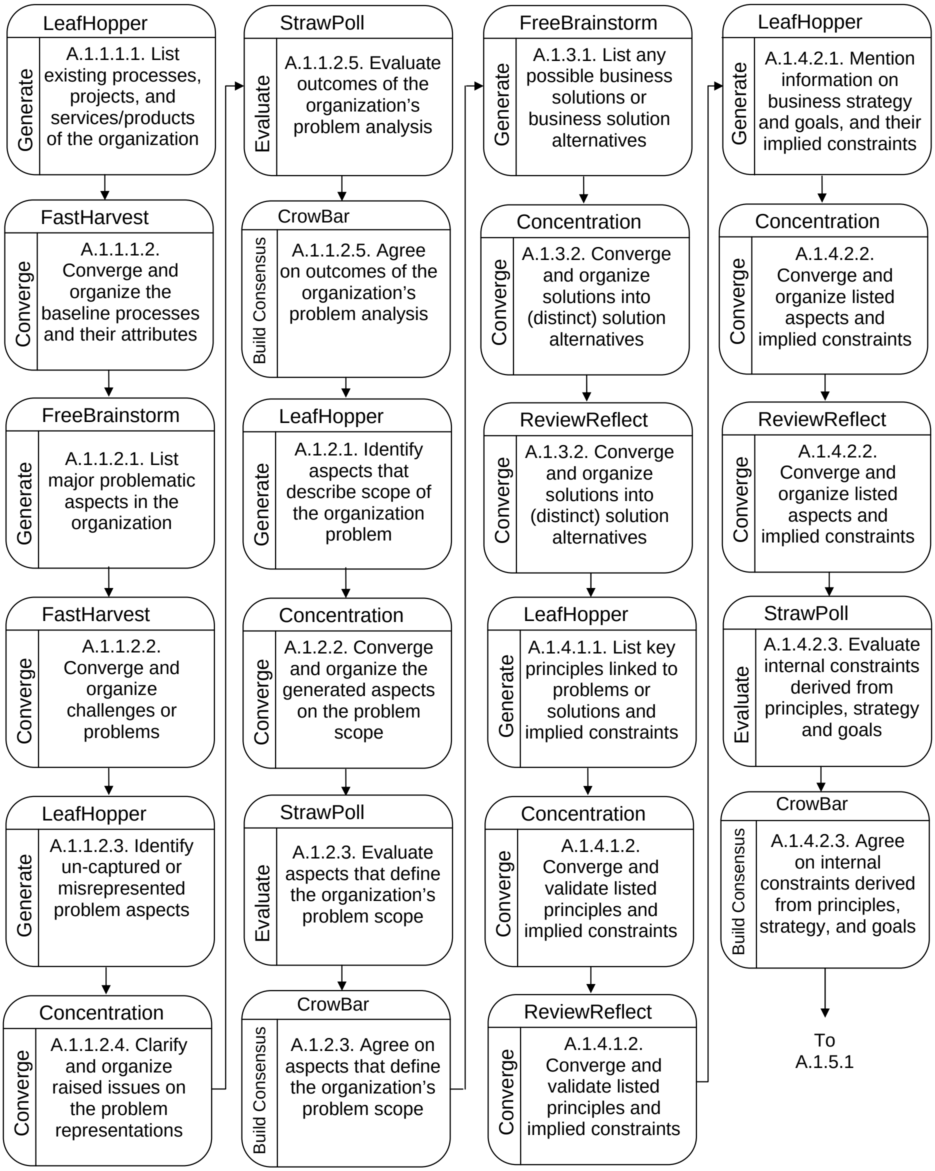

Figure 6.17: *Facilitation Process Model of CEADA's Collaborative Intelligence Module*

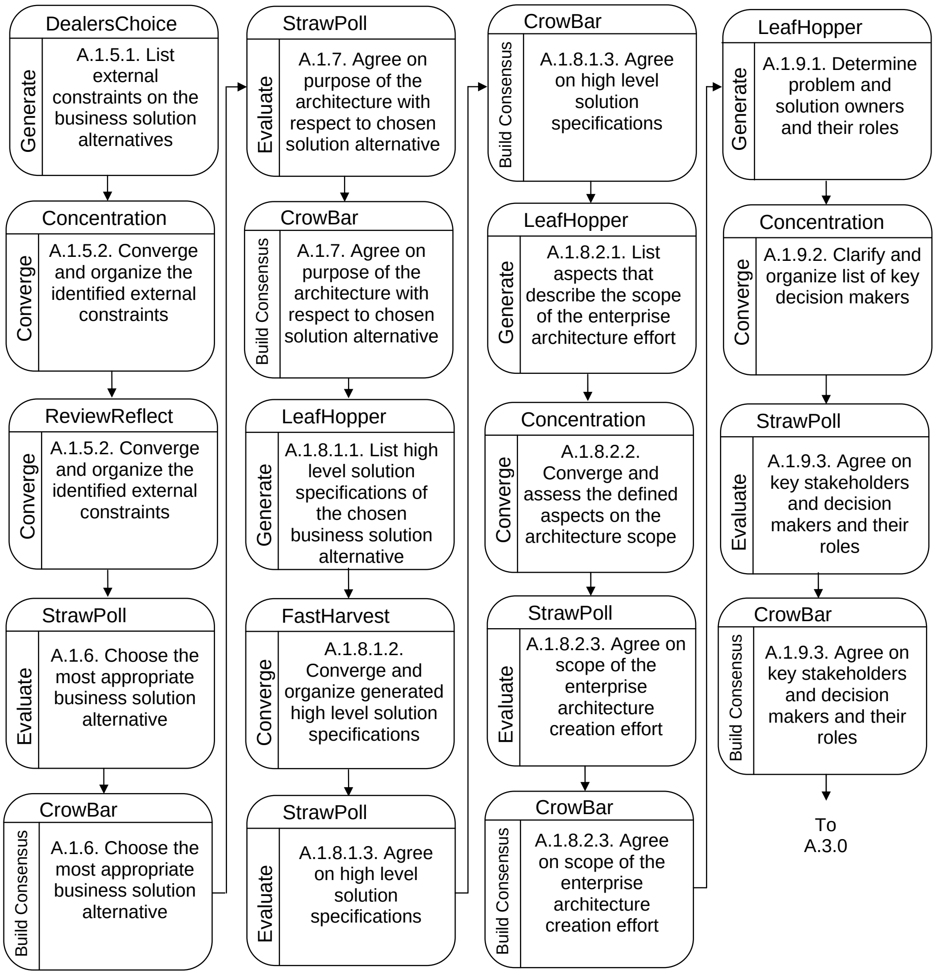

Figure 6.18: *Facilitation Process Model of CEADA's Collaborative Intelligence Module(continued)*

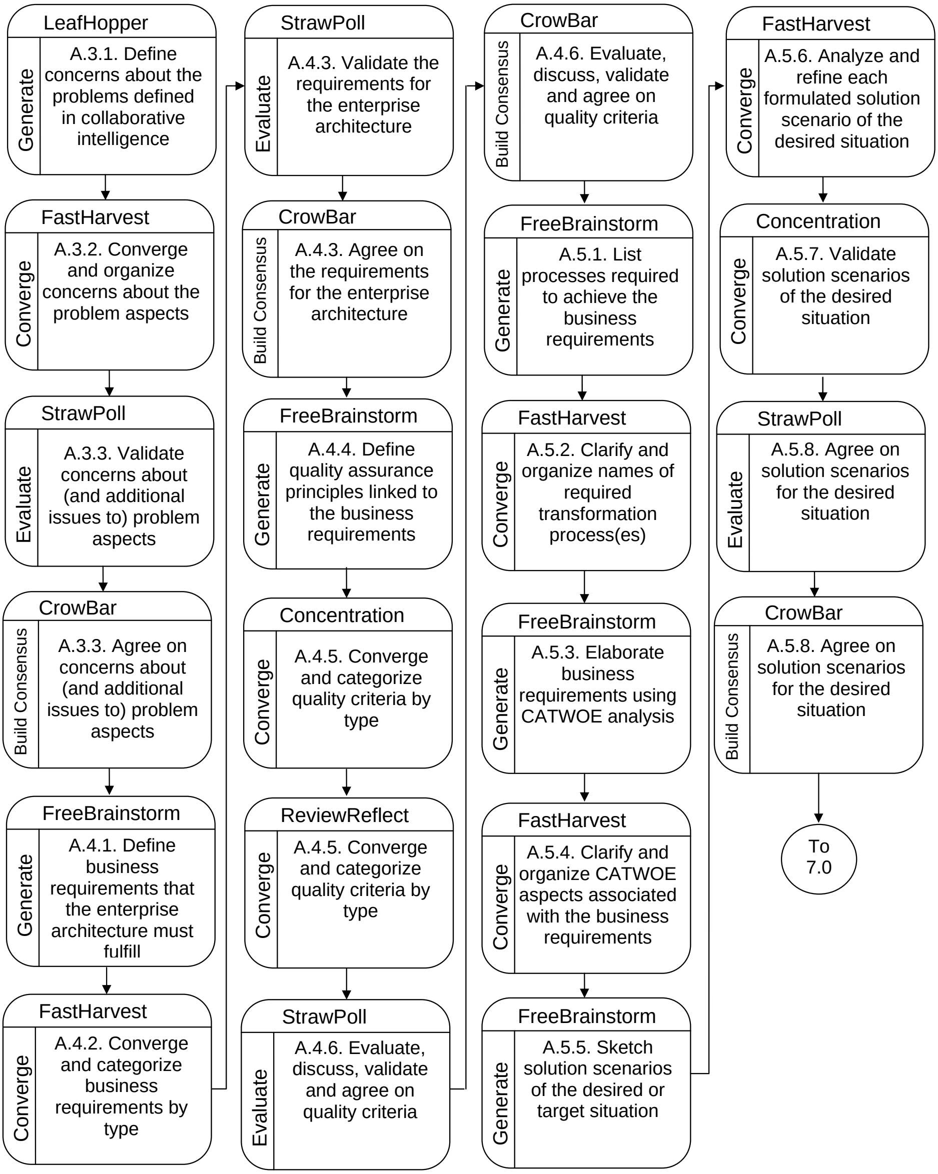

Figure 6.19: *Facilitation Process Model of CEADA's Collaborative Design Module*

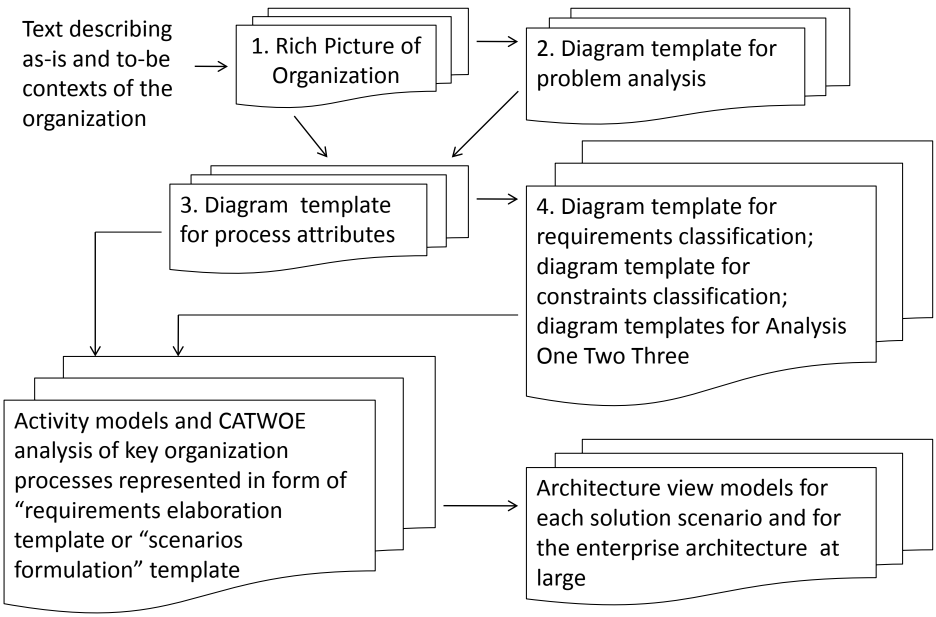

Figure 6.20: *Roadmap From CEADA's Diagram Templates to Architecture View Models*

6.5 Selected ThinkLets in CEADA

Section 3.7 discusses general criteria for selecting thinkLets, and detailed discussions on selecting thinkLets can be found in [17, 26, 62]. From the general thinkLets selection criteria (see section 3.7), appropriate thinkLets for CEADA activities were chosen basing on the following factors: (a) aim of the activity, (b) number of stakeholders required to accomplish the activity, (c) input required to accomplish the activity, (d) desired output of the activity, (e) questions or topics to be dealt with during the execution of the activity, (f) time or availability of stakeholders, and/or (g) any combination of these factors. The set of thinkLets selected in CEADA include LeafHopper, DealersChoice, FreeBrainstorm, FastHarvest, Concentration, ReviewReflect, StrawPoll, and CrowBar. Below we discuss why these thinkLets were chosen.

6.5.1 LeafHopper in CEADA

LeafHopper is used when one knows before hand that the group will brainstorm on various topics at a given time, and different group members have different expertise and interest levels in the topics, and every participant does not have to contribute to every topic [16, 14, 17]. This thinkLet was selected to support the execution of the following activities represented in tables 6.3 – 6.5, or figures 6.17 – 6.19. The topics or questions of discussion used and other details associated with the use of this thinkLet are provided in CEADA's thinkLet notation model (see appendix C).

In activity A.1.1.1.1 LeafHopper was chosen because there are many topics and diagram templates to populate with information. Thus, stakeholders do not have to comment on every diagram template or topic therein. In A.1.1.2.3 LeafHopper was chosen because populated diagram templates for problem analysis in organization units/departments may be more than one, in addition to the causal loop diagram if it was formulated. Thus, to save time, stakeholders are allowed to hop from model to model commenting on aspects of their interest. However, in situations where there is only one problem analysis template used to represent all organization problems, FreeBrainstorm can be used. In A.1.2.1 LeafHopper was chosen because there is more than one question that applies to more than one model. In A.1.4.1.1 and A.1.4.2.1 LeafHopper was chosen because different people may have different interests in the various questions or topics associated with these activities. In A.1.8.1.1 LeafHopper was chosen because there are two types of diagram templates that are used with various questions associated with them. In A.1.8.2.1 and A.1.9.1, LeafHopper was chosen because there are various topics of discussion in those activities.

In activity A.3.1 we have readable prints of partially populated diagram templates, and on each template there is an assignment box (see appendix D, figure D.4). The assignment box defines topics of brainstorming that are associated with a given activity. As shown in appendix C (figure C.12) we have conceptual models or populated diagram templates marked A – E in this activity, that require to be edited or validated. However, some people may not be interested in some models (e.g. one may be interested in the problem analysis diagram template, and may not be interested in process attributes diagram template). So we use LeafHopper here because it allows stakeholders to hop from template to template making comments on diagram templates on which their interest or expertise fall. Alternatively, FreeBrainstorm can be used in A.3.1 whereby the copies of say model

C are heaped in the middle of the table (without an EMS tool) and participants comment on only that particular model until they run out of ideas (see appendix C, figure C.17 in activities A.5.5 and A.5.6). This is inspired by the procedure provided in [17] of how to use FreeBrainstorm thinkLet without an EMS tool. With an EMS tool participants post their comments on model C using the data capture functions or formats provided by the facilitator. However, using FreeBrainstorm here takes more time since the group will deal with only one model at a time. That is why we prefer LeafHopper to FreeBrainstorm in A.3.1.

6.5.2 FreeBrainstorm in CEADA

FreeBrainstorm is used when one wants to cause group members to deviate from ordinary thinking to creative or innovative thinking, avoid having an overload of contributions to process from a team of at least 6 people, to help group members of a new heterogeneous team to reach a shared vision [17]. This thinkLet was selected to support the execution of the following activities represented in tables 6.3 – 6.5, or figures 6.17 – 6.19. The topics or questions of discussion used and other details associated with the use of this thinkLet are provided in appendix C.

In activities A.1.1.2.1 and A.1.3.1, FreeBrainstorm is used to avoid overwhelming contributions. Besides, these activities have one question or topic of discussion that is likely to result in several answers. While LeafHopper deals with multiple questions that are simultaneously answered, FreeBrainstorm deals with one question. Thus, most CEADA activities with one question or topic of discussion (or one diagram template) to deal with are supported by FreeBrainstorm. For example, we use FreeBrainstorm in A.4.1 to prevent overwhelming responses on a single model (i.e. the requirements classification template). LeafHopper is not selected at A.4.1 because we are using only one diagram template (i.e. the requirements classification diagram template), which is already structured in a way that enables the participant to freely comment on a node they are interested in and then move on to another node. So using LeafHopper in A.4.1 ends up taking a lot of time on one model and may lead to overwhelming number of contributions on requirements. Same argument goes for activities A.5.1, A.5.3, A.5.5. Moreover, in A.4.1 and A.5.1, the Root Definition technique by Checkland was adopted (see section 6.2.2) to help us find a structured way of defining and elaborating business requirements, and the questions or topics of discussion in A.4.1 and A.5.1 were adopted from TOGAF [124]. In A.5.3 we adopt the CATWOE analysis technique of SSM to elaborate requirements (see section 6.2.2). At A.5.5 we adopt the activity models technique of SSM (see section 6.2.2) to further elaborate requirements by defining their associated solution scenarios. These techniques were adopted to formulate the requirements classification template and the scenarios formulation template that are used in A.5.1 – A.5.8, and to enable the use of FreeBrainstorm. This is because diagram templates serve as compound questions.

6.5.3 DealersChoice in CEADA

DealersChoice is used when one wants all group members to brainstorm on several topics in a particular order because the organization positions (expertise and backgrounds) of group members is a critical matter in the topics at hand [17]. Several CEADA activities need support from DealersChoice since the interests and expertise of stakeholders in the enterprise vary across departments or units and within departments or units. However, scheduling and conducting a group session where all key stakeholders (in the architecture effort) must attend suffers several postponements and disappointments (see sections 7.6.1 and 7.6.2). These are mainly caused by busy work schedules of stakeholders and at times due to organization politics to frustrate the architecture effort. Thus, we adopted the techniques of dividing group labour (see section 6.2.3) to define four ways we use in CEADA to involve various types of stakeholders in an enterprise into the architecture creation effort. Thus, most brainstorming activities in CEADA that require stakeholders with particular expertise to be consulted are executed by invoking a specialization-driven division. This way, exploratory and/or validation interviews and/or small group sessions are scheduled to execute such tasks. DealersChoice is then invoked in the small group sessions to execute some activities by dealing with some aspects in a particular order.

The activity supported by DealersChoice in CEADA is A.1.5.1, since the order in which topics or questions in this activity are addressed matters. In A.1.5.1 external policies are first discussed and then their implications or constraints are discussed. Also, DealersChoice can be used in A.1.4.2.1, whereby business strategies and goals are first discussed, and then their implications on possible solutions are discussed. However LeafHopper is better in A.1.4.2.1.

6.5.4 FastHarvest in CEADA

FastHarvest is used when one wants group members to form subgroups that will (a) clean particular categories or subsets of brainstormed issues to obtain explicit and non-redundant issues within a given category, and (b) present and clarify the meaning of their extractions to the whole group [26]. We chose FastHarvest thinkLet to support the execution of several CEADA activities that involve converging ideas on baseline and target aspects of an enterprise. This is done to enhance awareness and create a shared understanding of such information within subgroups and then eventually within the whole group. This is because FastHarvest thinkLet enables an exhaustive analysis of ideas, allows participants to add new important ideas to their extractions, produces properly abstracted (or generalized) and explicit (or non-redundant) contributions, results in a moderate level of shared understanding, supports the filtering of aspects, and supports the creation of shared meaning of aspects [26]. Below we discuss how FastHarvest thinkLet is used in CEADA.

First, we invoke subgroups using a specialization-driven division. In FastHarvest there is a tendency that good ideas may be filtered out due to the bias that a given subgroup has [26]. In CEADA we attempt to overcome this by using specialization-driven division to invoke subgroups (when using the FastHarvest thinkLet), such that each subgroup deals with aspects that pertain to its department/unit/area of specialization. As a result, a subgroup filters ideas that its own members presumably contributed or generated. In addition, FastHarvest does not work well if subgroups do not understand the concept that the resulting ideas need to describe [26]. In CEADA when using the FastHarvest thinkLet, we attempt to overcome this by issuing out copies of a diagram template that is associated with a given task to subgroups, which are invoked based on a specialization-driven division. Also, depending on the nature of the task, an interest-driven division or task-driven division or governance-driven division (or a combination of these) may be invoked.

Second, we use diagram templates to enhance visualization of aspects. In FastHarvest there is a risk of limited shared understanding between subgroups and the facilitator needs to monitor that subgroups filter and synthesize ideas rather than literally copying the brainstormed ideas [26]. In CEADA we attempt to overcome this by using diagram templates to enhance visualization of aspects within subgroups and then merging diagram templates (populated by subgroups) so as to provide a holistic view of aspects. Using diagram templates helps to enable a hands-on involvement of participants when converging (or filtering and synthesizing) of ideas. Representing ideas on diagram templates helps to quickly identify redundant ideas, in the sense that two similar ideas plotted on the same diagram template can be quickly identified compared to a scenario where those ideas were presented in text only.

With FastHarvest in CEADA, when a subgroup completes working on a given subset of ideas that were assigned to it, it does not process another subset of ideas. If FastHarvest is not used, BucketBriefing thinkLet is an alternative one. However, the weakness with BucketBriefing is that after the subgroups report back their cleaned ideas to the entire group, the facilitator cannot filter out vague (poorly worded, irrelevant ideas) nor frame them at a better abstraction level [26]. This is one of the reasons why FastHarvest was chosen over BucketBriefing.

6.5.5 Concentration and ReviewReflect in CEADA

Concentration is used when one wants group members to clean one or more lists of brainstormed issues that are redundant, ambiguous, or overlapping [17]. In CEADA Concentration thinkLet was chosen to support various activities that follow either a LeafHopper or FreeBrainstorm activity, e.g. in A.1.1.2.4, A.1.2.2. In such activities, Concentration was chosen because aspects in those activities were to be processed by the group as a whole rather than in subgroups. Also, aspects in those activities were to be processed as a whole rather than in subsets. With Concentration thinkLet group members interact and discuss on a list of items until they resolve any redundancies, reduce any ambiguities, acquire a shared understanding of the resultant items, and/or acquire a list that can be used as quality criteria for evaluating aspects [17]. These are the reasons why Concentration thinkLet was chosen to support particular activities in the collaborative intelligence module and collaborative design module of CEADA. In some incidences, we follow the Concentration thinkLet with StrawPoll and CrowBar, e.g. in A.1.1.2.4, A.1.2.2, A.1.8.2.2, A.5.7. In other incidences, we chose to follow the Concentration thinkLet with the ReviewReflect thinkLet, e.g. in A.1.3.2, A.1.4.1.2, A.1.4.2.2, A.1.5.2, and A.4.5 (see figures 6.17 – 6.19 or appendix C).

ReviewReflect is used when one wants to create shared meaning of aspects in a group by enabling the group to (a) first review and comment on existing content, and then (b) discuss, restructure, and reword the content [26]. With ReviewReflect, one is able to adapt existing generic content or text to the needs of a given specific task or situation, or to review and comment on a deliverable document [17]. Therefore, in CEADA ReviewReflect was chosen to support activities that involve extracting or generating internal constraints, external constraints, and quality criteria from (a) existing organizational aspects (such as policies or principles, business strategy, business goals) and (b) existing regulations from governing or regulatory bodies. Such activities include A.1.3.2, A.1.4.1.2, A.1.4.2.2, A.1.5.2, and A.4.5 (see figures 6.17 – 6.19 or appendix C). In addition, ReviewReflect demands that group members must review, validate, and modify contents of an existing layout or any form of information composition [17]. In CEADA the existing information layout or structure appears in form of the various types of diagram templates.

6.5.6 StrawPoll and CrowBar in CEADA

StrawPoll is used when one wants to measure consensus within a group, to reveal patterns of agreement or disagreement within a group, to assess or evaluate a set of concepts [17]. In CEADA StrawPoll was chosen to support various activities that involve evaluation of items. For example, A.1.1.2.5, A.1.2.3, A.1.4.2.3, A.1.6, A.1.7, A.1.8.1.3, A.1.8.2.3, A.1.9.3, A.3.3, A.4.3, A.4.6, A.5.8, and A.7.3 (see figures 6.17 – 6.19 or appendix C).

With StrawPoll the facilitator does the following, (a) chooses the appropriate voting method, (b) defines voting criteria, (c) posts a list of items to vote, (d) prompts group members to cast votes, and (e) uses voting results to provoke discussions rather than end them [17]. In CEADA activities that are supported by StrawPoll, various evaluation or voting methods and evaluation or voting criteria are used (see appendix C). Examples of evaluation or voting methods used include Vote (Yes/No) in A.1.1.2.5, "Mark all that apply" in A.1.2.3 and A.1.7, "Rate from 1 to N" in A.1.4.2.3, MultiCriteria in A.1.6 (see appendix C). The evaluation or voting criteria vary depending on aspects associated with a given activity (see appendix C). As patterns of agreement and disagreement are revealed during the execution of activities supported by StrawPoll, the facilitator inclines group focus on resolving disagreements [17]. For example in activities A.3.3, A.4.3, A.4.6, A.5.7, A.5.8, A.7.4. This is done because encouraging and dealing with open disagreements on problem and solution aspects is easier than dealing with "buried" disagreements [107]. Often discussions in these activities lead to incidences where feedback loops in the execution of CEADA activities are triggered to enable deeper shared understanding of problem and solution aspects.

CrowBar is used after applying a StrawPoll to reveal and examine assumptions or reasons for lack of consensus on particular issues, to encourage group members to share unshared information, to reveal hidden agendas of group members, and to incite discussions on issues where the group has a low consensus [17]. Thus, CEADA activities that involve evaluation and build consensus patterns of reasoning are supported by both StrawPoll and CrowBar thinkLets (see appendix C).

In general, the thinkLet layer of CEADA comprises eight thinkLets, seven of which recur in various activities. Brainstorming or generate tasks in CEADA are supported by LeafHopper, DealersChoice, or FreeBrainstorm. Convergence and organize tasks in CEADA are supported by FastHarvest, Concentration, or ReviewReflect. Evaluation and consensus building tasks in CEADA are supported by StrawPoll and CrowBar.

6.6 Situational Parameters in CEADA

This section gives insights into customizing CEADA in order to get an enterprise-specific CEADA process that can support the execution of collaboration dependent tasks during architecture creation in a given enterprise. This is done because "there is no method that fits all situations" ([48], page 6). Due to differences in organization cultures and operations, different architecture projects often require a rather different approach for managing their collaborative tasks. Therefore, the following are situational parameters that can be considered when preparing CEADA for use in a given architecture project.

Size of enterprise and scope of organization problem or desired change. Organizations vary in complexity and scope of the baseline and/or target aspects (see sections 7.6.1 and 7.6.2). Obtaining information on the size or scope of the enterprise helps to determine the number of stakeholders that are to be involved in the architecture creation conversation and the conversation techniques that will be used (as discussed in section 6.4.1).

In an enterprise, CEADA modules can be executed using (a) short exploratory and/or validation interview sessions, and (b) three group sessions (each with a duration of at most 3 hours). The first group session involves executing activities in the collaborative intelligence module, the second group session involves executing activities in the collaborative design module, and the third group session involves executing activities in the collaborative choice module. However, in enterprises where stakeholders have extremely busy work schedules, it may be difficult to schedule and conduct three group sessions (see section 7.6.1 – 7.6.2). Thus, some activities in CEADA modules can be executed using interview sessions. Thereafter, one or two group sessions can be organized to review output from the interview sessions (see section 7.6.1 – 7.6.2). In such incidences output from interview sessions is used to (partially) populate CEADA's diagram templates, which are then used as SNTs to stir discussions in the group sessions. Thus, in CEADA the use of (partially) populated diagram templates as SNTs enables one to use interview sessions to supplement group sessions, and/or use group sessions to supplement interview sessions.

In the supplementary use of interview sessions and group sessions, the following aspects are considered.

- Exploratory interview sessions or exploratory group sessions. These involve executing brainstorming tasks in CEADA's process layer. Such tasks involve gathering or eliciting aspects on baseline and target enterprise contexts. Using exploratory interviews in CEADA helps to overcome situations where some stakeholders have no time or interest to participate in the group sessions. They also help to overcome incidences where some dominant stakeholders deny others the chance to express their views in a group session. Such incidences are bound to occur if a group session is conducted without an EMS [95, 78].

- Validation interview sessions or validation group sessions. These involve executing convergence and organize tasks in CEADA's process layer. Such tasks involve converging brainstormed aspects, organizing (or classifying) aspects, and evaluating or validating and approving aspects. Validation interviews help to overcome situations where some stakeholders have no time to participate in the group sessions in which convergence and organize tasks are executed.

Stakeholders' participation and duration of sessions. The scheduling of short discrete exploratory and/or validation interview sessions and exploratory and/or validation group sessions in CEADA depends on various factors. These include the nature of work in an enterprise, the number of stakeholders that are to be involved, stakeholders' work schedules, and the way labour would be divided during architecture creation conversations. An enterprise-specific CEADA process specifies the type of division to invoke so as to form subgroups of stakeholders that can be assigned tasks during architecture creation (this concept is discussed in section 6.2.3). The group sessions can be divided into small, medium-size, or large group sessions. Basing on the selected type of division, an enterprise-specific CEADA process specifies schedules for exploratory interview sessions, validation interview sessions, exploratory group sessions, and validation group sessions that will be conducted to execute activities in CEADA modules. Moreover, basing on the selected type of division and the number of sessions scheduled, an enterprise-specific CEADA process also gives an estimate of sufficient quantities of resources required to conduct the scheduled interview sessions or group sessions. The preparation and estimation of resources also considers the following estimates.

- Interview sessions are planned to involve 1 – 3 stakeholders.
- Small group sessions are planned to involve 4 – 8 stakeholders.
- Medium-sized group sessions are planned to involve 9 – 15 stakeholders.
- Large group sessions are planned to involve 16 or more stakeholders.

The type of division invoked determines the number of subgroups and the number of stakeholders in each subgroup. The number of subgroups determines the number of interview sessions or subgroup sessions that will be conducted. In incidences where there is absolutely no time to populate CEADA diagram templates in a group session, CEADA diagram templates are populated in exploratory and/or validation interview sessions. If these are also impossible to conduct, then the architect populates diagram templates with baseline and target information gathered through interview and/or group sessions (and organization documentation), and presents the (partially) populated diagram templates as SNTs to stakeholders in CEADA sessions. The populated diagram templates are then discussed and refined.

Available documentation or information resources about operations in the enterprise. CEADA activities that involve questions whose answers are available in existing organization documentation are not included in the agendas of interview sessions or group sessions of a customized enterprise-specific CEADA process. For example, if information about the organization is documented, some activities in the collaborative intelligence module of CEADA do not need to be executed using group sessions, e.g. activities A.1.4.1, A.1.1.1. Alternatively, if an organization has its operations documented, then activities for gathering baseline information can be executed using interview sessions, and activities for gathering target information can be executed using group sessions (along with interview sessions). In [93] we discuss a customized CEADA process for creating baseline architectures, while in [94] we discuss a customized CEADA process for creating target architectures.

The possibilities of conducting CEADA group sessions with or without an EMS in the enterprise. The thinkLet notation model of CEADA (see appendix C, figures C.1 – C.19) provides details of using an EMS tool and/or non-computer based tools. An enterprise-specific CEADA process specifies the tools that are to be used in interview sessions and group sessions during architecture creation.

Social complexity issues in an enterprise. Some organization cultures or management styles do not encourage collaborative work practices. In such incidences, CEADA activities are executed using interview sessions. In customizing CEADA, it is vital to learn some features about the organization's culture (from the preliminary dialogs with stakeholders) so as to properly customize its execution plan and supporting tools and techniques. For example, according to Nunamaker et al. [95], in some organizations anonymous contributions and anonymous voting do not motivate some stakeholders to participate in the sessions, since they want to impress their bosses or their colleagues through the quality of their contributions to a given topic. In such incidences, tools and techniques can be setup in a way that enables some stakeholders to get the recognition that they need in order to be motivated, e.g. by invoking divisions such as specialization-driven, interest driven (see section 6.2.3.3). Thus, knowing cultural aspects of an enterprise helps one to customize CEADA modules appropriately.

In general, not all activities in CEADA modules can be executed in a given enterprise. Thus, if enterprise information on the parameters discussed above is obtained, then the following can be done to obtain an enterprise-specific CEADA process. First, some activities in CEADA modules can be selected and others can be eliminated. Second, the way of dividing stakeholders into subgroups can be determined, and discrete short sessions can be scheduled. Third, the duration of executing CEADA in a given enterprise can be determined. Fourth, the required resources for executing selected CEADA activities can be determined. Fifth, the required results from each session can be determined. Sections 7.6.1 – 7.6.2 show various ways in which CEADA was applied in real enterprise contexts.

6.7 Summary of CEADA

A good decision making framework should be easy to use and understand (such that mental energy is left for working on the group task), it should not limit the group's thinking or outcome, it should encourage expression and discussion of disagreements, and provide ways of gathering information that will help resolve disagreements [107]. In this research, we attempted to adopt these features in the design of CEADA to support the execution of collaboration dependent tasks during architecture creation. Following Design Science, we adopted Collaboration Engineering, SSM, and other techniques and concepts discussed in sections 6.2.1 – 6.2.3.

Basing on the Collaboration Engineering design approach, we formulated the process, pattern, and thinkLet layers of CEADA (as discussed in section 6.2.1). After an experiment and field study evaluation of the process, it was found appropriate to adopt SSM techniques to enrich the thinkLet layer of CEADA with support for systemic or rational thinking during enterprise architecture creation (see section 6.2.2 and 7.8). For example, Rich Picture and Analysis One Two Three techniques support exploratory reasoning about baseline contexts or architectures. Also, Root Definitions, CATWOE analysis, and activity models techniques enhance exploratory reasoning about business requirements that drive the creation of target architectures. In addition, other techniques were adopted to enhance visualization of aspects during the execution of convergence and organize tasks in CEADA's process layer (see section 6.3). Such techniques include the Ishikawa diagram technique. These techniques were adopted to formulate diagram templates that support the elicitation and documentation of baseline information and target information of the enterprise.

In addition, techniques for dividing group labour were adopted to enhance communication, negotiations, and shared understanding (see sections 6.2.3 and 7.7). However, synthesizing output of subgroups is a difficult task, but is often allocated inadequate time in a session or the wrong people to accomplish it, and no guidelines are usually provided on how to integrate output from subgroups [107]. In CEADA we have provided diagram templates that can be used in synthesizing output from subgroups. For example, CEADA's thinkLet notation model shows how the requirements classification templates and scenarios formulation templates can be used along with thinkLets to enable a comprehensive definition of business requirements and solution scenarios from various units of an enterprise (see appendix C). The diagram templates also enable the supplementary use of interview sessions and group sessions scheduled with respect to the number of subgroups of key stakeholders in the architecture effort. CEADA's thinkLet notation model in appendix C shows how the entire set of CEADA's diagram templates can be used along with the selected set of thinkLets in CEADA.

CEADA comprises three modules, and the design of these modules has been discussed in sections 6.4.1 – 6.4.3. The design of CEADA shows its process layer and pattern layer (which define the execution plan) and its thinkLet layer (comprising the social modes, communication modes, cognitive modes, type of media, and description languages). Section 6.5 discussed the set of eight thinkLets that recur in the thinkLet layer of CEADA, and section 6.6 discussed the situational factors or customization clues that can be considered to make an enterprise-specific CEADA. The evaluation of CEADA is discussed in chapter 7, and examples of models resulting from sessions supported by CEADA in field study I and field study II are given in appendix D.

Chapter 7

Evaluation of CEADA

Abstract. This chapter presents details of how CEADA was evaluated in four phases by using an analytical evaluation method, experimental evaluation method, and two field studies based on Action Research method in at least eight enterprises. This chapter also discusses findings from each evaluation phase and refinements that were made to improve CEADA to its current state.

7.1 Chapter Overview

In Design Science a complete understanding of the environment in which an artifact operates helps one to properly design the artifact and to overcome its potential and undesirable side effects [71]. One of the ways through which the operational environment of an artifact can be learned is evaluating it in a variety of settings. In Design Science proper evaluation of an artifact involves examining its design or performance by applying existing design evaluation methods such as analytical methods, experimental methods, observational methods [49]. This chapter discusses the evaluation iterations and refinements that CEADA underwent.

This chapter is structured as follows. Section 7.2 lists the design evaluation methods that were selected for use in this research and discusses reasons why they were selected. Sections 7.3 – 7.6 discuss how each of the selected design evaluation methods was used. Sections 7.3.3 and 7.7 – 7.9 discuss findings from evaluating CEADA using the selected design evaluation methods. Section 7.10 concludes this chapter. Some parts of this chapter are a (slightly) modified version of sections of work in [85, 86, 88, 90, 91, 93, 94].

7.2 Roadmap for Evaluating CEADA

This section presents methods that can be used during the evaluation or validation of Design Science artifacts. It also discusses why particular methods were selected and adopted in the evaluation phase of this research.

Hevner et al. [49] and Wieringa [135] discuss various design evaluation methods. An overview of these has been provided in table 7.1. Basing on specific aspects associated with each evaluation method in table 7.1, we chose methods where researchers actively participate in the evaluation of an artifact. This is because we found it appropriate to first evaluate CEADA in settings where we are actively involved (e.g. as the facilitators of CEADA sessions), prior to evaluating it in settings where we are passively involved (e.g. where other people are the facilitators of the sessions). Thus, from table 7.1, the selected methods include laboratory demo (i.e. an experiment method), field study or field demo by Action Research (i.e. an observational method), analytical method, and descriptive method. Key aspects on these methods are shown in the shaded rows of table 7.1.

Table 7.1: *Examples of Design Evaluation Methods [49, 135]*

#	Type of design evaluation method (Hevner et al., 2004; Wieringa, 2010)	Key aspects of the design evaluation/validation method (Wieringa, 2010)
1	Experiment methods (controlled experiments, simulations with artificial data)	
	Field experiment	Other people use the designed artifact in the field but under controlled settings, with the aim of achieving the researchers' goals and justifying that the artifact will serve its intended purpose
	Laboratory experiment	Other people use designed artifact in artificial and controlled settings, with the aim of achieving the researchers' goals and justifying that the artifact will serve its intended purpose
	Laboratory demo	Researchers use designed artifact on a realistic example in an artificial setting, with the aim of showing that the artifact will serve its intended purpose
2	Observational methods (case study, field study)	
	Case study	Other people use designed artifact in the field with the aim of solving a given (enterprise) problem, and demonstrating that the artifact will serve its intended purpose
	Action research	Researchers use designed artifact in the field with the aim of solving a given (enterprise) problem, acquiring knowledge, and demonstrating that the artifact is usable in practice
	Pilot project	Other people use designed artifact in the field with the aim of providing data to the researcher, and justifying that the artifact will serve its intended purpose
	Field demo	Researchers use designed artifact in the field and demonstrate that the artifact is usable in practice
	Opinion	Researchers ask stakeholders if the artifact could be useful, with the aim of eliciting information about possible support for the artifact
3	Descriptive methods (informed argument, scenarios)	
	Illustration	Researchers provide an example with the aim of explaining the artifact such that readers understand the artifact
	Benchmark	Researchers use the designed artifact on a standard example in an artificial setting, and they compare the artifact with other existing artifacts
4	Testing methods (functional testing, structural testing)	
5	Analytical methods (static analysis, architecture analysis, optimization, dynamic analysis)	

Figure 7.1 shows the roadmap that was taken in this research to evaluate CEADA (process) models using the selected methods. Herein, the term CEADA (process) models is used to refer to the whole constellation of figures and tables that describe (or present information associated with) the design of CEADA. The boxes in figure 7.1 represent a specific step in the CEADA evaluation roadmap, the solid arrows represent connections between steps to imply the order of steps in the roadmap, the dashed arrows represent information exchange between step 3 in the roadmap and the cylinder symbol (which represents a repository of existing related literature). The roadmap shown in figure 7.1 was found to be an economical way of evaluating CEADA (process) models.

Steps 1, 6, 9, 12, and 15 in figure 7.1 indicate that CEADA (process) models have undergone five evaluation iterations. An overview of these iterations and their relevance in this research is provided in sections 7.2.1 – 7.2.3 below.

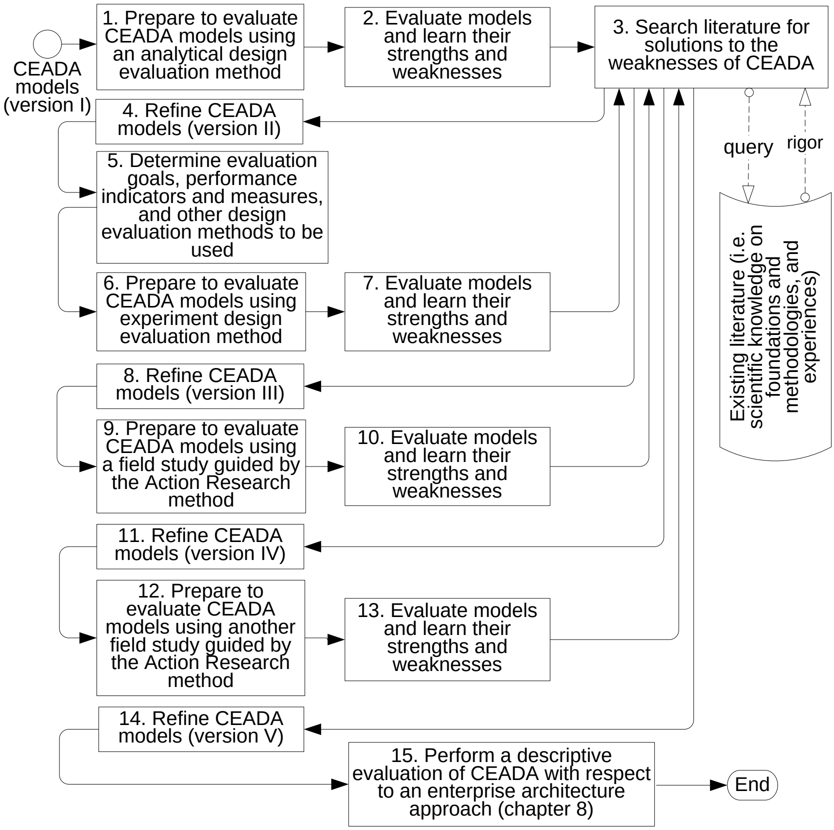

Figure 7.1: *Roadmap for Evaluating CEADA (Process) Models*

7.2.1 Relevance of Analytical Evaluation

Design Science research is considered to be relevant to IS and IT practitioners if the resultant artifact addresses the problems they face and maximizes opportunities from the interaction of people, organizations, and IT [49]. In order to find out whether the design of CEADA mirrored any of these features, it was vital to first expose it to enterprise architects and professional facilitators. This was done, as shown in step 1 of figure 7.1, by evaluating version I of CEADA (process) models (provided in appendix B) using an analytical design evaluation method (more on this is discussed in section 7.3). Since evaluation reveals weaknesses in a theory or artifact and the need for its refinement and reassessment [49], feedback obtained from evaluating artifacts is used to progressively refine them [49, 50]. In this research, as shown in steps 2, 3, and 4 of figure 7.1, findings from the analytical evaluation were used to refine version I and obtain version II (see appendix B).

7.2.2 Relevance of Experiment Evaluation

After the analytical evaluation, there was need to evaluate CEADA in a fictitious setting of an environment where it is intended to operate. Evaluating an artifact in its intended operational environment involves determining quality criteria, determining the performance of an artifact against those defined criteria, and determining whether the artifact does (not) work or if there is any progress made towards solving the problem [71]. As shown in step 5 of figure 7.1, the evaluation goals, the performance indicators, and the performance measures that were considered in the evaluation of the CEADA (process) models were determined (see section 7.4). Step 5 of figure 7.1 also shows that other design evaluation methods were chosen to further evaluate CEADA. From the methods listed in table 7.1, these other methods are the experiment method, observational method, and descriptive method. This is indicated in steps 6, 9, 12, and 15 of figure 7.1.

In Design Science research, unless unavoidable, it is vital that an artifact is first tested in a laboratory or experiment setting before evaluating it in its real or intended operation environment [55]. This is the reason why after the analytical evaluation phase (in section 7.3), it was appropriate to evaluate CEADA using an experiment setting prior to using a real organization setting. As shown in step 6 of figure 7.1, version II was then evaluated using an experiment as a fictitious setting of the artifact's operational environment. As shown in steps 7, 3, and 8 of figure 7.1, experiment findings were used to refine version II and this resulted in version III.

7.2.3 Relevance of Field Study by Action Research

As shown in step 9 of figure 7.1, version III was further evaluated in a real operational environment using an observational evaluation method. According to Hevner et al. [49], observational methods for evaluating the design of an artifact are (a) case study – studying the artifact in a given business environment, and (b) field study – studying and monitoring the use of an artifact in several projects or contexts. Other observational methods are listed in table 7.1.

The term case study can be used to refer to "*a unit of analysis*" (like an enterprise) or to a qualitative "*research method*" [81]. Either way case study is at times avoided because its protocol is lengthy and its results limit *scientific generalization* [137], since one or a few subjects are investigated [140]. Also, with the case study method, the researchers or designers of the artifact let other people use the deigned artifact in the field [135] (see table 7.1). Therefore, in this research the field study observational evaluation method was selected. In addition, a field study can be conducted using the Action Research method [50], since Action Research can guide the evaluation or testing of a Design Science artifact and helps to reveal ways of improving the artifact [55]. In Action Research, researchers steadily work with subjects in the investigation and transformation experience [7]. Accordingly, using Action Research method enabled us to first evaluate CEADA in a setting where we participated as the facilitators of CEADA modules, before evaluating them in a setting where real enterprise architects (practitioners) participate as the facilitators of CEADA modules. Thus, Action Research was used in the field study evaluation of CEADA. More on the complementary use of Design Science and Action Research in this research is discussed in section 1.8.1.

As shown in steps 10, 3, and 11, findings from the field study were used to refine version III and this resulted in version IV. As shown in step 12 of figure 7.1, version IV was evaluated using another field study guided by Action Research method. As shown in steps 13, 3, and 14, findings from the second field study were used to refine version IV and this resulted in version V (which is presented in chapter 6). As shown in step

15 of figure 7.1, version V has been descriptively evaluated by showing its use in an enterprise architecture approach (see discussion in chapter 8). Sections 7.3 – 7.10 discuss the analytical, experimental, and observational evaluation iterations of CEADA, while chapter 8 discusses the descriptive evaluation of CEADA.

7.3 Analytical Evaluation of CEADA

According to Hevner et al. [49], analytical evaluation can be done in four ways, i.e. (1) static analysis – inspecting static qualities in the structure of an artifact, (2) architecture analysis – inspecting how an artifact fits into a technical Information Systems architecture, (3) optimization – inspecting and revealing the in-built optimal properties of an artifact, and (4) dynamic analysis – investigating dynamic qualities of an artifact while it is being used. Additional ways in which (domain) experts can do analytical evaluation of an artifact include usability inspection [120] and (cognitive) walkthroughs [117, 129]. Since version I of the CEADA (process) models was entirely based on literature, it was considered appropriate to analytically evaluate them using walkthroughs with practitioners.

A walkthrough is a step by step review and discussion (with practitioners) of activities that make up a process to reveal errors that are likely to hinder the effectiveness and efficiency of the process in realizing its intended purpose [62, 64]. Walkthroughs generally involve one or more evaluators or experts performing a stepwise review of a scenario or representation of the design of an artifact, so as to note possible problems [117]. Several variations of walkthroughs are commonly used in software development to find errors in software code and functionality, verify software requirements, validate software against predefined standards, reduce risks of discontinuity, and generally improve software quality [58]. Similarly in Collaboration Engineering, walkthroughs are used as one of the methods for evaluating and validating the design of a collaboration process [62]. Therefore, in this research, prior to using other evaluation methods, conducting walkthroughs with enterprise architects and professional facilitators was an economical way of validating version I of CEADA (process) models. Sections 7.3.1 and 7.3.3 present the setup and findings from the analytical evaluation of CEADA.

7.3.1 Setup of Walkthroughs

The analytical evaluation of CEADA (process) models was conducted in two iterations. The first iteration involved three bilateral structured walkthrough sessions with four experienced enterprise architects. The second iteration involved another three bilateral structured walkthrough sessions with one enterprise architect and two professional facilitators. This second iteration involved analytically evaluating the intermediate models that resulted from considering and incorporating findings from the first analytical evaluation iteration. The walkthroughs were setup and conducted as follows.

1. Aim. The aim of each walkthrough was to obtain practice-driven insights into executing collaboration dependent tasks in enterprise architecture creation, and to identify and eliminate faults and ambiguities in the CEADA (process) models.

2. Participants. Bilateral structured walkthrough sessions were used, thus each session involved two actors, i.e. a practitioner (an experienced enterprise architect or professional facilitator) and a researcher. The four enterprise architects who participated in the walkthrough sessions were from Capgemini Netherlands. For the two

professional facilitators who participated in the walkthrough sessions, one was from Venture Informatisering Adviesgroep (VIAgroep) and another was from Capgemini Netherlands.

3. Duration. Each session lasted for at least one hour and at most two hours.

4. Inputs. Inputs to the first analytical evaluation iteration were version I of CEADA models (see appendix B – figure B.2 and table B.1). Inputs to the second analytical evaluation iteration were the intermediate models that were obtained by incorporating findings from the first analytical evaluation iteration (see appendix B – figures B.3, B.4, and table B.4).

5. Agenda. Each session started with an explanation of the aim of the research (which was provided in section 1.6), the aim of the walkthrough (provided in (1) above), and the roles of the practitioner (i.e. an architect or professional facilitator) during the walkthrough. The roles of the practitioner were accomplished through a stepwise discussion of the inputs to the walkthrough. The roles of the practitioner were:

   - To comment on the relevance of CEADA in practice.
   - To review the activities that constitute the synergy of collaboration dependent tasks and other aspects described in CEADA (process) models. The review focused on identifying faults and ambiguities, and giving practical insights into eliminating them.
   - To verify, based on his or her experience, the relevance of the CEADA activities in achieving the general aim of the research.

6. Output. During the walkthroughs, notes about the discussions were taken. Details of notes from each walkthrough session are provided in appendix B (see tables B.2, B.3, B.5, and B.6). Output or feedback from the first analytical evaluation iteration was used to refine version I of CEADA (process) models, and this resulted in the intermediate CEADA (process) models (provided in appendix B – figures B.3, B.4, and table B.4). Also, output or feedback from the second analytical evaluation iteration was used to refine the intermediate CEADA models, and this resulted in version II (see appendix B – figures B.6, B.7, and tables B.7, B.8).

The analytical evaluation phase of CEADA (process) models was concluded by an expert review, which was done by a collaboration engineer. A collaboration engineer is someone who "*creates standard and repeatable procedures that need to be followed to achieve predictable success with group processes*" ([129], page 3). Section 7.3.2 classifies findings from the analytical evaluation of CEADA (process) models, while section 7.3.3 discusses main findings from the analytical evaluation phase of these models.

7.3.2 Classification of Findings

Based on the framework for coordinating enterprise architecture creation conversations (see section 4.4), this section classifies findings from evaluation iterations of CEADA (process) models into the following three aspects:

- *Findings associated with improving the execution plan or agenda of each CEADA module.* The execution plan of each CEADA module generally refers to activities that constitute the process layer of CEADA, the patterns of reasoning that constitute the pattern layer of CEADA, and the set of thinkLets that constitute the thinkLet layer of CEADA. In the analytical evaluation and other evaluation iterations (see sections 7.7 – 7.9) we discuss findings on CEADA's execution plan.

- *Findings associated with tools or media used in the thinkLet layer of each CEADA module or when implementing the execution plan.* From Brinkkemper's [19] definition of a tool, herein we treat a tool as *means* used to support the execution of CEADA modules. As discussed in sections 6.4.1 – 6.4.3, in this research the tools or media used in CEADA can be computer-based and/or non-computer-based (paper-based). In the analytical evaluation and other evaluation iterations (see sections 7.7 – 7.9) we discuss findings on the tools or media used in CEADA.

- *Findings associated with techniques used in the thinkLet layer of each CEADA module or when implementing the execution plan.* Brinkkemper [19] defines a technique as "*a procedure, possibly with a prescribed notation, to perform a development activity*" (page, 2). Herein we treat a technique as a course of action taken during the execution of CEADA modules. In the analytical evaluation and other evaluation iterations (see sections 7.7 – 7.9) we discuss findings on the techniques used in CEADA.

Section 7.3.3 discusses findings from the analytical evaluation iterations (with respect to the above three aspects), while sections 7.7 – 7.9 discuss findings from the experiment and field study evaluation iterations (with respect to the above three aspects).

7.3.3 Main Findings from Analytical Evaluation

The analytical evaluation phase resulted in various ideas that were used to refine CEADA (process) models (see table 7.2). Appendix B (tables B.2, B.3, B.5, and B.6) shows output from each walkthrough session. This section provides a summarized account of the main findings from the analytical evaluation phase (see items 1 – 6 in the last column of table 7.2) and the refinements made to CEADA (process) models with respect to these findings (see discussion below).

7.3.3.1 Findings on CEADA's Execution Plan

Following is a discussion of items 1 – 4 in the last column of table 7.2.

The need to further decompose or elaborate activities in the synergy of collaboration dependent tasks. This elaborates item 1 in the last column of table 7.2. Practitioners in the walkthrough discussions highlighted the need to elaborate or decompose some activities in the synergy of collaboration dependent tasks, or some activities in the process layer of version I of CEADA modules. This was done by incorporating aspects and (sub) activities that practitioners recommended during the walkthrough discussions. Activities that were suggested (by practitioners) to be amended to the collaborative intelligence session of the synergy of collaboration dependent tasks include the need to ensure that stakeholders collaboratively determine (a) the organization's problem scope, (b) business goals and strategic drivers, (c) external constraints from regulatory bodies, (d) purpose of

Table 7.2: *Main Findings from Analytical Evaluation Phase*

<table>
<tr><th>Analytical evaluation</th><th>Number of participant(s)</th><th>Aim of evaluation</th><th>Summary of main findings from the analytical evaluation</th></tr>
<tr><td>Session 1</td><td>1 enterprise architect</td><td rowspan="7">To validate concepts and activities in CEADA (process) models, and to elicit practice-driven insights into CEADA</td><td rowspan="7"><u>Findings on execution plan or agenda</u>
1. The need to further decompose or elaborate activities in the synergy of collaboration dependent tasks.
2. The need to ensure that stakeholders prepare their contributions or suggestions on the baseline situation and/or target situation prior to CEADA's group sessions.
3. Design alternatives can occur at two levels i.e. high level (business) solution alternatives and low level solution design alternatives.
4. The need to distinguish between causal and conditional relations in the theory on CDM in architecture creation.

<u>Findings on tools or media used in the thinkLet layer</u>
5. The use of Electronic Meeting Systems in CEADA's collaborative intelligence module.

<u>Findings on techniques used in the thinkLet layer</u>
6. The need to adopt the take-a-panel and share-a-panel techniques of Accelerated Solutions Environment (ASE).</td></tr>
<tr><td>Session 2</td><td>2 enterprise architects</td></tr>
<tr><td>Session 3</td><td>1 enterprise architect</td></tr>
<tr><td>Session 4</td><td>1 enterprise architect</td></tr>
<tr><td>Session 5</td><td>1 professional facilitator</td></tr>
<tr><td>Session 6</td><td>1 professional facilitator and architect</td></tr>
<tr><td>Expert review</td><td>1 collaboration engineer</td></tr>
</table>

architecture effort, (e) high level solution specifications, and (f) key stakeholders and decision makers in the architecture creation effort. Practitioners added that the rationale for amending these activities to the collaborative intelligence session is to gather information that is useful in the preparation and execution of activities in the collaborative design and collaborative choice sessions of CEADA modules. Sections 5.3 and 6.4 show how these insights from practitioners were incorporated into CEADA (process) models.

The need to ensure that stakeholders prepare their contributions or suggestions on the baseline and target situation prior to CEADA's collaborative sessions. This elaborates item 2 in the last column of table 7.2. Practitioners in the walkthrough discussions highlighted the need to ensure that stakeholders prepare the problem and solution aspects that they would like to share and discuss with others prior to the group sessions of CEADA's collaborative design module. This implied that in CEADA's collaborative intelligence module, there was need to determine a way of specifying to stakeholders the following two aspects. (a) The type of information that is to be shared and discussed in the collaborative design session, and (b) that their contributions (such as concerns and requirements) are to be evaluated and validated basing on the organization's internal constraints (such as the organization's policies, principles, high level solution specifications) and external constraints. Thus, practitioners highlighted that at the completion of CEADA's collaborative intelligence session, it would be useful if an informal meeting is organized among organizational stakeholders and architects. In the informal meeting the architectural team communicates its expectations from the stakeholders during the subsequent sessions of the architecture creation effort, and stakeholders also communicate their expectations from the architectural team during the architecture creation effort. Section 6.4.1 shows how these insights from practitioners were incorporated into CEADA (process) models.

Design alternatives can occur at two levels i.e. high level (business) solution alternatives and low level solution design alternatives. This elaborates item 3 in the last column of table 7.2. Practitioners in the walkthrough discussions highlighted that there was need to consider that during enterprise transformations, (design) alternatives can occur at two levels (i.e. high level business solution alternatives and low level solution design alternatives) and that it should be made explicit which of these alternatives are considered in CEADA. To distinguish these two types of alternatives, the following example was given by an enterprise architect in one of the walkthroughs. If an organization's strategy is to expand its operations to country X, then at least two types of design alternatives can be identified. These include:

(a) Business solution alternatives, i.e. alternative ways in which the organization can execute its strategy, e.g. by arranging a take-over of an already existing organization in country X, by arranging a merger with an already existing organization in country X, or completely starting a new branch in country X.

(b) Implementation (or low) level design alternatives, i.e. design alternatives for each of the three business solution alternatives (listed in (a) above) for executing the business strategy in country X. This implies that if the organization has chosen the business solution alternative of completely starting a new branch in country X, then an architect can devise alternative ways (i.e low level design alternatives) in which this can be implemented. Therefore, it was highlighted that CEADA should clearly indicate when it deals with business solution alternatives or implementation level design alternatives, and the type of stakeholders involved in the formulation and evaluation of each of these types of alternatives.

Translation of a business solution alternative into low level solution design alternatives. Practitioners also highlighted that during the formulation and evaluation of high level business solution alternatives, stakeholders' participation is very important. However, the translation of a given business solution alternative into low level solution design alternatives involves technical aspects that are difficult for most stakeholders to understand. Thus, enterprise architects (in sync with domain experts) perform this task. This implies that architects need to indicate (in a language that the stakeholders understand) the positive and negative implications of the low level solution design alternatives. These positive and negative implications are useful during the evaluation (and selection) of enterprise architecture design alternatives in CEADA's collaborative choice module. Section 6.4.3 shows how these insights from practitioners were incorporated into CEADA (process) models.

The need for architects to formulate draft ideas on possible business solution alternatives or solution scenarios prior to collaborative sessions with stakeholders. Practitioners further highlighted that it saves time if architects formulate some possible business solution alternatives or solution scenarios prior to organizing sessions in which some activities (such as "determine business solution alternatives", "sketch solution scenarios of the solution/desired or target situation") are executed. These possible formulations (by architects) give stakeholders a clue of the kind of information that is required during the identification of business solution alternatives and formulation of solution scenarios. This is one of the reasons why diagram templates were formulated in CEADA so that they can be (partially) populated with data (from e.g. interviews, organization documentation, or earlier group sessions) and then used as Single Negotiating Texts (SNTs) in CEADA sessions. This concept is discussed in section 6.2.3, and findings from its adoption in CEADA are discussed in section 7.9.

The need to decompose quality criteria for evaluating enterprise architecture design alternatives. Walkthrough discussions revealed that in CEADA's collaborative design module, in order to define explicit evaluation criteria for the enterprise architecture design alternatives, there was need to decompose evaluation criteria into *business, architectural, governance,* and *operational* criteria. In addition, different stakeholders are crucial in defining these criteria. For example, senior management stakeholders are crucial when defining business criteria and general governance criteria but may not be crucial when defining the other criteria categories, IT professionals and members of operational department are crucial when defining IT governance and operational criteria, and architects (and organizational IT domain experts) define the architectural criteria. Criteria categories can then be merged and their interrelationships defined, in order to enable stakeholders to evaluate and select alternatives in an informed way. Section 6.4.2 shows how these insights from practitioners were incorporated into CEADA's collaborative design module.

There is need to consider stakeholders' relevance of opinion during the validation of concerns and requirements. Practitioners also highlighted that during the validation of stakeholders' concerns and requirements and the evaluation of enterprise architecture design alternatives, there was need to consider the "relevance of opinion" of each stakeholder. This can be done by assigning weights to stakeholders during the voting activities. Moreover, from the walkthrough with a professional facilitator it was highlighted that in incidences where it is not possible to assign weights to scores of stakeholders, scores are filtered such that those that were assigned by stakeholders from a given unit or position in the organization are separated from other scores. This aspect of "relevance of opinion" has been incorporated in CEADA sessions by ensuring that in the collaborative intelligence session, key decision makers are selected. These key decision makers then serve as members of the architecture board of the organization and are responsible for all decision or choice activities in CEADA modules. Section 6.4.1 shows how these insights from practitioners were incorporated into CEADA's collaborative intelligence module.

The need to distinguish between causal and conditional relations in the theory on CDM in architecture creation. This elaborates item 4 in the last column of table 7.2. The expert review done by a collaboration engineer revealed that there was need to distinguish between causal and conditional relations in that theory. This is because the theory on CDM in architecture creation guided the formulation of the synergy of collaboration dependent tasks and the structuring of activities in CEADA modules. In version I of the theory on CDM in architecture creation, it was not explicit which relations were causal or conditional. Thus, it was vital to specify which relations in the theory were causal (i.e. where more of factor x leads to more of factor y), and which relations were conditional (i.e. where factor x is required for the success or attainment of factor y – incidences where without sufficient x there is no y). Section 4.2.2 shows these refinements in the theory. The expert review also highlighted mismatches in thinkLets that had been selected to support CEADA activities that required the 'convergence', 'organize', 'evaluate', and 'build consensus' patterns of reasoning. Thus, there was need to assign new thinkLets to support some activities in CEADA. These refinements were considered in CEADA versions II – V (see appendix B and section 6.4).

7.3.3.2 Findings on Tools/Media Used in CEADA's thinkLet Layer

Following is a discussion of item 5 in the last column of table 7.2.

The use of Electronic Meeting Systems (EMSs) in CEADA's collaborative intelligence module. In version I of the CEADA (process) models (see appendix B) it was indicated that activities in the collaborative intelligence session were to be executed using interviews. However, in the walkthrough discussions it was highlighted that these activities at times involve a number of stakeholders at strategic or management level and that it would be vital to execute collaborative intelligence activities in a group session or by using interviews and a group session, but not only by using interviews. This implied the need to determine facilitation guidance (in terms of patterns of reasoning and thinkLets) for supporting the execution of activities in the process layer of CEADA's collaborative intelligence module. Section 6.4.1 shows these refinements. Actually these refinements were useful because in the field study evaluation of CEADA (see section 7.6.1), CEADA's collaborative intelligence module (in enterprises 1, 2, and 4) was executed using interviews, but in enterprise 3 it was executed using both interviews and a group session. This is because in enterprise 3, many tactical level stakeholders had to be contacted during the execution of CEADA's collaborative intelligence module, and yet some of them only had time for interviews but did not have time for a group session.

7.3.3.3 Findings on Techniques Used in CEADA's thinkLet Layer

Following is a discussion of item 6 in the last column of table 7.2.

The need to adopt the take-a-panel and share-a-panel techniques of the Accelerated Solutions Environment (ASE). Walkthrough discussions revealed that some activities in CEADA modules could be executed by adopting the take-a-panel and share-a-panel techniques in the Accelerated Solutions Environment (ASE) approach. ASE is a generic approach that is used in practice to manage large group interventions at the start of a business transformation initiative, to create commitment, agreement, and approval by aligning critical stakeholders [51]. It is also used to undertake collaborative activities when developing artifacts using the Integrated Architecture Framework (IAF).

ASE addresses problems that are complex (in scope, market, politics) and involve a large number of key stakeholders (e.g. 30 – 110) who have divergent interests and views. ASE is more than traditional facilitated workshops, and involves intensive collaborative work that is done without using EMSs for a duration of three days. Output obtained from a three-day ASE event is used by architects to create a comprehensive high level solution (e.g. a high level architecture description), which is later translated into a low level detailed solution. Prior to the three-day event, several sponsor meetings are held with company executives and the architect team. The sponsor meetings aim at developing content on (a) the objectives of the three-day event, input information for the success of the event, expected output from the event, and (b) selecting stakeholder categories that are to be invited to the event.

The three-day event is managed by a team of skilled facilitators, who design their facilitation intervention strategies based on desired end results of the event. The event generally follows a *Scan-Focus-Act* cycle. Scan phase involves seeking a common language and understanding of aspects. This involves: (a) a plenary presentation for all invited stakeholders, (b) parallel sessions known as "take-a-panel", which are knowledge bursts of 15-20 minutes that enable stakeholders to work in small groups that focus on problem solving and learning new skills, (c) parallel small group presentations of aspects addressed and learned from the knowledge bursts (these are known as "share-a-panel"), and

(d) a plenary brainstorming session (led by a facilitator) on all aspects learned from this scan phase. Focus phase is assignment-driven and aims at finding solutions. Stakeholder groups handle domain specific aspects by answering questions and developing content for a given domain. Different scenarios are sought, stretched, evaluated, and validated to get the desired products and to gain stakeholders' commitment. Act phase involves building group alignment and implementation plans for defined aspects.

It was learned that ASE "take-a-panel" and "share-a-panel" techniques could be adopted to define execution support for some activities in CEADA modules. Section 6.2.3 discusses how these two techniques (along with the committee and subcommittee techniques of Raiffa et al. [107]) were adopted in CEADA. The effects of (not) adopting these techniques in CEADA are explained in sections 7.7 and 7.8.

Findings discussed above indicate that the analytical evaluation phase of CEADA also served as an effort of eliciting knowledge (from practitioners) that was used to refine version I of the CEADA (process) models. The refinements resulted in version II (see appendix B) which was further evaluated as discussed in section 7.4 below.

7.4 Experiment and Field Study Evaluation

Section 7.2 explains why evaluating CEADA (process) models in an experiment and two field studies was considered relevant in this research. However, prior to evaluating CEADA in both the experiment and field studies, there was need to first define the evaluation goals, performance indicators, and performance measures to be used. These are discussed in sections 7.4.1 – 7.4.3 below.

7.4.1 Evaluation Goals

In the experiment and field study evaluation of CEADA, the main goal in evaluating CEADA was to find out whether CEADA's process layer (i.e. its execution plan or agenda) and thinkLet layer (i.e. its tools and techniques) support the core parameters of achieving CDM in architecture creation. These parameters include effective collaboration, communication, negotiation, and shared understanding (as discussed in section 4.2.2). Thus, the goals in evaluating CEADA are mainly four, i.e.:

1. *Investigate CEADA's support for collaborative and interactive activity.* In this we examine whether CEADA possesses any of these specific aspects. (a) Whether CEADA provides a clear and flexible operational procedure and facilitation support for collaboration dependent tasks. (b) Whether using CEADA yields stakeholder satisfaction with its activities and the way they are executed. This concept of investigating stakeholders' satisfaction with activities executed in a meeting was adopted from [18] (see discussion in section 7.4.3). Performance indicators and performance measures associated with this goal are presented in sections 7.4.2 and 7.4.3.

2. *Investigate CEADA's support for communication.* In this we examine whether CEADA supports any of these specific aspects. (a) Whether stakeholders freely express their ideas. (b) Whether stakeholders and architects use a common and easily understandable vocabulary when communicating their contributions on the baseline and/or target aspects of the enterprise. Performance indicators and per-

formance measures associated with this goal are presented in sections 7.4.2 and 7.4.3.

3. *Investigate CEADA's support for creating a shared understanding.* In this we examine whether CEADA supports specific aspects such as creating a shared understanding of the organization's baseline and target aspects among stakeholders and enterprise architects. This specifically involves assessing mainly two specific aspects. First, we examine whether the use of CEADA increases stakeholders' understanding of problems faced, existing projects, other baseline aspects of the enterprise, business requirements, quality criteria, and solution scenarios that must be addressed in the target architecture of the enterprise. Second, we examine whether the use of CEADA yields stakeholder satisfaction with the results of the architecture effort. This concept of investigating stakeholders' satisfaction with results from a meeting was adopted from [18] (see discussion in section 7.4.3). Performance indicators and performance measures associated with this goal are presented in sections 7.4.2 and 7.4.3.

4. *Investigate CEADA's support for negotiation.* In this we examine whether CEADA supports any of these specific aspects. (a) Whether CEADA supports the creation of an understanding (among stakeholders) of reasons why all their validated concerns and requirements can not be satisfied. (b) Whether CEADA supports the creation of an understanding (among stakeholders) of reasons why some of their concerns and requirements are considered invalid by other stakeholders. Performance indicators and performance measures associated with this goal are presented in sections 7.4.2 and 7.4.3.

The specific aspects or sub-goals under each of the evaluation goals presented above were derived from the problems faced in enterprise architecture creation that were reported in literature (see section 2.2.1) and findings from the survey we conducted among architects (see section 2.3.3). Sections 7.4.2 and 7.4.3 discuss the performance indicators and performance measures associated with the above evaluation goals.

7.4.2 Performance Indicators

Basing on evaluation goals (1) – (4) in section 7.4.1 above, indicators (1) – (4) below were used to determine the performance of CEADA under each evaluation goal.

1. *Indicator of support for collaborative and interactive activity.* CEADA's support for providing a clear and flexible operational procedure and facilitation support for collaboration dependent tasks was determined by basing on two indicators.

    - First, the researchers' observations when using CEADA to support sessions of conversations on enterprise architecture creation. In this indicator, the provision of a clear and flexible operational support was determined by (a) the clarity of operational guidelines in CEADA's thinkLet layer, and (b) the presence of clearly defined situational parameters that guide the customization of CEADA modules to suit a given enterprise situation (an indication of flexibility). The operational guidelines are discussed in section 6.4 and appendix C, the situational parameters are discussed in section 6.6, and the researchers observations regarding CEADA's flexibility are discussed in sections 7.6.1 and 7.6.2.

- Second, the *level of consensus among stakeholders on their satisfaction with the activities* executed in CEADA sessions and/or how particular activities were executed. Details of how this level of consensus was measured are discussed in section 7.4.3.

2. *Indicator of support for communication.* CEADA's support for communication was determined by the *level of consensus among stakeholders on their satisfaction with the activities* executed in CEADA sessions and/or how particular activities were executed. Details of how this level of consensus was measured are discussed in section 7.4.3.

3. *Indicator of support for creating a shared understanding.* CEADA's support for creating a shared understanding of the organization's problem and solution aspects (among stakeholders) was determined by basing on two indicators.

   - First, the *level of consensus among stakeholders on the ranks or scores or weights assigned to the content derived* from CEADA sessions. Such content includes concerns, requirements, quality criteria, solution scenarios that the architecture must address, and enterprise architecture design alternatives. Details of how this level of consensus was measured are discussed in section 7.4.3.
   - Second, the *level of consensus among stakeholders on their satisfaction with the results* from CEADA sessions. Details of how this level of consensus was measured are discussed in section 7.4.3.

4. *Indicator of support for negotiation.* CEADA's support for negotiation among stakeholders was determined by basing on two indicators. First, the *level of consensus among stakeholders on their satisfaction with the activities* executed in CEADA sessions and/or on how particular activities were executed. Second, the *level of consensus among stakeholders on their satisfaction with results* from CEADA sessions. Details of how these two levels of consensus were measured are discussed in section 7.4.3.

From the above discussion, we identify three types of "*level of consensus among stakeholders*". (a) Level of consensus among stakeholders on their satisfaction with the activities executed in CEADA sessions and/or how particular activities were executed. (b) Level of consensus among stakeholders on their satisfaction with the results from CEADA sessions. (c) Level of consensus among stakeholders on the ranks or scores or weights assigned to the content derived from CEADA sessions. Section 7.4.3 discusses how these indicators were measured during the evaluation of CEADA.

7.4.3 Performance Measures and Data Collection

This section discusses how performance indicators in section 7.4.2 above were measured. Table 7.3 gives an overview of the evaluation goals (in section 7.4.1), their performance indicators (in section 7.4.2), and performance measures.

Table 7.3: *Evaluation Goals, Performance Indicators, and Measures*

<table>
<tr><th>#</th><th>Evaluation goal</th><th>Performance indicator</th><th>Performance measurement</th></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Investigate support for collaborative and interactive activity</td><td>Clarity and flexibility of operational guidelines in CEADA</td><td rowspan="3">Consider mean score and standard deviation of scores that stakeholders give in a session evaluation questionnaire</td></tr>
<tr><td rowspan="2">Level of consensus among stakeholders on their satisfaction with CEADA activities and their execution</td></tr>
<tr><td>2</td><td>Investigate support for communication</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">Investigate support for creating a shared understanding</td><td>Level of consensus among stakeholders on scores/weights they assign to content derived from CEADA sessions</td><td>Consider variance in scores that stakeholders assign to content derived in CEADA sessions</td></tr>
<tr><td>Level of consensus among stakeholders on their satisfaction with results from CEADA sessions</td><td rowspan="2">Consider mean score and standard deviation of scores that stakeholders give in a session evaluation questionnaire</td></tr>
<tr><td>4</td><td>Investigate support for negotiation</td><td>Level of consensus among stakeholders on their satisfaction with CEADA activities and their execution, and satisfaction with results from CEADA sessions</td></tr>
</table>

In the last column of table 7.3, we present two ways in which the level of consensus or degree of variation among stakeholders was measured. (a) By considering the variance in the ranks or weights or scores that stakeholders assigned to content derived in CEADA sessions. (b) By considering the mean score and standard deviation of scores on CEADA's performance that stakeholders gave in the questionnaires that they filled at the end of CEADA sessions. These two ways are discussed below.

Determining level of consensus based on variance in the weights or scores that stakeholders assigned to content derived in CEADA sessions. This involves interpreting the variability in the ranks or weights or scores that stakeholders assigned to aspects associated with the concerns, requirements, quality criteria, solution scenarios, and enterprise architecture design alternatives during CEADA sessions. Data on these scores was captured by the EMS that was used (i.e. Meetingworks^{TM} version 7.0), and the variability among scores was also computed by the EMS.

When interpreting the variability, a low value of variance indicates a high level of consensus on score(s) assigned to aspects under consideration. A high value of variance indicates a low level of consensus on score(s) assigned to aspects under consideration. For sessions in which an EMS was not used, the number of stakeholders who agreed on particular aspects were noted and then compared to the number of stakeholders who disagreed. However, this approach of measuring level of consensus was not sufficient in sessions that were not supported by an EMS. Thus, in sessions that were not supported by an EMS, the second way of measuring level of consensus was used (see discussion below). Table 7.3 shows the performance indicators and evaluation goals that were associated with this performance measure.

Determining level of consensus based on the mean score and standard deviation of scores that stakeholders gave in the questionnaires. This involves interpreting the mean score and standard deviation of scores that stakeholders gave in the questionnaires that they filled at the end of CEADA sessions. This approach of using a questionnaire to measure participants' satisfaction with a collaboration process and its results or outcomes was adopted from [18]. Besides, in a system development initiative there is no entirely unbiased way of determining some aspects (e.g. the level of awareness, level of agreement, level of commitment) among a group of actors, since the values of these are in the "*eyes of the beholders*" who are the actors themselves [104]. The actors in this case are the stakeholders and the researchers. The possible way through which stakeholders' judgements of CEADA's support for some evaluation goals could be captured was to use questionnaires. Researchers' judgements were based on their observations during the execution of CEADA activities.

Briggs et al. [18] developed a questionnaire instrument that can be used after a meeting (that is supported or not supported by groupware) to measure participants' satisfaction with the outcomes of the meeting and satisfaction with the processes executed in the meeting. These two concepts (i.e. satisfaction with meeting process and satisfaction with meeting outcome) were adopted to formulate a one-page questionnaire with both closed and open ended questions (see appendix B). The closed questions in the questionnaire were used to evaluate CEADA's performance using a 5 point Likert scale, with responses ranging from strongly disagree (point 1) to strongly agree (point 5). The open-ended questions in the questionnaire were used to prompt stakeholders to provide comments that elaborate or account for scores assigned in the closed questions. Questionnaires were filled by participants or stakeholders who attended the CEADA group session(s). To obtain the mean scores and standard deviation, responses on the closed questions in the questionnaires were processed using the Statistical Package for Social Sciences (SPSS). Results on the mean scores and standard deviation were then interpreted as follows:

1. The value of the mean score of CEADA under a given evaluation goal or sub goal is interpreted according to its location on the Likert scale. For example, a mean score of 4.30 under a given evaluation goal (or sub goal) indicates a good performance of CEADA under that evaluation goal, since the value 4.30 is between points 4 and 5 of the Likert scale. Real mean scores of CEADA under the evaluation goals and subgoals are presented in sections 7.7 – 7.9.

2. The value of the standard deviation associated with a given mean score shows the level of consensus among stakeholders on CEADA's performance under a given evaluation goal or sub goal. For example, a standard deviation of 0.57 on a mean score of 4.30 shows a high level of consensus among stakeholders on the performance of CEADA under the evaluation goal or sub goal where it had a mean score of 4.30. Real values on standard deviations associated with mean scores of CEADA under the evaluation goals and subgoals are presented in sections 7.7 – 7.9.

In addition to the mean score and standard deviation of scores that stakeholders assigned to the closed questions, other aspects were considered in assessing CEADA's performance. These aspects are the stakeholders' comments (or responses in the open-ended questions of the questionnaire) and the observations of the researchers during the execution of CEADA activities. These aspects were vital in assessing CEADA's performance under evaluation goal 1 (or the clarify and flexibility performance indicator) in row 2 of table 7.3.

The evaluation goals, performance indicators, and performance measures discussed in this section were applied during the evaluation of CEADA in an experiment and two field studies (that we conducted by following Action Research method). Sections 7.5 – 7.6 discuss the setup and execution of CEADA in the experiment and two field studies, while sections 7.7 – 7.9 discuss the results of CEADA's performance and insights that motivated its refinements.

7.5 Setup of Experiment

Experiment evaluation involves studying the usability qualities of a designed artifact in a controlled environment, or executing it with artificial data [49]. Table 7.1 in section 7.2 shows three types of experiments, from which we chose the laboratory demo method. With a laboratory demo, researchers use the artifact to address a rational problem in a fictitious setting [135]. Thus, in this research CEADA modules were executed to address a practical problem (that can be encountered by a National University) in a fictitious setting. Participants were 26 students who were undertaking the course unit of Information Architecture at Radboud University Nijmegen, The Netherlands.

Theme or problem used in the laboratory demo. A national University in The Netherlands has several departments but desired to expand its Education and Examination Institute (EEI) so as to exploit opportunities of becoming a networked European University. To gain insight into how to achieve this transformation, there was need to create an enterprise architecture vision for the EEI (see table 7.4). The architecture vision of the EEI was to clearly illustrate the required (business or operational) processes, data flows, application systems, and technology infrastructure. Table 7.4 summarizes key facts about this laboratory demo.

Table 7.4: *Summary of Key Aspects about the Laboratory Demo*

#	Attributes of the Laboratory Demo	
1	Background	There was need to address the growth needs of a national University by expanding it to become a networked European University. This was to be done by expanding the EEI of the national university such that it offers education services to all European countries. However, there was lack of insight into how to achieve this desired transformation.
2	Theme	Develop an enterprise architecture vision for the EEI of the desired networked European University, such that it may guide and inform the transformation from a national University to a networked European University.
3	Research activity	(a). CEADA modules were used to support enterprise architecture creation conversations among the researchers and the 26 participants in the demo. (b). The architecture method that was adopted to be used along with CEADA is the Architecture Development Method of The Open Group Architecture Framework (TOGAF ADM) – details are provided in chapter 8. (c). CEADA's performance was evaluated by participants using questionnaires. (d). CEADA's execution environment was observed by the researchers. (e). Lessons learned from the experiment were used to refine version II of CEADA so as to obtain version III. Version III was then evaluated in field study I.

At step 3(a) in table 7.4, the researchers customized CEADA modules in order to support the enterprise architecture creation conversation with the participants. There were mainly two participant roles, i.e. "enterprise architects" role and "stakeholders" role. Six students volunteered to participate in the enterprise architects' role, and 20 students volunteered to participate in the stakeholders' role. Participants who played the stakeholders' role were further divided into 6 subgroups, where each subgroup took up any of the following specific types of roles, i.e. director, educational coordinator, lecturer, administrative staff, IT technical staff, and students' representative.

Three group sessions were conducted following version II of CEADA modules (see appendix B, tables B.7 and B.8). The first session aimed at enabling participants to (a) acquire a shared understanding of the problem and solution aspects that are motivating the desired expansion of the EEI, (b) acquire a shared understanding of the purpose of creating an architecture vision in this expansion, and (c) define concerns that stakeholders would like the architecture vision to address. The second session aimed at enabling participants to define requirements, quality criteria, and solution scenarios that the architecture vision (of the EEI of the networked European University) must address. These requirements and scenarios were then used by the 6 participants who played the role of "enterprise architect" to create three possible design alternatives of the architecture vision of the EEI (of the networked European University). To achieve this, the 6 students who played the architect role paired up, used a modeling language that they were familiar with, and were given one week to design an architecture vision that addresses the solution aspects that were defined in the second session.

The third session aimed at enabling participants (who played the role of stakeholders) to collaboratively select the appropriate design alternative for the architecture vision of the EEI (of the networked European University). In the third session the 6 students (i.e. 3 pairs) who played the architect role presented their architecture vision models to the participants who played the stakeholders' role. After the presentation and discussion of the three architecture design alternatives, the participants who played the stakeholders' role evaluated the three design alternatives and selected the most appropriate. As shown in step 3(c) in table 7.4, participants filled in the CEADA evaluation questionnaire (which is discussed in section 7.4.2). Results of their evaluation and the researchers' observations are discussed in section 7.7. As shown in step 3(e) in table 7.4, lessons learned from the experiment (see discussion in section 7.7) were used to refine version II of CEADA modules and obtain version III. Version III was further evaluated as discussed in section 7.6.

7.6 Field Study by Action Research

Sections 1.8.1 and 7.2.3 discuss the reason why Action Research method was used in this research. According to Susman and Evered [122], action research involves five cyclic steps, i.e. diagnosing, action planning, action taking, evaluating, and specifying learning. According to Baskerville [7], these steps involve the following:

1. *Diagnosing,* identifying the root cause of the desire for change in an organization.
2. *Action planning,* determining possible actions to address the diagnosed problem.
3. *Action taking,* researchers collaborating with stakeholders (and practitioners) to implement the planned action so as to realize the desired changes in the organization.
4. *Evaluating,* researchers and stakeholders (and practitioners) determining whether the (practical and theoretical) effects of the action taken were achieved.
5. *Specifying learning,* using knowledge gained from the research intervention (irrespective of whether it was successful or not) to improve a theoretical framework or the organization's situation.

Sections 7.6.1 and 7.6.2 discuss how the above steps were adopted to customize CEADA in order to evaluate its modules in enterprise settings that were encountered in two field studies. Every organization setting is unique (in the sense that it has its own problems and business goals), therefore one cannot treat all organizations using the same medication [55]. This is the reason why we customized CEADA modules to form enterprise-specific CEADA processes, which supported enterprise architecture creation conversations that occurred in each enterprise. This helped to reveal situational factors that indicate the flexibility of CEADA (see section 6.6). This is elaborated in sections 7.6.1 – 7.6.2.

7.6.1 Action Research in Field Study I

Findings from the experiment (discussed in section 7.7) were used to refine version II of CEADA modules, and preparations were made to evaluate the resultant version III in a field study. This section discusses how the above steps of Action Research were applied to guide the evaluation of version III.

7.6.1.1 Diagnosis and Action Planning in Field Study I

Field study I was conducted in a period of six months (i.e. March – August 2010). In the search for enterprises in which CEADA could be evaluated, formal requisitions were sent to eleven enterprises in Uganda. These include (a) National Social Security Fund, (b) Micro Enterprise Development Network, (c) Uganda Police, (d) National Water and Sewerage Corporation, (e) Program for Accessible Health Communication and Education, (f) Uganda Communications Commission, (g) National Medical Stores, (h) Makerere University Guest House, (i) Nsambya Home Care, (j) Bugema University, and (k) Wakiso District Local Government Headquarters. The formal requisition to these enterprises comprised two items, i.e. an introductory letter and a brief one-page description of what the evaluation of CEADA in the enterprise would entail.

The selection criteria of enterprises for CEADA evaluation were:

1. *The architecture maturity level of the enterprise.* Enterprises that were considered suitable for CEADA evaluation were those at architecture maturity level 0 or 1 (reasons for this and definitions of architecture maturity levels are provided in sections 5.4 and 6.4). Thus, enterprises at architecture maturity levels 2 – 5 were not to be considered because their problem or desired situations would be outside the scope of this research.

2. *The type of response from officials contacted in the enterprise.* A positive response would be a signal to the researchers that the enterprise was interested in the research. A negative response obviously indicated lack of interest, which could have resulted from (a combination of) several factors.

After dialogs via emails and/or preliminary interviews (and/or presentations) with the officials we contacted in the eleven enterprises, seven enterprises were eliminated and only four were selected. Enterprises (a) – (d) were eliminated based on criterion (2) above. Then basing on criterion (1) above, enterprises (e) – (g) were not considered because their architecture maturity level was in the range of 2 – 5. Enterprises (h) – (k) were selected because their architecture maturity level was in the range 0 – 1 and they had provided a positive response. Table 7.5 summarizes the output of the diagnosis and action planning steps of Action Research in the four enterprises that were considered in field study I.

Table 7.5: *Action Research in Field Study I*

#	Action Research	Enterprise 1 – NHC	Enterprise 2 – MUKGH	Enterprise 3 – WDLG	Enterprise 4 – BU
1	Problem Diagnosis	The hectic and time consuming process of capturing patients' data, retrieving records, and compiling reports for donors funding the enterprise.	The desire to improve basic infrastructure and service management so as to improve the quality of services delivered to its clients.	The desire to achieve coordinated service delivery to residents in Wakiso district, and to effectively communicate with other district local governments in Uganda.	The desire to enhance the management of student records in the University.
2	Action Planning	Automate some operational processes in NHC so as to ensure effective and efficient data capturing, storage, sharing, retrieval and reporting.	Upgrade from a guest house to a 3-star hotel, provide quality services, diversify products and services, and increase customer base.	Automate some of the operational processes in each department, and foster IT-enabled information capturing, storage, and sharing across all departments in WDLG.	Develop a centralized information system for managing students' data and academic records across departments.
		Create an enterprise architecture vision to guide and inform the desired enterprise transformation			
3	Action Taking	(a). CEADA modules were customized to support the enterprise architecture creation conversation among the researchers and the stakeholders in each of these four enterprises.			
		(b). TOGAF ADM was the guiding architecture method, and BPMN was the modeling language.			
4	Evaluate	(a). CEADA's performance was evaluated by stakeholders using questionnaires.			
		(b). CEADA's execution environment was observed by the researchers.			
5	Specify learning	(a). Regarding the organization's situation: Detailed effects of the architecture vision that was created can be better determined after the architecture is implemented. However, this is beyond the scope of this research.			
		(b). Regarding CEADA: Lessons learned from evaluating CEADA in these enterprises were used to refine version III so as to obtain version IV, which was further evaluated in field study II.			

Enterprise 1 – Nsambya Home Care (NHC). This is a donor funded organization whose mission is to offer free services to HIV positive patients in Uganda. It has six units, i.e. medical, pharmacy, laboratory, psychosocial, finance and administration, and monitoring and evaluation. The medical unit is divided into HIV medical unit (that clinically monitors HIV positive patients) and Tuberculosis unit (a referral unit in Uganda that treats tuberculosis patients and finds out how many of them are actually HIV positive). The pharmacy unit dispenses prescribed drugs to patients and manages stock and orders of drugs. The laboratory unit monitors laboratory investigations for patients. The psychosocial unit manages relations between NHC and its patients, listens to patients' social and psychological issues, counsels, and sensitizes HIV patients. The finance and administration unit manages incomes and expenditures, and oversees pharmacy, laboratory, and psychosocial units. The monitoring and evaluation (or data) unit tracks the execution of all activities in NHC, collects reports from all units, compiles them and sends them to the right destinations. Data unit reports to the assistant coordinator of NHC, who oversees the implementation of planned activities. The main official that we always contacted in this enterprise was the data manager. Column 3 of table 7.5 shows the output of the diagnosis and action planning steps of Action Research in NHC.

Enterprise 2 – Makerere University Guest House (MUKGH). This offers hotel services to the Makerere University community, to guests visiting the University, and to the general public. At the time MUKGH was visited, it had mainly six units, i.e. management, accounts, housekeeping, front office, security, foods and beverage units. These units were to be expanded and new units were to be defined as a result of a business strategy that its management had devised. The business objectives in this strategy included improving the quality of MUKGH's products and services to competitive standards, improving the efficiency and effectiveness in the operations of the business, upgrading to a 3-star hotel (with 100 rooms) by 2016, automating its booking system, and implementing an internship program for the large student pool of Makerere University. The main official that we always contacted in this enterprise was the manager. Column 4 of table 7.5 shows the output of the diagnosis and action planning steps of Action Research in MUKGH.

Enterprise 3 – Wakiso District Local Government (WDLG). This is an administrative and service delivery organization that operates under the Ministry of Local Government in Uganda, and consists of eleven departments, each having a number of subsections [133]. The departments at WDLG include the chief administrative office and registry, finance, statutory bodies (which includes the council section and service commission section), production and marketing, health, education, works (which includes sections such as roads, buildings, and water), natural resources (which includes sections such as physical and urban planning, forestry, and wetlands), community based development, internal audit, and planning (which includes statistics section and IT services section). Each WDLG department is responsible for delivering welfare services, associated with its responsibilities, to residents of Wakiso district and other government ministries, departments, and agencies. The main official that we always contacted in this enterprise was the district planner. Column 5 of table 7.5 shows the output of the diagnosis and action planning steps of Action Research in WDLG.

Enterprise 4 – Bugema University (BU). At the time BU was visited, it had 6 units which can be classified into two, i.e. academic and administrative. The academic units include School of Social Sciences, School of Business, School of Education, and School of Graduate Studies. The administrative units include Registrar, and Accounting and Finance departments. BU was contacted at the time when it had a plan of establishing a centralized students' information management system. The problem owners in this case were all units handling students' information, i.e. the academic units (schools and their constituent departments) and the administrative units. In this establishment the goal was to first achieve effective IT-enabled transfer of students' marks from departments within schools to the registrar's department. Thereafter, the student's financial records would then be dealt with. The main official that we always contacted in this enterprise was the head of the Computer Science department. Column 6 of table 7.5 shows the output of the diagnosis and action planning steps of Action Research in BU.

Output from the diagnosis and action planning steps of Action Research in each of the above enterprises was used in the action taking step as discussed below.

7.6.1.2 Action Taking, Evaluate, Specify Learning in Field Study I

At action taking we customized version III of CEADA modules with respect to a number of factors (see section 6.6) to form an enterprise-specific CEADA process. For each enterprise that was considered in field study I, we based on the customization clues provided in section 6.6, to do the following:

- We eliminated some CEADA activities that were irrelevant to the planned action in each enterprise.
- We then determined the type and number of stakeholders to work with in each enterprise.

- Thereafter, we determined the appropriate type(s) of labour division in a given enterprise, e.g. specialization-driven division, governance-driven division, task-driven division, or interest-driven division (these are discussed in section 6.2.3). Invoking a given type of labour division enabled us to ensure that key stakeholders are actively involved and this helped us to interact with them in a flexible way.

- Basing on the invoked type(s) of labour division, we then determined the number of (exploratory and/or validation) interview sessions and (exploratory and/or validation) group sessions to be scheduled. We also specified whether the group sessions would be small size, medium size, or large size (these are discussed in section 7.6.1).

- We further determined the tools to be used in the sessions (i.e. whether an EMS will be used or whether non-computer based tools will be used), the techniques to be used, and resources.

Details on these customization clues in CEADA modules are discussed in section 6.6. Below we give an overview of enterprise-specific CEADA encounters that occurred at the action taking step of Action Research in field study I.

Action taking in enterprise 1 (NHC). At NHC 13 stakeholders were involved in the execution of CEADA activities. NHC deals with patients. This type of work implies busy work schedules of stakeholders at NHC. Thus, architecture creation conversations with these stakeholders were conducted by invoking a specialization-driven division (this concept is discussed in section 6.2.3). As a result, it was planned that in the NHC-customized-CEADA process we would (a) first conduct exploratory interview sessions with heads of units, (b) conduct exploratory and validation small group sessions involving members in a particular unit in NHC, and thereafter (c) conduct an exploratory and validation medium-sized group session that includes all key stakeholders in the planned action at NHC. Out of the six units in NHC, three units (i.e. pharmacy, psychosocial, and monitoring and evaluation units) were considered part of the problem scope.

Due to the busy work schedules of the key stakeholders, the execution of the NHC-customized-CEADA process did not exactly transpire as planned. Instead, architecture creation conversations with the key stakeholders were conducted using exploratory interview sessions, validation interview sessions, and two exploratory and validation small group sessions. The small group sessions involved 5 stakeholders, and were supported by an EMS tool. Attempts were made to have an exploratory and validation medium-sized group session that was to include all the 13 stakeholders who were involved. This was not conducted because the work schedules of key stakeholders made it difficult to have all stakeholders in one session or meeting. Stakeholders who participated in the NHC-customized-CEADA process included 6 females and 7 males in the age bracket of 25 years – 42 years.

Action taking in enterprise 2 (MUKGH). At MUKGH one stakeholder (the manager) was involved in the execution of CEADA activities, therefore only interview sessions were conducted. MUKGH offers hotel services. Due to the nature of operations in this enterprise and the nature of the problem and desired situation (as shown in table 7.5), only the managerial level stakeholders were to be involved. Conducting small group sessions with key stakeholders at MUKGH was not possible. This because the time slot that MUKGH allocated for CEADA sessions was only on Saturday afternoons and other stakeholders at managerial level were not able to attend CEADA sessions on weekends. This stakeholder who participated in the MUKGH-customized-CEADA process was one male in the age bracket of 50 – 55 years.

Action taking in enterprise 3 (WDLG). At WDLG 20 stakeholders were involved in the execution of CEADA activities. WDLG has several departments and many stakeholders (with various specialities and varying field work schedules and office work schedules). Thus, architecture creation conversations with these stakeholders were conducted by invoking a specialization-driven division. As a result, it was planned in the WDLG-customized-CEADA process we would (a) first conduct exploratory interview sessions with heads of departments or heads of sections in a given department, (b) conduct exploratory and validation small group sessions involving members in a particular section or department at WDLG, and (c) conduct an exploratory and validation large group session that includes all key stakeholders in the planned action at WDLG. All the eleven departments in WDLG were considered part of the problem scope.

However, due to the busy work schedules of the key stakeholders (like in enterprises 1 and 2) the execution of the WDLG-customized-CEADA process did not exactly transpire as planned. Instead, the researchers conducted several exploratory interview sessions, validation interview sessions, and one exploratory and validation small group session (involving 7 stakeholders). These sessions were conducted with representatives from seven departments. Sessions with representatives of the other four departments could not be conducted due to their field work schedules. Therefore, concerns and requirements of these four departments (that the researchers did not interact with) were voiced by stakeholders in the planning department. Also, in the small group session at WDLG, no EMS tool was used. This happened due to equipment failure on the side of the researchers and the lack of a Local Area Network at WDLG. Attempts were made to have an exploratory and validation large group session that was to include all the 20 stakeholders who were involved. This was not conducted because the various WDLG programmes and field work schedules made it difficult to have all stakeholders in one session or meeting. Stakeholders who participated in the WDLG-customized-CEADA process included 5 females and 15 males in the age bracket of 25 years – 55 years.

Action taking in enterprise 4 (BU). At BU 8 stakeholders were involved in the execution of CEADA activities. Like in enterprises 1 and 3, architecture creation conversations with these stakeholders were conducted by invoking a specialization-driven division. As a result, it was planned that in the BU-customized-CEADA process we would (a) first conduct exploratory interview sessions with deans of the four schools and the registrar, and (b) conduct exploratory and validation medium-sized or large group session(s) involving lecturers in the four schools and members in the registrar's department. Out of the six units of BU, five units were considered part of the problem scope (i.e. the four schools and the registrar's department).

The execution of the BU-customized-CEADA process did not exactly transpire as planned (like in enterprises 1 – 3 above). This is because at the time the researchers visited BU, it was in a recess period. Thus, several key stakeholders were often out of office supervising their students who were undertaking field work and industrial training or internship projects. Also, other key stakeholders were on holiday. Therefore, the researchers conducted exploratory and validation interview sessions with the deans of the four schools. In the two schools where the deans were absent, the heads of departments or lecturers within that school were contacted. Attempts were made to have a medium-sized or large group session that was to include all the 8 stakeholders and other stakeholders or lecturers who had not participated in the interview sessions. This was not conducted because the student internship supervision programme and holiday programme at BU made it difficult to have all stakeholders in one session or meeting. Stakeholders who participated in the BU-customized-CEADA process included 3 females and 5 males in the age bracket of 35 years – 55 years.

Evaluate and specify learning in enterprises 1 – 4. In enterprises 1 – 4 the customized enterprise-specific processes could not be executed as planned due to the busy schedules of stakeholders. This is why we resorted to classifying CEADA activities in each module into those that are exploratory-like and those that are validation-like (see section 6.6). Thereafter, we scheduled to supplementary use interview sessions and group sessions to execute these activities. Although all CEADA activities were not executed in each of the four enterprises, each CEADA activity was executed in at least one of the enterprise-specific CEADA processes. Thus, CEADA is generic or flexible in the sense that it includes a range of situational activities for executing collaboration dependent tasks.

Also, in all the four enterprises, the resultant models were only architecture vision models and not detailed domain-specific models. Examples of these models are provided in section 7.8 or in appendix D. Section 7.8 discusses the evaluation results of CEADA's performance in field study I and specific lessons learned from field study I.

7.6.1.3 Enterprise 5 – The Open University, The Netherlands

This was conducted as a joint project at The Open University (The Netherlands) in the period of November 2010 – January 2011. In this joint project some activities in the collaborative intelligence module and the collaborative design module of CEADA were considered in preparing the agenda of two group sessions that were conducted at the Open University. These two sessions involved defining problems and requirements that were associated with the desired transformation in the Open University. In this joint project we participated in only the preparation of the agenda of the group sessions and the observation of the sessions. Other details of this joint project are documented in [36].

7.6.2 Action Research in Field Study II

Findings from field study I (see discussion in section 7.8) implied the need to refine version III of CEADA and then further evaluate the design of the resultant version IV in another field study. This section discusses how the steps of Action Research (discussed in section 7.6.2) were applied to guide the evaluation of version IV in field study II.

7.6.2.1 Diagnosis and Action Planning in Field Study II

Field study II was conducted in a period of six months (i.e. April – September 2011). The search for enterprises in which CEADA could be evaluated in field study II started with sending formal requisitions to eight enterprises in Uganda. These include (a) National Forum of People Living with HIV/AIDS Network in Uganda, (b) Uganda Clays Kajansi, (c) Multi-Bulk Clearing and Forwarding, (d) Ministry of Information and Communications Technology, (e) Radiotherapy Department at Mulago Hospital, (f) Joint Clinical Research Center, (g) Central Public Health Laboratories, (h) Ministry of Local Government. Like in field study I, the formal requisition to these enterprises comprised an introductory letter and a brief one-page description of what CEADA research in the enterprise would entail.

The selection criteria of enterprises for CEADA evaluation are defined in section 7.6.1. After dialogs via emails and/or preliminary interviews (and/or presentations) with the officials we contacted in these enterprises, four enterprises were eliminated and only four were selected. Enterprise (a) was not considered because it was not possible to conduct group sessions therein. Basing on the architecture maturity level criterion in section 7.6.1, enterprise (b) was not considered because its architecture maturity level was 2. Enterprise (c) was not considered because its problem situation was beyond the scope of problems addressed by CEADA. Enterprise (d) was considered but the research therein did not exceed the collaborative intelligence session of CEADA. This was due to a number of factors that can not be explained here. As a result, the evaluation of CEADA in field study II involved four enterprises, whose architecture maturity level was 0 – 1. Table 7.6 summarizes the output of the diagnosis and action planning steps of Action Research in field study II.

Table 7.6: *Action Research in Field Study II*

#	Action Research	Enterprise 6 – RDM	Enterprise 7 – JCRC	Enterprise 8 – CPHL	Enterprise 9 – MOLG
1	Problem Diagnosis	The desire to enhance service delivery in the department with IT capabilities	The desire to address the challenges faced in the laboratory units and other associated units in the enterprise, by implementing a Laboratory Information Management System (LIMS)	The desire to achieve coordinated service delivery, effective data management, and effective communication with all public health laboratory facilities in Uganda by using IT capabilities	The need to get insight into reasons why LOGICS application is not fulfilling its intended purpose of supporting standardized electronic monitoring
2	Action Planning	Determine ways in which IT capabilities can enhance processes of cancer treatment and patient care	Understand the existent way of operation and details of challenges faced in the laboratory units and other associated units, and customize an open-source LIMS to support tasks in these units	Understand the existent way of operation and details of challenges faced, and determine ways of addressing those challenges and opportunities of using IT capabilities to improve service delivery country-wide	To determine ways in which the LOGICS application can be improved to support standardized electronic monitoring system, and enable evidence based planning for all districts
		Create an enterprise architecture vision to guide and inform the desired transformation in the enterprise			
3	Action Taking	a). CEADA modules were customized to support the enterprise architecture creation conversation among researchers and stakeholders in each of these four enterprises.			
		b). TOGAF ADM was the guiding architecture method, and BPMN was the modeling language.			
4	Evaluate	a). CEADA's performance was evaluated by stakeholders using questionnaires.			
		b). CEADA's execution environment was observed by the researchers.			
5	Specify learning	a). Regarding the organization's situation: Detailed effects of the architecture vision that was created can be better determined after the architecture is implemented, but that is beyond the scope of this research.			
		b). Regarding CEADA: Lessons learned from evaluating CEADA in these enterprises were used to refine version IV so as to obtain version V, which is presented in chapters 4 – 6.			

Enterprise 6 – Radiotherapy Department at Mulago (RDM). RDM is a department in Mulago Hospital that is concerned with the treatment of cancer, training of radiography students of the Makerere University College of Health Sciences, undertaking research on cancer treatment, and sensitizing the public about cancer issues. The main official that we contacted in this enterprise was the head of the radiotherapy department. Table 7.6 shows the output of the diagnosis and action planning steps of Action Research in RDM.

Enterprise 7 – Joint Clinical Research Center (JCRC). This is a national reference laboratory that offers specialized health laboratory services in Uganda. The research at JCRC was confined to cover units that deal with laboratory service delivery, i.e. the patient care reception, cashier, phlebotomy, records and outside samples, and the seven laboratory units (i.e. chemistry, immunology, virology, microbiology, haematology, sample separation and storage, and resistance testing). The main official that we always contacted in this enterprise was the data manager and medical statistician at JCRC. Table 7.6 shows the output of the diagnosis and action planning steps of Action Research in JCRC.

Enterprise 8 – Central Public Health Laboratories (CPHL). CPHL is affiliated to Ministry of Health. CPHL supervises all public health laboratories in Uganda, and it is the technical focal point mandated to advise the Ministry of Health on all matters related to health laboratory services. At the time CPHL was visited it comprised two distinct units, i.e. reference laboratory services unit and the laboratory technical support services unit. CPHL was planning a transformation that is to result into a major restructuring for the purpose of improved service delivery with respect to public health laboratory services in Uganda. The restructuring will also cause it to change its name to National Health Laboratory Services (NHLS) to reflect the supervisory role it has regarding laboratory facilities nation-wide. The main official that we always contacted in this enterprise was the project administrator at CPHL. Table 7.6 shows the output of the diagnosis and action planning steps of Action Research in CPHL.

Enterprise 9 – Ministry of Local Government (MOLG). This coordinates, supports, and advocates for local governments for sustainable, efficient, and effective service delivery in the decentralized system of governance [75]. The policy and planning division and the monitoring and evaluation division of MOLG rolled out a stand-alone application system known as Local Government Information Communication System (LOGICS). LOGICS was rolled out in all districts in Uganda in 1995 to help these two divisions to move from a stage of monitoring local governments using non-standardized paper system, to a standardized electronic monitoring system. Also, LOGICS was rolled out to enable evidence based planning for all districts in Uganda. However, LOGICS was not serving these purposes and MOLG officials in the policy and planning division found it relevant to undertake an investigation into this matter. The main official that we always contacted in this enterprise was the IT Manager. Table 7.6 shows the output of the diagnosis and action planning steps of Action Research in MOLG.

Output from the diagnosis and action planning steps of Action Research in enterprises 6 – 9 above was used in the action taking step as discussed below.

7.6.2.2 Action Taking, Evaluate, Specify Learning in Field Study II

Like in field study I, at action taking we customized version IV of CEADA modules to form an enterprise-specific CEADA process. Like in field study I (see section 7.6.1), we based on the customization clues provided in section 6.6 to customize CEADA to support architecture creation conversations in each enterprise that was considered in field study II. The common feature in the four enterprise-specific processes that were used in field study II is that it was not possible to use an EMS tool in all the group sessions that were conducted. This is because the continuous and uncertain outbreak of strikes in Kampala city between the period of April – September 2011 (when field study II was conducted) made it risky to travel with University equipment that was required to conduct EMS-supported CEADA sessions in these enterprises. Thus, all CEADA sessions in enterprises 6 – 9 were conducted without an EMS tool, but with non-computer based tools discussed in section 6.4.

Action taking in enterprise 6 (RDM). At RDM 14 stakeholders were involved in the execution of CEADA activities. The RDM-customized-CEADA process was planned after the first preliminary interview session. It was planned that we would (a) first conduct an exploratory interview session with the head of department, and (b) conduct an exploratory and validation medium-sized group session that includes all key stakeholders at RDM. The execution of the RDM-customized-CEADA process transpired as planned, i.e. an exploratory interview session was successfully conducted and an exploratory and validation medium-sized group session involving 14 stakeholders was successfully conducted. Output from the exploratory interview sessions was used to populate CEADA diagram templates that were relevant to the situation at RDM. The resultant (partially) populated diagram templates were discussed in the exploratory and validation group session. Due to the busy schedule of the department (given its various cancer patients), only one group session was conducted, in which activities that constituted the RDM-customized-CEADA process were executed. In this enterprise, the (partially) populated diagram templates were used as SNTs in CEADA sessions (this is discussed in section 6.2.3). Stakeholders who participated in the RDM-customized-CEADA process included 6 females and 8 males in the age bracket of 35 years – 58 years.

Action taking in enterprise 7 (JCRC). At JCRC 21 stakeholders were involved in the execution of CEADA activities. The nature of work and busy work schedules of stakeholders at JCRC implied the need to invoke a specialization-driven division so as to execute CEADA activities. Thus, in the JCRC-customized-CEADA process we did the following. (a) We conducted exploratory interview sessions and exploratory small group sessions with heads of units or members of units that were selected to be contacted regarding the problem situation and desired situation. Output from the exploratory interview sessions was used to populate CEADA's diagram templates that were relevant to the situation at JCRC. (b) The resultant (partially) populated diagram templates were validated in the exploratory and validation interview sessions. (c) The fully populated and validated diagram templates were then discussed in an exploratory and validation medium-sized group session that involved 10 stakeholders. Stakeholders who participated in the JCRC-customized-CEADA process included 7 females and 14 males in the age bracket of 27 years – 58 years.

Action taking in enterprise 8 (CPHL). At CPHL 15 stakeholders were involved in the execution of CEADA activities. The CPHL-customized-CEADA process was somewhat similar to the JCRC-customized-CEADA process. At CPHL a governance-driven division, specialization-driven division, and task-driven division were invoked during the execution of CEADA activities. These techniques are discussed in section 6.2.3. Thus, in the CPHL-customized-CEADA process we did the following. (a) We conducted exploratory interview sessions with particular selected officials. Output from the exploratory interview sessions was used to populate CEADA diagram templates that were relevant to the situation at CPHL. (b) We then conducted an exploratory and validation medium-sized group session (involving 13 stakeholders), in which the (partially) populated diagram templates were discussed. (c) Thereafter, we conducted exploratory and validation interview sessions, in which aspects in the diagram templates were further discussed and validated. (d) We then conducted an exploratory and validation small group session (involving 6 stakeholders) in which models were further discussed and validated. Stakeholders who participated in the CPHL-customized-CEADA process included 5 females and 10 males in the age bracket of 35 years – 58 years.

Action taking in enterprise 9 (MOLG). At MOLG 13 stakeholders were involved in the execution of CEADA activities. A specialization-driven division and a task-driven division were invoked during the execution of CEADA activities. Thus, in the MOLG-customized-CEADA process the researchers did the following. (a) We first conducted an exploratory small group session (involving 5 stakeholders) in which CEADA research was discussed so that officials would see the benefits of participating in the research. (b) Thereafter, we conducted exploratory interview sessions with particular officials to define and scope the problem and desired situations regarding LOGICS at MOLG. (c) We then conducted exploratory interview sessions with particular officials that were selected to be involved in aspects associated with LOGICS at MOLG, WDLG, and Luwero district Local Government. Output from the exploratory interview sessions was used to populate CEADA diagram templates that were relevant to the situation at MOLG. (d) We then conducted an exploratory and validation small group session (involving 5 stakeholders), in which the populated diagram templates were discussed. Attempts were made to have a group session in which all key stakeholders of LOGICS at MOLG would be involved. This was not conducted because the various MOLG programmes and field work schedules made it difficult to have all key stakeholders in one session or meeting. Stakeholders who participated in the MOLG-customized-CEADA process included 4 females and 9 males in the age bracket of 30 years – 58 years.

Evaluate and specify learning in enterprises 6 – 9. In field study II we did not get an opportunity of using an EMS tool along with CEADA diagram templates. Thus data was gathered using diagram templates. Thereafter, the (partially) filled diagram templates were used as SNTs to trigger discussions and elicit more information on problem and solution aspects from stakeholders in CEADA sessions. Examples of the populated diagram templates are provided in section 7.9 and appendix D. The resultant filled diagram templates (which can be perceived as conceptual models of the problem and solution aspects) were then used as structured sources of information for formulating architecture models using BPMN (see examples in sections 7.8 and 7.9 and appendix D).

Sections 7.7 – 7.9 discuss evaluation results of CEADA's performance and findings or lessons learned from the experiment evaluation, field study I evaluation, and field study II evaluation of CEADA.

7.7 Main Findings From the Experiment

This section discusses CEADA's performance results and lessons learned from the experiment evaluation. The setup of the experiment was discussed in section 7.5. Table 7.7 shows participants' evaluation of CEADA's performance in the experiment and table 7.8 summarizes the main lessons learned from the experiment. The following discussion elaborate aspects presented in tables 7.7 and 7.8.

The performance results in table 7.7 were obtained by analyzing data from the questionnaires that were filled by the participants after the experiment (details on this are discussed in section 7.4.3). The shaded cells in table 7.7 show evaluation sub goals that are associated with two performance indicators that were inspired by [18] (as discussed in section 7.4.3). These indicators include (a) level of consensus among participants on their satisfaction with CEADA activities and their execution, and (b) level of consensus among participants on their satisfaction with results from CEADA sessions. As discussed in section 7.4.3, the performance measures for these two indicators are mean and standard

Table 7.7: *Performance Evaluation of CEADA in the Experiment*

#	Evaluation goals	Evaluation sub goals	Questionnaire-based performance measure	
			Mean score	St. dev.
1	Investigate support for collaborative and interactive activity	Stakeholders were satisfied with activities executed in CEADA sessions and/or how they were executed	2.00	0.88
2	Investigate support for communication	CEADA sessions helped stakeholders to freely express their views	3.53	1.22
3	Investigate support for creating a shared understanding	CEADA sessions helped to increase stakeholders' understanding of concerns and requirements that the architecture must address	3.89	0.94
		Stakeholders were satisfied with the results from CEADA sessions	2.05	0.91
4	Investigate support for negotiation	CEADA sessions helped stakeholders to understand why some of their views/contributions were not voted by others	3.11	1.05
5 point Likert scale: (1) – strongly disagree, (3) neutral, and (5) – strongly agree				

deviation of scores that stakeholders assign to questions provided in a session evaluation questionnaire.

Table 7.7 shows that the mean score of CEADA's performance under participants' satisfaction with CEADA activities is 2.00 and the mean score of CEADA's performance under participants' satisfaction with results from CEADA sessions is 2.05. Since these mean scores lie between points 1 and 3 of the Linkert scale (see last row of table 7.7), it can be interpreted that CEADA's performance under these two evaluation sub goals was low. The values of standard deviation associated with these means are presented in the last column of table 7.7, and they indicate that participants had a moderate level of consensus on the low mean score of CEADA under these evaluation sub goals.

In addition, we considered mean scores of CEADA's performance under other specific evaluation sub goals (see the un-shaded cells in column 3 of table 7.7). Looking at CEADA's performance under these specific aspects helped us to gain insight into particular issues that had to be addressed in CEADA so as to improve its performance under particular evaluation goals. Lessons learned from this performance are summarized as items 1 – 4 in the last column of table 7.8). The lessons listed in table 7.8 are classified into three key attributes of CEADA, i.e. its execution plan or agenda, the tools it uses, and the techniques it uses during the sessions (this classification is discussed in section 7.3.2).

Following is a discussion of lessons learned from the experiment (which are summarized as items 1 – 4 in the last column of table 7.8).

7.7.1 Findings on CEADA's Execution Plan or Agenda

Following is a discussion of items 1 – 2 in the last column of table 7.8.

The need to allocate more time to CEADA's collaborative design module. This elaborates item 1 in the last column of table 7.8. The experiment revealed that there was need to allocate more time in CEADA sessions for activities such as (a) negotiating on the validity of participants' concerns and requirements, (b) formulating and evaluating

Table 7.8: *Main Findings from the Experiment*

Participants involved	Aim of evaluation	Summary of main findings from the experiment evaluation
26 students	To evaluate the design of the CEADA process	**Findings on execution plan or agenda** 1. The need to allocate more time to CEADA's collaborative design module. 2. The core phenomena in CEADA are effective communication, negotiation, and shared understanding among enterprise architects and stakeholders. **Findings on tools or media used in the thinkLet layer** 3. The need to enhance the execution of convergence tasks. **Findings on techniques used in the thinkLet layer** 4. The need to adopt techniques for dividing group labour to enable stakeholders to synergically define baseline and target aspects.

solution scenarios that the architecture must address, and (c) evaluating possible design alternatives for the enterprise architecture. This is because in the experiment, participants were allowed to submit as many concerns and requirements (and ideas of solution scenarios) as they had, but all their concerns and requirements could not be evaluated and validated during a group session which had been scheduled to last for two hours.

However, stakeholders are often not willing (due to their busy schedules) to sit in a group session for more than one or two hours. Thus, adopting techniques for group labour division (e.g. the take-a-panel and share-a-panel techniques) can enable the supplementary use of interviews and group sessions (see sections 7.6.1, 7.6.2, 7.8, and 7.9). In that case, some activities can be executed in either interview sessions or group sessions. In field study I it was noted that the supplementary use of interview sessions and group sessions revealed that two hours of a group session were sufficient (see discussion in section 7.8).

The core phenomena in CEADA are effective collaboration, communication, negotiation, and shared understanding among enterprise architects and stakeholders. This elaborates item 2 in the last column of table 7.8. A reflection on the experiment results and their implications points to a core notion in CEADA that was drawn from the theory on CDM in architecture creation (in section 4.2.2). This notion states that "the core phenomena for enabling *collaborative evaluation of enterprise architecture design alternatives* are effective collaboration, communication, negotiation, and shared understanding among enterprise architects and stakeholders". This notion can be explained using the following two insights from the experiment (and the findings from field studies I and II in sections 7.8 – 7.9).

First, all participants worked in one group during the group sessions in the experiment. As a result, there was insufficient individual-to-individual interaction or communication among participants who played the same role in the experiment. This resulted in the failure to minimize heterogeneity within a subgroup of participants who played the same role (e.g. "lecturers" subgroup), let alone the heterogeneity between subgroups of participants playing different roles (e.g. "lecturers" subgroup and "administrators" subgroup or other subgroups listed in section 7.5). This heterogeneity was indicated by the fact that participants who played the same role (e.g. "lecturer") would assign high priorities to concerns and requirements that pertain to their role, and then assign low priorities to concerns and requirements from participants playing the same role and/or other roles (e.g. "administrative staff"). As a result, during the evaluation of requirements and architecture design alternatives, results indicated that there was a low level of consensus on the requirements and the design alternative that was chosen.

Moreover, during the selection of architecture design alternatives in the collaborative choice session of CEADA, there was a need for participants who volunteered as "architects" to first explain the architecture vision to each subgroup of participants. In that case each subgroup gains a shared understanding of how its concerns are addressed in the architecture view that pertains to its concerns. In notion E of the theory on CDM in architecture creation (see section 4.2.2) it is argued that effective communication (directly and indirectly) helps to create a shared understanding among stakeholders and architects. Therefore, in the experiment shared understanding among participants was not achieved because there was ineffective communication. This ineffective communication was partially caused by not adopting techniques for dividing group labour during CEADA sessions.

Second, participants working in one group during the collaborative sessions hindered fruitful negotiation (this is explained in section 7.7.3). Therefore, poor communication (explained above) and insufficient negotiations explain why a shared understanding (of the problem and solution aspects) among participants in the experiment could not be achieved. These issues pointed to the need for finding ways of enhancing communication, collaboration, and negotiations. When measures were taken to enhance these aspects, the performance of CEADA improved (see sections 7.8 – 7.9). Thus, the low performance of CEADA in the experiment and the improved performance of the refined version of CEADA in field studies I and II, help to explain the core notion of the theory on CDM in architecture creation.

7.7.2 Findings on Tools/Media Used in the ThinkLet Layer

Following is a discussion of item 3 in the last column of table 7.8.

The need to enhance the execution of convergence tasks. In version II of CEADA there was need to select other thinkLets for activities that were supported by FastFocus in the collaborative intelligence module (see appendix B, table B.7). This is because during the execution of activities that had been assigned FastFocus, most participants were passively involved and only a few were actively involved in making contributions towards a clean list of concerns that had been gathered. Besides, Davis et al. [26] report that using FastFocus requires both the facilitator and the participants to be enthusiastic, and that it is a very difficult thinkLet to use if the facilitator is not experienced with handling group meetings. These issues pointed to the need for either selecting other thinkLets, or adopting additional tools or techniques that could be used along with FastFocus thinkLet (in order to ensure active participation of participants).

7.7.3 Findings on Techniques Used in the ThinkLet Layer

Following is a discussion of item 4 in the last column of table 7.8.

The need to adopt techniques for dividing group labour to enable stakeholders to synergically define baseline and target aspects. The experiment was conducted without adopting any technique for dividing group labour in CEADA sessions. Examples of such techniques include committees and subcommittees by Raiffa et al. [107] (discussed in section 6.2.3.3), the take-a-panel and share-a-panel techniques of ASE [51] (discussed in section 7.3.3). In the experiment, none of these techniques was adopted. This is because the number of participants who had volunteered to act as stakeholders in the experiment were few in number (i.e. 20) compared to the large numbers of stakeholders (i.e. 30 – 100) that attend ASE sessions where take-a-panel and share-a-panel techniques are used. Thus, in all group sessions conducted in the experiment, all participants worked in one group to accomplish activities in each CEADA session. This hindered participants from properly negotiating on the requirements for the enterprise architecture, and on the design alternatives of the enterprise architecture vision. As a result, the level of consensus (among participants) on these aspects was seriously impaired (as indicated in table 7.7). Moreover, some participants did not understand how their concerns and requirements were catered for in the three architecture design alternatives that had been designed (as indicated in table 7.7).

On reflecting upon how these issues could have been avoided, it was noted that when executing some activities in the group sessions, participants would have been divided to work in small groups that could be formed based on their specialization roles. For example, participants who had volunteered to play the role of "lecturer" (discussed in section 7.5) would have closely worked in a subgroup labeled "lecturers" that would collaboratively define and negotiate the concerns and requirements of lecturers. Also, participants who had volunteered to play the role of "administrative staff" would have closely worked in a subgroup labeled "administrators" that would collaboratively define and negotiate the concerns and requirements of administrators.

In order to implement this, there was need to specify activities in CEADA that required use of techniques for dividing group labour. The techniques that were first adopted were take-a-panel and share-a-panel techniques of ASE (discussed in section 7.3.3). There was also need to determine how these two techniques were to be used along with the thinkLets that had been selected to support activities in CEADA sessions. Moreover, adopting take-a-panel and share-a-panel in the collaborative choice module of CEADA implied the need to decompose activities in that module. Doing this would (hopefully) enable stakeholders to understand why all their concerns cannot be addressed and how their particular concerns and requirements are addressed in the possible enterprise architecture design alternatives. This would also (hopefully) enable stakeholders to rationally evaluate design alternatives (this is discussed in item (2) of table 7.8 in section 7.7.1 above). However, in field study I evaluation, some boundaries of using the take-a-panel and share-a-panel techniques in CEADA were identified (see discussion in section 7.8).

The above findings from the experiment were used to refine version II of CEADA, so as to obtain version III. Version III was then evaluated in field study I (as discussed in section 7.6.1).

7.8 Main Findings From Field Study I

The setup of field study I and the use of CEADA therein is discussed in section 7.6.1. This section discusses CEADA's performance in field study I and lessons learned from field study I. Table 7.9 shows stakeholders' evaluation of CEADA's performance and table 7.10 summarizes the main lessons learned from field study I. The following discussion elaborate aspects presented in tables 7.9 and 7.10.

Table 7.9: *Performance of CEADA in the Experiment and Field Study I*

#	Evaluation goals	Evaluation sub goals	Type of Evaluation	Questionnaire-based performance measure	
				Mean score	St. dev.
1	Investigate support for collaborative and interactive activity	Stakeholders were satisfied with activities executed in CEADA sessions and/or how they were executed	Experiment	2.00	0.88
			Enterprise 1	4.20	0.42
			Enterprise 3	3.71	0.76
2	Investigate support for communication	CEADA sessions helped stakeholders to freely express their views	Experiment	3.53	1.22
			Enterprise 1	4.50	0.53
			Enterprise 3	3.71	1.38
3	Investigate support for creating a shared understanding	CEADA sessions helped to increase stakeholders' understanding of concerns and requirements that the architecture must address	Experiment	3.89	0.94
			Enterprise 1	4.50	0.53
			Enterprise 3	4.12	0.54
		Stakeholders were satisfied with the results from CEADA sessions	Experiment	2.05	0.91
			Enterprise 1	4.20	0.42
			Enterprise 3	3.43	0.79
4	Investigate support for negotiation	CEADA sessions helped stakeholders to understand why some of their views/contributions were not voted by others	Experiment	3.11	1.05
			Enterprise 1	3.30	1.25
			Enterprise 3	3.86	0.90
5 point Likert scale: (1) – strongly disagree, (3) neutral, and (5) – strongly agree					

Performance results presented in table 7.9 were obtained by analyzing data from the questionnaires that were filled by stakeholders of enterprises 1 and 3 (who participated in CEADA group sessions). Since CEADA sessions in enterprises 2 and 4 were executed using interview sessions (see discussion in section 7.6.1), table 7.9 presents evaluation results of CEADA's performance in only enterprises 1 and 3. This questionnaire evaluation approach has been discussed in section 7.4.3, and the interpretation of results obtained using this questionnaire approach has been discussed in sections 7.4.3 and 7.7.

The shaded cells in column 3 of table 7.7 show two evaluation sub goals that are associated with two key performance indicators that were discussed in section 7.4.3. These indicators include the level of consensus among stakeholders on their satisfaction with activities executed in CEADA sessions, and the level of consensus among stakeholders on their satisfaction with results from CEADA sessions. The performance measures for these two indicators are mean score and standard deviation of scores that stakeholders assign to questions provided in a session evaluation questionnaire (as discussed in section 7.4.3).

Column 5 of table 7.9 shows that the mean scores of CEADA's performance in field study I under each evaluation sub goal improved compared to its performance in the experiment. For example, the shaded cells in column 5 of table 7.9 show that the mean score of CEADA's performance under stakeholders' satisfaction with CEADA activities improved from 2.00 in the experiment to 4.20 in enterprise 1 and 3.71 in enterprise 3. Also, the mean score of CEADA's performance under stakeholders' satisfaction with results from CEADA sessions is improved from 2.05 in the experiment to 4.20 in enterprise 1 and 3.43 in enterprise 3. Since the mean scores in field study I lie between points 3 and 5 of the Linkert scale (see last row of table 7.9), it can be interpreted that CEADA's performance under these two evaluation sub goals was fair. The values of standard deviation associated with these means are presented in the shaded cells in last column of table 7.9, and they indicate that stakeholders had a moderate level of consensus on the fair mean score of CEADA under these evaluation sub goals.

Also, the mean scores of CEADA's performance under other evaluation (sub) goals indicate an improvement (see the un-shaded cells in column 5 of table 7.9). CEADA's performance under the evaluation sub goals helped us to gain insight into particular issues that had to be addressed in CEADA so as to improve its performance under particular evaluation goals. The mean scores under the other evaluation sub goals somewhat justify mean scores of CEADA under the two key evaluation sub goals (i.e. those in the shaded cells of column 3 in table 7.9). Lessons learned from CEADA's performance in field study I are classified and summarized as items 1 – 4 in the last column of table 7.10). The classification of findings in table 7.10 is based on three key selected attributes of CEADA, i.e. its execution plan or agenda, the tools it uses, and the techniques it uses during the sessions (as discussed in section 7.3.2).

Table 7.10: *Main Findings from Field Study I*

Field study I evaluation	Stakeholders involved	Summary of main findings from field study I evaluation
Enterprise 1 (NHC)	13	**Findings on execution plan or agenda** 1. The need to make an explicit distinction between business solution alternatives and solution scenarios in CEADA modules. **Findings on tools or media used in the thinkLet layer** 2. The need to adopt approaches that can offer additional support during the execution of CEADA's convergence and organize tasks. **Findings on techniques used in the thinkLet layer** 3. The need to find a flexible way of adopting techniques for dividing group labour during the execution of CEADA modules. 4. The need to devise a way of enhancing negotiations in CEADA's collaborative design module.
Enterprise 2 (MUKGH)	1	
Enterprise 3 (WDLG)	20	
Enterprise 4 (BU)	8	

Following is a discussion of lessons learned from field study I (which are summarized as items 1 – 4 in the last column of table 7.10).

7.8.1 Findings on CEADA's Execution Plan

Following is a discussion of item 1 in the last column of table 7.10.

The need to make an explicit distinction between business solution alternatives and solution scenarios in CEADA modules. Table 7.10 shows that there was need to specify the difference between business solution alternatives in CEADA's collaborative intelligence module and solution scenarios in CEADA's collaborative design module. During the sessions, some stakeholders felt that some aspects were difficult to distinguish, e.g. business solution alternatives and solution scenarios, or concerns and requirements. Also, some stakeholders preferred to be given templates clarifying the kind of information that was required in a given session prior to the day on which the session was to be conducted. This would enable them to prepare, consult, search, and deliberate on information that is to be discussed in a given session.

These issues implied the need to improve communication of aspects in CEADA modules. In other words, there was need to use a mutually understandable language or vocabulary when formulating questions or topics of discussion associated with activities in CEADA. This would enable stakeholders to understand information required in a given activity if they are to be given templates prior to a session. This is one of the reasons why diagram templates were formulated and why the VPEC-T framework was adopted to formulate discussion topics regarding some aspects in CEADA activities (see sections 6.2.3 and 6.4). Thus, the formulated diagram templates and the questions in the thinkLet notation model of CEADA (see appendix C) were attempts towards helping stakeholders to distinguish aspects that seemed similar.

7.8.2 Findings on Tools/Media Used in the ThinkLet Layer

Following is a discussion of item 2 in the last column of table 7.10.

The need to adopt approaches that can offer additional support during the execution of CEADA's convergence and organize tasks. In field study I it was noted that there was need to improve CEADA by devising ways of properly executing its activities in situations where there is no EMS tool. Moreover, in situations where there is an EMS tool, there was need to find additional ways of executing tasks that require stakeholders to undergo the *reduce*, *clarify*, and *organize* patterns of reasoning. Tasks that require the "reduce and clarify" patterns of reasoning can be referred to as convergence tasks [26]. Performance results of CEADA in field study I (see evaluation subgoals in rows 2, 4, and 5 of table 7.9) show that CEADA's support for creating a shared understanding among stakeholders was unreliable and therefore needed improvement. This is because its mean score under these evaluation sub goals varied considerably. A somewhat similar problem was also observed in enterprise 5 [36].

These issues implied the need to enhance CEADA's support for tasks that require stakeholders to converge, organize, and discuss problem and solution aspects that arise from brainstorming activities in CEADA. The problem was that CEADA lacked adequate support for stirring discussions and having stakeholders actively interact when executing activities that required them to classify aspects and assess possible interrelationships and implications thereof. This was reflected in the feedback from stakeholders who participated in the group sessions and the researchers' observations (as discussed in section 7.4.3). The following three issues elaborate this.

First, more time in the sessions was spent seeking a shared understanding and shared vision of problem and solution aspects, and yet some stakeholders complained (at the end of the sessions) that they had less discussion time. Second, stakeholders suggested that using informal visual representations of their ideas (prior to discussing and evaluating the architecture models) would have helped them to better analyze and understand the problem and solution aspects represented in the architecture models. Third, the participation of stakeholders decreased during activities that required converging, organizing, and discussing problem and solution aspects. This could have been caused by the less hands-on nature of the way the organize tasks were executed. In order to achieve proper stakeholder involvement in architecture creation, these issues had to be dealt with.

These issues indicated the need to devise a way that would improve the execution of CEADA activities that require explicit articulation, proper organization, and thorough discussion of problem and solution aspects. As discussed in section 6.2.2, this is the main reason why we were motivated to refine CEADA by adopting techniques that enabled us to formulate diagram templates that could be used in the classification and discussion of aspects during CEADA sessions. The diagram templates can be used along with an EMS tool or without an EMS tool to trigger purposeful discussions that help stakeholders to acquire a shared understanding of problem and solution aspects during enterprise architecture creation (see sections 6.4 and 7.6.2). The implications of these refinements are discussed in section 7.9.

Table 7.9 shows that CEADA's performance in enterprise 1 was much better compared to its performance in enterprise 3. In enterprise 1 an EMS tool was used and CEADA fairly supported the execution of tasks that involved brainstorming problem and solution aspects and evaluating concerns, requirements, and design alternatives for the architecture. However, executing CEADA without an EMS tool had a negative impact on CEADA's performance in enterprise 3, compared to its fairly good performance in enterprise 1. In enterprise 3 it was not possible to use an EMS tool because there was no Local Area Network in the enterprise (see section 7.6.1.2). We attempted to temporarily set up one for only supporting a CEADA session, but this was not successful due to equipment failure. On the other hand, the situation encountered in enterprise 3 was an opportunity to evaluate CEADA's performance in situations when it is not possible to use an EMS tool to execute CEADA group sessions. Such situations are bound to occur in resource-constrained enterprises. Thus, the situation encountered in enterprise 3 and CEADA's performance therein highlighted the need to find alternative manual techniques to support the execution of brainstorming tasks, converging tasks, and organizing tasks in CEADA (as discussed above).

Furthermore, in field study I the formulation of architecture models from gathered text that describes solution scenarios regarding the current and desired situation was complex and very time consuming. For example, a lot of time was spent interpreting text gathered from CEADA sessions in order to formulate a high level business architecture models such as the ones shown in figures 7.2 and 7.3.

Another reason that motivated us to formulate diagram templates in CEADA. In field study I CEADA did not have any guiding way of formulating or sketching solution scenarios. Thus, stakeholders were not motivated to participate in sketching scenarios of the existing or desired situation. This was addressed by formulating the solution scenarios template that is discussed in section 6.2.3. Thus, the scenarios formulation diagram template (in figure 6.7 in section 6.2.3 was devised to encourage stakeholder participation during the formulation of solution scenarios, and to enhance visualization of aspects regarding solution scenarios in the baseline and target enterprise contexts. Moreover, diagram templates were formulated to help in synergizing aspects gathered from organization documentation, and/or gathered from interview sessions and (sub)group sessions. These aspects were applied in field study II and findings are discussed in section 7.9.

7.8.3 Findings on Techniques Used in the ThinkLet Layer

Following is a discussion of items 3 – 4 in the last column of table 7.10.

The need to find a flexible way of adopting techniques for dividing group labour during execution of CEADA modules. This elaborates item 3 in the last column of table 7.10. The performance of CEADA improved when take-a-panel and share-a-panel techniques of ASE were adopted in CEADA sessions. This was indicated by the fair

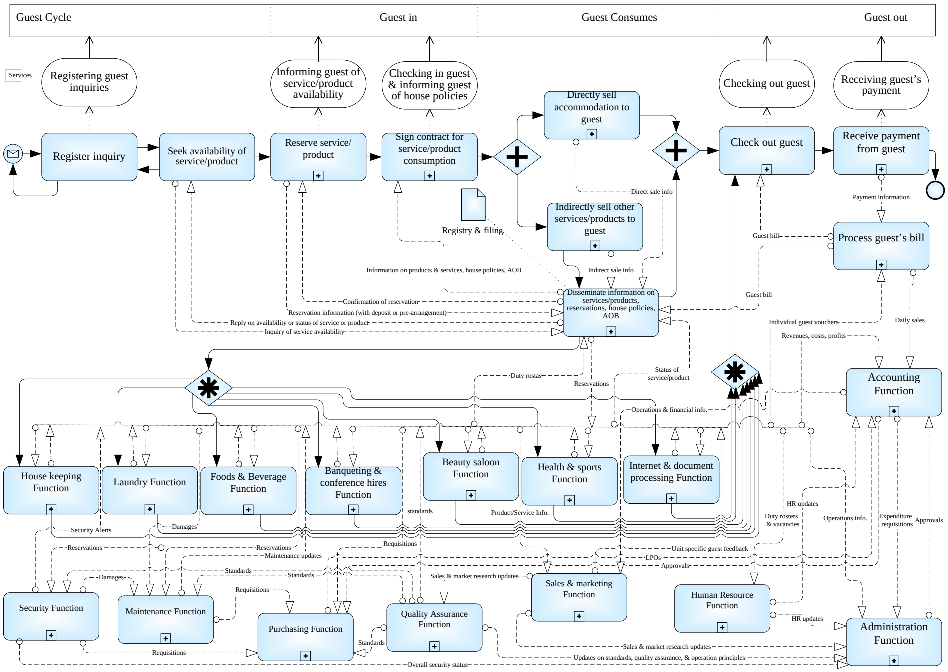

Figure 7.2: *Architecture Vision – Processes in MUKGH*

performance of CEADA in enterprises 1 and 3 compared to its performance in the experiment (see table 7.9). However, it was noted that the way take-a-panel and share-a-panel techniques can be adopted depends on the situation in a given organization. For example, in enterprises 1 and 3 these two techniques were adopted by dividing stakeholders according to their specialization units or departments in the organization. However, in enterprise 3 it was noted that dividing stakeholders into subgroups based on their specialization was not the appropriate way, since some departments in enterprise 3 ended up being represented by only one or two persons in the CEADA sessions. Therefore, although CEADA's performance improved when take-a-panel and share-a-panel techniques of ASE were adopted, there was need to find a flexible way of adopting these techniques into CEADA modules.

The search for this flexible way led to the adoption of a broader technique for dividing and maximizing group labour, i.e. the committees and subcommittees by Raiffa et al. [107]. We adopted this technique in addition to the take-a-panel and share-a-panel techniques (see discussion in section 6.2.3). As discussed in section 6.2.3, stakeholders can be divided into subgroups (to execute particular CEADA activities) by using specialization-driven division, and/or task-driven division, and/or governance-driven division, and/or interest-driven division. The refined version of CEADA explicitly shows when and why any of these divisions is invoked in CEADA sessions (see discussion in sections 6.2.3 and 6.4). These aspects were applied in field study II and findings are discussed in section 7.9.

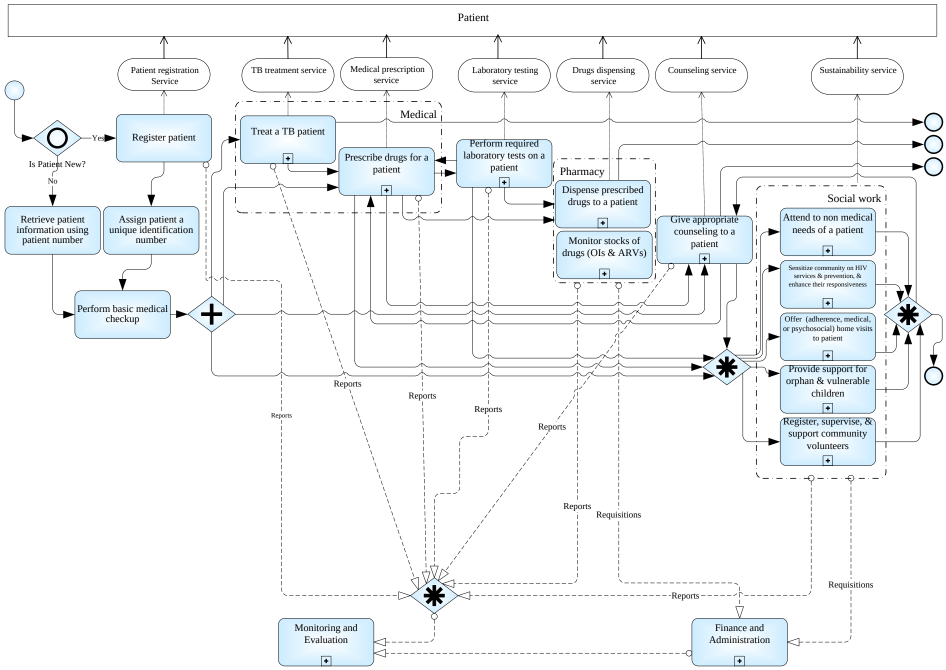

Figure 7.3: *Architecture Vision – Processes in NHC*

The need to devise a way of enhancing negotiations in CEADA's collaborative design module. This elaborates item 4 in the last column of table 7.10. The last row of table 7.9 shows that stakeholders did not understand why some of their concerns, requirements, or views were not chosen or voted by other stakeholders. This implied that there was need to find a way of enhancing negotiations during CEADA sessions so as to build consensus on concerns, requirements, quality criteria, solution scenarios, and enterprise architecture design alternatives. Besides, based on the core notion of CEADA discussed in section 7.7 (see under item 2 in table 7.8), improving negotiations will help stakeholders to understand why (some of) their concerns or requirements or views are considered invalid by others in the sessions. In the effort to address this, we took two measures. First, we adopted techniques of dividing and maximizing group labour that enabled us to define four ways of dividing stakeholders so as to enhance communication and collaboration among subgroups in CEADA (as discussed in item 3 above). This is likely to reduce heterogeneity within subgroups.

Second, we adopted the SNT technique to enhance negotiations in CEADA (see discussions in sections 6.2.3 and 6.4). In CEADA we use conceptual models or CEADA diagram templates that have been populated with data from interview sessions or (sub) group sessions as SNTs in order to encourage stakeholders to negotiate on enterprise aspects presented in the models. The refined version of CEADA shows when and how we use models as SNTs in CEADA sessions (see discussion in sections 6.2.3 and 6.4). These aspects were applied in field study II and findings are discussed in section 7.9.

In addition to the items discussed above, it was found important to improve the CEADA evaluation questionnaire by defining additional evaluation sub goals so as to get insight into other aspects that were causing low scores of CEADA that could not be accounted for. For example, the scores of CEADA under evaluation goal 4 in table 7.9. Table 7.11 in section 7.9 shows the evaluation sub goals that were amended.

7.9 Main Findings From Field Study II

The setup of field study II and the use of CEADA therein is discussed in section 7.6.2. This section discusses CEADA's performance and lessons learned in field study II. Table 7.11 shows stakeholders' evaluation of CEADA's performance in field study II and table 7.12 summarizes the main lessons learned from field study II.

Table 7.11: *Performance of CEADA in Field Study II*

#	Evaluation goals	Evaluation sub goals	Enterprise number	Mean Score	St. dev.	Overall Mean Score
1	Investigate support for collaborative and interactive activity	Stakeholders were satisfied with activities executed in CEADA sessions and/or how they were executed	Enterprise 6	4.50	0.52	4.22
			Enterprise 7	4.11	0.60	
			Enterprise 8	4.75	0.50	
			Enterprise 9	3.50	0.58	
		CEADA sessions involved constructive critiquing of ideas generated by the participating stakeholders	Enterprise 6	4.50	0.52	4.31
			Enterprise 7	4.44	0.73	
			Enterprise 8	4.50	0.58	
			Enterprise 9	3.80	0.84	
		Stakeholders were able to understand the objectives of the sessions	Enterprise 6	4.29	0.61	4.51
			Enterprise 7	4.78	0.44	
			Enterprise 8	4.75	0.50	
			Enterprise 9	4.20	0.45	
2	Investigate support for communication	CEADA sessions helped stakeholders to freely express their views	Enterprise 6	4.43	0.94	4.56
			Enterprise 7	4.67	0.50	
			Enterprise 8	4.75	0.50	
			Enterprise 9	4.40	0.55	
3	Investigate support for creating a shared understanding	CEADA sessions helped to increase stakeholders' understanding of concerns and requirements that the architecture must address	Enterprise 6	4.36	0.50	4.55
			Enterprise 7	4.67	0.50	
			Enterprise 8	4.75	0.50	
			Enterprise 9	4.40	0.55	
		Stakeholders were able to understand results or aspects defined and models formulated during the sessions	Enterprise 6	4.25	0.45	4.43
			Enterprise 7	4.33	0.50	
			Enterprise 8	4.75	0.50	
			Enterprise 9	4.40	0.55	
		Stakeholders were able to understand concerns of others about the baseline and future/target operations in the enterprise	Enterprise 6	4.36	0.84	4.36
			Enterprise 7	4.56	0.53	
			Enterprise 8	4.25	0.96	
			Enterprise 9	4.25	0.50	
		Stakeholders were satisfied with the results from CEADA sessions	Enterprise 6	4.23	0.60	4.36
			Enterprise 7	4.44	0.73	
			Enterprise 8	4.50	0.58	
			Enterprise 9	4.25	0.96	
4	Investigate support for negotiation	CEADA sessions helped stakeholders to understand why some of their contributions were not voted or were found invalid by others	Enterprise 6	4.15	0.55	3.95
			Enterprise 7	3.89	1.27	
			Enterprise 8	3.50	1.00	
			Enterprise 9	4.25	0.96	
5 point Likert scale: (1) – strongly disagree, (3) neutral, and (5) – strongly agree						

The performance results presented in table 7.11 were obtained by analyzing data from the questionnaires that were filled by stakeholders who participated in CEADA group sessions. This questionnaire evaluation approach has been discussed in section 7.4.2, and the interpretation of results obtained using this approach is discussed in sections 7.4.2 and 7.7.

The mean score of CEADA's performance under each evaluation sub goal is shown in column 5 of table 7.11. The last column of table 7.11 shows the overall average score of CEADA in the four enterprises that were considered in field study II. CEADA's mean scores in table 7.11 indicate an improved performance compared to the performances in field study I and the experiment. For example, the shaded cells in column 5 of table 7.11 show that the mean score of CEADA's performance under stakeholders' satisfaction with CEADA activities is 4.22, and the mean score of CEADA's performance under stakeholders' satisfaction with results from CEADA sessions is 4.36. According to the Linkert scale that was used (see last row of table 7.11), it can be interpreted that CEADA's performance under these two evaluation sub goals was good. The standard deviation of scores (shown in column 6 of table 7.11) illustrates a moderate level of consensus among stakeholders regarding CEADA's mean score under each evaluation sub goal.

The overall mean scores in table 7.11 also indicate that CEADA's performance was good regarding the support for creating a shared understanding and shared vision among stakeholders. Moreover, comparing CEADA's performance results in field study II with CEADA's performance results in field study I (see section 7.8, table 7.9), the performance of CEADA regarding the support for creating a shared understanding and shared vision among stakeholders has improved. For example, in field study I, the overall average score of CEADA's performance in enterprises 1 and 3 under "creating a shared understanding and shared vision among stakeholders" was 3.95 (see table 7.9). In field study II, the overall average score of CEADA's performance in enterprises 6 – 9 under "creating a shared understanding and shared vision among stakeholders" increased to 4.43. This value is obtained by getting the overall average of CEADA's mean scores under the four evaluation sub goals of evaluation goal 3 in table 7.11.

Following is a discussion of lessons learned from field study II (which are summarized as items 1 – 4 in the last column of table 7.12).

Table 7.12: *Main Findings from Field Study II*

Field study II evaluation	Stakeholders involved	Summary of main findings from field study II evaluation
Enterprise 6 (RDM)	14	<u>**Findings on execution plan or agenda**</u> 1. Using diagram templates to gather data on baseline and target aspects quickens the processing of results from interviews and group sessions. <u>**Findings on tools or media used in the thinkLet layer**</u> 2. CEADA's diagram template for problem analysis can be used along with causal loop diagrams for better conceptualization of problematic aspects in some enterprises. 3. The Rich Picture is not self guiding if it is congested with a lot of details, and becomes hard to follow. <u>**Findings on techniques used in the thinkLet layer**</u> 4. Using CEADA's diagram templates as SNTs triggers discussions and negotiations but may reduce stakeholders' hands-on interactivity.
Enterprise 7 (JCRC)	21	
Enterprise 8 (CPHL)	15	
Enterprise 9 (MOLG)	13	

7.9.1 Findings on CEADA's Execution Plan

Following is a discussion of item 1 in the last column of table 7.12.

Using diagram templates to gather data on baseline and target aspects quickens the processing of results from interviews and group sessions. In field study II the use of diagram templates to gather data on problem and solution aspects in the enterprise made the processing of results from interviews and group sessions less hectic than the text-intensive approach of gathering and documenting data on problem and solution aspects. For example, the diagram template for formulating solution scenarios is used to gather and document data on a given process in either the baseline or target situation (see figure 7.4). Information in this template is then used to formulate a corresponding view in a business architecture model (see figure 7.5). Thus, the CEADA diagram templates partially helped to overcome challenges faced when translating interview notes or group session notes into architecture models. This was one of the issues enterprise architects raised in the findings from the exploratory survey (see section 2.3.3).

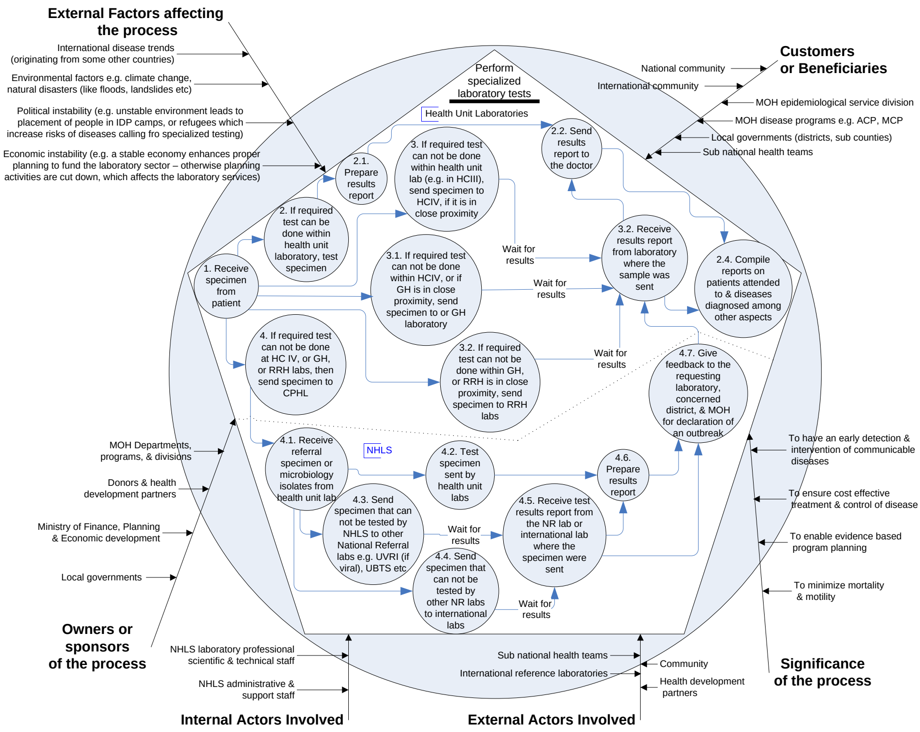

Figure 7.4: *Scenarios Formulation Showing Details of an Event or Operational Process of "Perform Specialized Laboratory Tests" in Enterprise 8 (CPHL)*

7.9.2 Findings on Tools/Media Used in the ThinkLet Layer

Following is a discussion of items 2 – 3 in the last column of table 7.12.

CEADA's diagram template for problem analysis can be used along with causal loop diagrams for better conceptualization of problematic aspects in some enter-

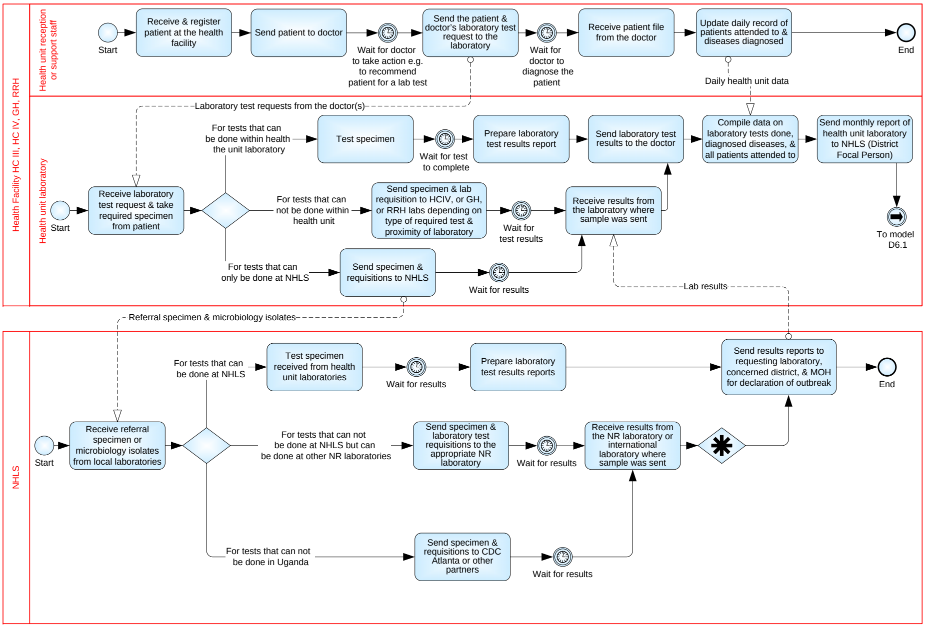

Figure 7.5: *View of the Operational Process of "Perform Specialized Laboratory Tests" in the Business Architecture Model of Enterprise 8 (CPHL)*

prises. This elaborates item 2 in the last column of table 7.12. The diagram template for problem analysis is useful for inciting discussions when analyzing problem aspects, however in some enterprises it is not sufficient and calls for the supplementary use causal loop diagrams for better conceptualization of problematic aspects. The need for a better conceptualization of problem aspects arises in enterprises that have several units which are challenged by several problems that are characterized by nested or compound causes and/or feedback loops. Hence the need for adopting causal loop diagrams, in addition to the diagram template for problem analysis. During execution of the problem analysis activity, it was better to use both the diagram template for problem analysis and the causal loop diagram. This is mainly because of the following two reasons.

First, the challenges of using the diagram template for problem analysis are situational, i.e. they occur in situations where the problem is messy or characterized with various compound aspects and feedback loops. For example in a small-sized enterprise, the Ishikawa-based diagram template for problem analysis model may sufficiently support the problem analysis activity. For example, in enterprises 6 and 9, one diagram template for problem analysis was used in the problem analysis activity (see figure 7.6).

Yet for a large-size enterprise with several departments, the problem analysis activity may result in various Ishikawa diagrams (each representing a particular department or group of departments). Having several separate models showing problems faced in various departments prevent stakeholders from having a holistic understanding of the problem or baseline situation. For example, in enterprises 7 and 8, multiple diagram templates for problem analysis were used to represent problems in the baseline situation and their

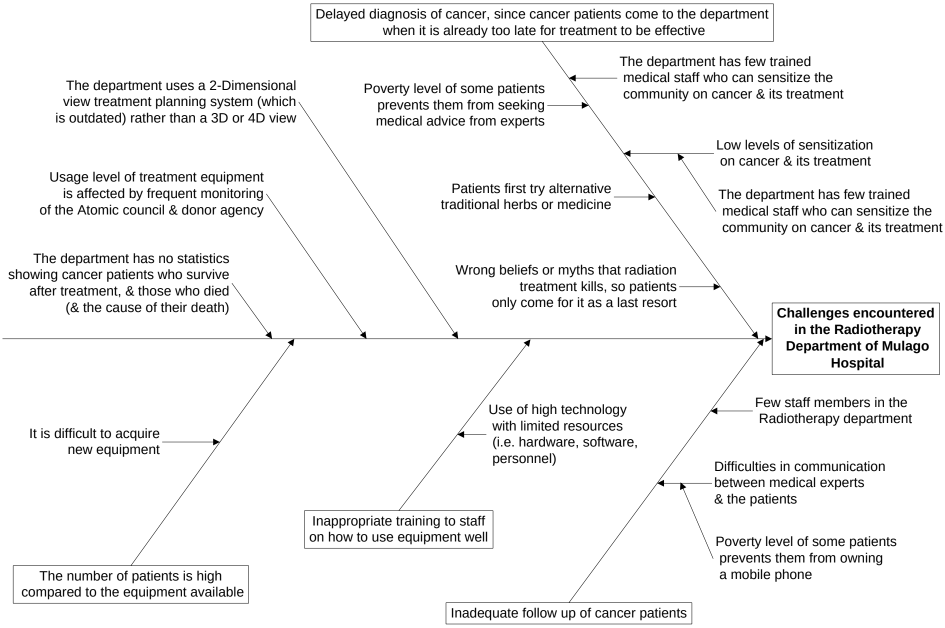

Figure 7.6: *Challenges Encountered in Enterprise 6 (RDM)*

causes. This is because the problem scope in these enterprises included various departments or units. For example, figure 7.7 shows problems faced in only one of the units in enterprise 8. Thus, if the organization problem scope covers several departments or units, then more diagram templates for problem analysis are used in order to avoid congestion or information overload in one template. As a result, there is need to represent some aspects using a causal loop diagram (for better conceptualization of the organization problem).

Second, the refined CEADA in section 6.2.3 only invokes the use of causal loop diagrams, but does not provide a script that shows how the practitioner can design the causal loop diagram with stakeholders. Providing such a script implies the need to delve into literature on group model building scripts, a task that is beyond the scope of this thesis. Thus, there is need to extend CEADA by ensuring that the causal loop diagrams are also formulated during the sessions with the stakeholders (see section 9.3).

If congested with a lot of details, the Rich Picture is not self guiding and becomes hard to follow. This elaborates item 3 in the last column of table 7.12. In field study II the Rich Picture technique of SSM was adopted in CEADA. However, it was noted that some stakeholders find the organization-wide Rich Picture too congested, and they prefer to have department/unit specific Rich Pictures. Some stakeholders complained that the organization-wide detailed Rich Pictures were not self guiding and were hard to follow without explanations from the researchers. This problem was reported in enterprises 7 and 8. For example, in enterprise 8 some stakeholders felt that an understandable or self guiding representation of the Rich Picture of their organization was figure 7.8, which would decompose into department-specific Rich Pictures (such as figure D.3 in appendix D). Even in large enterprises like WDLG, a Rich Picture can offer a holistic view of

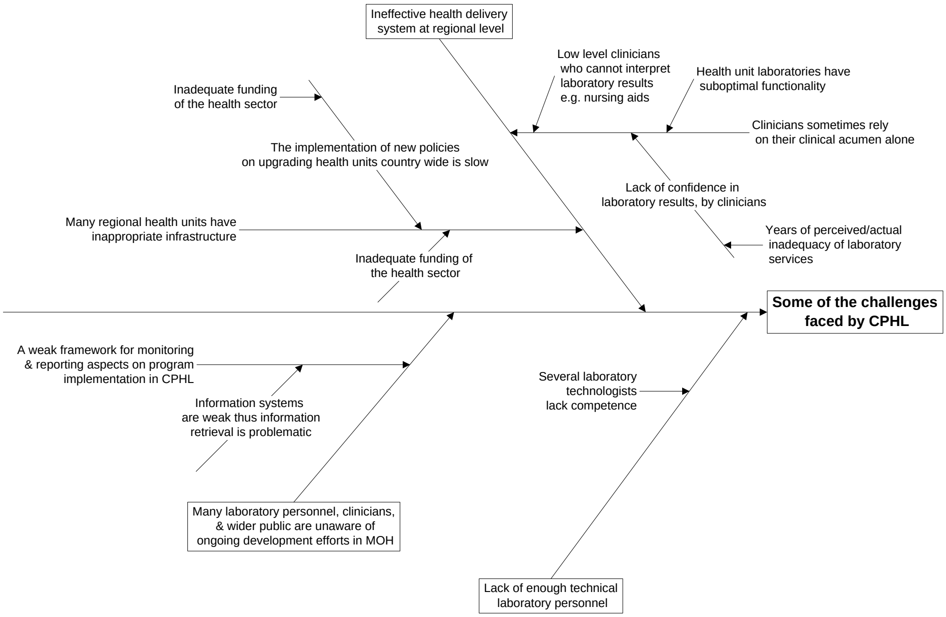

Figure 7.7: *Some of the Challenges Encountered in the (Laboratory) Technical Support Services Unit of Enterprise 8 (CPHL)*

aspects without being congested (e.g. see figure 7.9). Thus, in CEADA we address the self guiding issue by shading the starting point that one can use in order to read a Rich Picture of an organization or department (see figure 7.8).

7.9.3 Findings on Techniques Used in the ThinkLet Layer

Following is a discussion of item 4 in the last column of table 7.12.

Using CEADA's diagram templates as SNTs triggers discussions and negotiations but may reduce stakeholders' hands-on interactivity. This elaborates item 4 in the last column of table 7.12. In field study II it was noted that populating CEADA's diagram templates with data (from interview sessions, (sub)group sessions, and/or organization documentation) and then using the populated diagram templates as SNTs during the group sessions triggers discussions and negotiations among stakeholders, but reduces hands-on interactivity. In enterprise 6 and 9, where populated diagram templates were entirely used as SNTs, some stakeholders complained that the sessions were less interactive, whereas others appreciated the use of conceptual models (or populated diagram templates) as SNTs. Also in enterprises 7 and 8, the use of populated diagram templates as SNTs was appreciated. This suggests that the use of conceptual models (or populated diagram templates) as SNTs may work well in some enterprises and yet may not be suitable in other enterprises. Hence the need for flexibility in the use of these diagram templates.

In addition, flexibility in the use of CEADA diagram templates can also be looked at in the sense of eliminating some templates from a session or customizing some templates prior or during the sessions as need arises. For example, the diagram template for pro-

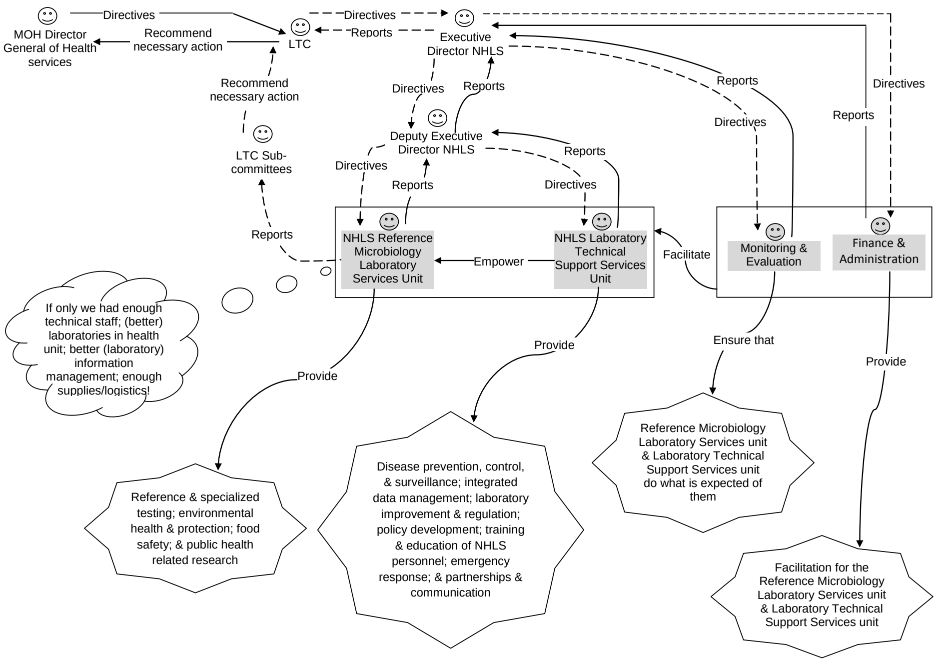

Figure 7.8: *High Level Rich Picture of Enterprise 8 (*this shows only the main units of NHLS, which is currently called CPHL*)*

cess attributes has 6 nodes, but in some enterprises, a node like "existing projects" can be eliminated, and/or substituted with a node like "core functions that an enterprise is responsible to fulfill". Also, the customization of such templates may entail substitution of all nodes with new terms that are in the stakeholders' vocabulary, or depending on the required detail of defining aspects (e.g. see appendix D, figures D.6 and D.7). In some situations, some diagram templates can be left out. For example, the diagram templates for process attributes can be left out and instead one can use the scenarios formulation template. This is because the scenarios formulation template captures adequate details on a process in either the baseline or target situation. For example, in enterprise 9 the scenarios formulation template was not used because the problem situation in the enterprise did not require the use of aspects in that template.

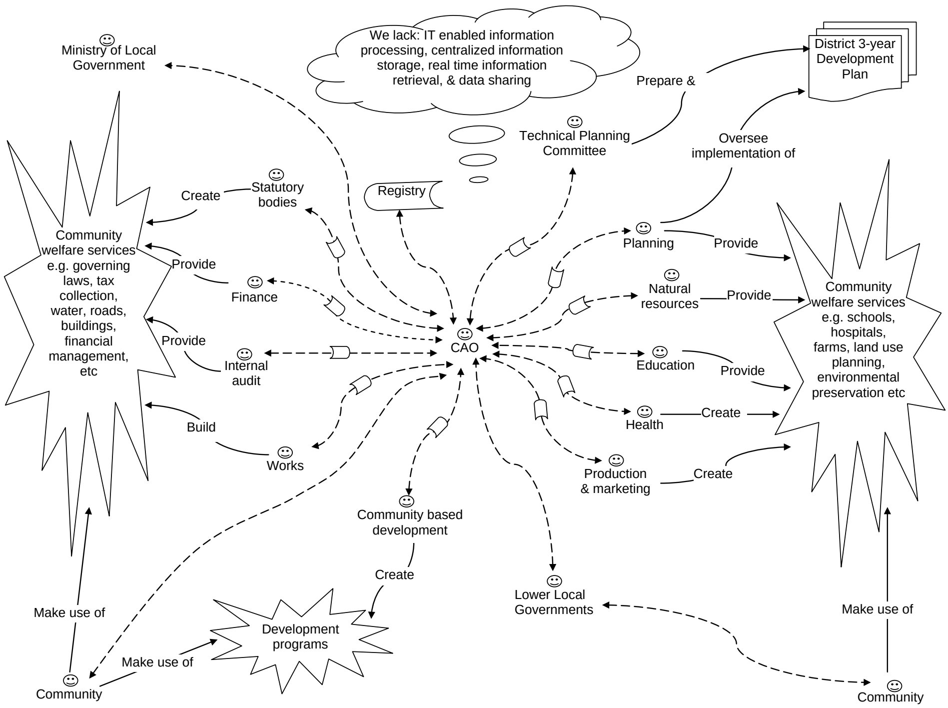

Figure 7.9: *Rich Picture For Baseline Situation in Enterprise 3 (WDLG)*

7.10 Summary of Evaluation Findings

Sections 7.3 and 7.7 – 7.9 discuss findings from the analytical, experimental, and field study evaluation iterations of CEADA. Table 7.13 shows a summary of key highlights from these evaluation iterations.

Basing on performance results in field study II, we can now claim that CEADA is repeatable and predictable in its support for collaboration, communication, negotiation, and shared understanding during the execution of collaboration dependent tasks in enterprise architecture creation. Details that support this claim are provided in sections 7.8 and 7.9. Below we provide an overview of key aspects that support this claim.

Repeatability. A collaboration process is repeatable if when executed, *"different groups working on different systems produce similar collaboration patterns"* ([129], page 2). CEADA is repeatable in the sense that when it is executed in enterprises with different types of stakeholders, the patterns of collaboration or reasoning that it creates across these stakeholder groups are similar. This claim is especially supported by the performance of CEADA in field study II (see section 7.9).

In this research, CEADA's performance in the experiment hardly indicated any repeatability qualities (see section 7.7). In our roadmap for evaluating CEADA, one would argue that the low performance of CEADA in the experiment would demand for another laboratory test before embarking on a field study. Although this would have been ideal, we considered the fact that experiments have a controlled environment where participants

Table 7.13: *Highlights from the Evaluation Phases of CEADA*

Type of evaluation	Summary of major findings from each evaluation phase of CEADA
Phase 1: Analytical evaluation	1. The need to distinguish causal and conditional relations in the theory on CDM in enterprise architecture creation 2. The need to distinguish business solution alternatives and architecture or solution design alternatives 3. The need to add, decompose, and elaborate activities in CEADA
Phase 2: Experiment evaluation	4. The need to adopt techniques for dividing group labour
Phase 3: Field study I evaluation by Action Research	5. The need to supplement CEADA with techniques for enhancing visualization of aspects and the creation of a shared understanding and vision during execution of activities that involve converging and organizing brainstormed aspects
Phase 4: Field study II evaluation by Action Research	6. The use of populated CEADA diagram templates as SNTs during CEADA sessions leaves inadequate "room" for hands-on or interactive work among participants
Phase 5	Descriptive evaluation to be discussed in chapter 8

have no "real" stake in the matters at play. Briggs et al. [18] advise that this affects the execution of activities and the performance scores of a given collaboration process under some evaluation goals, since satisfaction levels with the process and its outcomes are higher when participants have a personal interest in the collaborative tasks at hand. Therefore, it was found appropriate to instead evaluate CEADA in real environments rather than another fictitious environment. Besides, in Collaboration Engineering, using Action Research method to evaluate processes enables researchers to continually learn from multiple evaluation iterations and refinements which eventually yield a repeatable collaboration process [129]. Accordingly, a field study evaluation of CEADA was conducted by Action Research, but the performance of CEADA in field study I hardly indicated any repeatability qualities (see section 7.8). However, on refining CEADA (based on findings from the experiment and field study I), its performance in field study II indicated some level of repeatability.

In field study II the supplementary adoption and deployment of Collaboration Engineering and SSM enabled the formulation of diagram templates that served three purposes. First, the diagram templates were used for classifying and organizing aspects in an easily understandable way during the execution of convergence and organize tasks in CEADA. Second, the use of diagram templates enabled us to use interview sessions and group sessions in a supplementary way that enabled various key stakeholders to participate in the architecture creation conversations. Third, the use of diagram templates (that are partially populated with data) as SNTs helped to enhance negotiations on various aspects in CEADA sessions. Although CEADA's improved performance in field study II may not have been entirely caused by the adoption of SSM-based and non SSM-based techniques, these new techniques played a key role in supporting the convergence and organize patterns of reasoning in CEADA.

Predictability. A collaboration process is predictable if when executed, *"similar group dynamics for different groups and different systems"* ([129], page 2). CEADA is predictable in the sense that when it is executed in enterprises with different types of stakeholders, the dynamics and results that it creates across these stakeholder groups are similar and predictable. This claim is especially supported by the performance of CEADA in field study II (see section 7.9). This claim is supported by discussions on CEADA's performance and lessons learned from the experiment, field study I, and field study II (see sections 7.7 – 7.9). Items listed as "lessons learned" in tables 7.10 and 7.12, are issues identified from executing CEADA in at least eight different enterprises. It is only in table 7.8 were 'lessons learned" are identified from only one source – an experiment. Basing on performance results of CEADA in field study II (see table 7.11), the results or performance of CEADA in another setting can be predicted.

CEADA's support for organizational learning and critical thinking. Other than CEADA's repeatability and predictability, specific benefits of using CEADA during enterprise architecture creation can be classified into two. First, CEADA comprises techniques (i.e. the diagram templates, the selected thinkLets, and the four group division techniques) that are used to support *learning* of the organization's baseline and target situations. Stakeholders and architects learn the organization's *"baseline or problem system"* and the *"target or intervention system"* through executing CEADA activities by populating the diagram templates, deliberating on the populated diagram templates, and interacting with each other through the four group division techniques. Second, CEADA comprises techniques that are used to support collaborative critical thinking about the organization's baseline and target situations. This capability helps stakeholders to explore various dimensions of the baseline and target systems. These claims are substantiated by CEADA's performance under particular evaluation goals and subgoals that are discussed in sections 7.4.1, 7.8, and 7.9.

Conclusions. Among the situational parameters of CEADA (discussed in section 6.6), the order and duration of executing activities in CEADA modules mainly depends on the architecture maturity level of the organization and the social complexity issues in the organization.

Regarding architecture maturity level, the evaluation of CEADA in real contexts revealed that executing activities in CEADA's collaborative intelligence module in organizations with an architecture maturity level of 1 was less hectic and less time consuming than in an organization with architecture maturity level 0 (these levels are explained in section 5.4).

Regarding social complexity, organization culture and organization politics may affect the duration and the way in which activities in CEADA modules are executed. Concerning the culture dimension, the use of an EMS tool helped to minimize the influence of culture by enabling stakeholders to freely express their views through anonymous contributions. Without an EMS tool, implementing anonymity during brainstorming activities is time consuming. Also, cultural factors still affect the process of making the final decision on matters in all CEADA sessions. Unfortunately, although organization politics greatly affect decisions made when executing collaboration dependent tasks, this research does not offer any guidelines on handling this problem (more on this is discussed in section 9.3).

Executing CEADA process sessions in field study I resulted in a total of approximately 14 architecture models representing the business, application, data, and technology aspects of enterprises that participated. Some of the resulting models from CEADA sessions in field study I are provided in this chapter (e.g. figures 7.2, 7.3), while a small selection from the 14 models that were formulated in field study I is given in appendix D.

Executing CEADA process sessions in field study II resulted in a total of 143 models representing the business, application, data, and technology aspects of enterprises that participated. Some of the resulting models from CEADA sessions in field study II are provided in this chapter (e.g. figures 7.4, 7.5, 7.6, 7.7, 7.8, 7.9), while only a small selection from the 143 models that were formulated in field study II is given in appendix D.

Chapter 8

CEADA in TOGAF

Abstract. This chapter demonstrates how CEADA can be a potential plug-in for enterprise architecture approaches. It first provides a CEADA adoption model that can help one to customize CEADA such that it can be used with a given enterprise architecture approach. Thereafter, the CEADA adoption model is instantiated by showing how CEADA can be used in TOGAF ADM.

8.1 Chapter Overview

In section 1.7, we promised to illustrate how CEADA can be used along with an enterprise architecture framework or method. In the context of Design Science, this can be perceived as a descriptive evaluation of an artifact. This chapter focuses on providing this illustration or descriptive evaluation of CEADA in architecture framework or method.

In Design Science descriptive evaluation of an artifact involves examining its purpose using an informed argument (i.e. basing on scientific and expertise knowledge to build a realistic view of the utility of the artifact) or scenarios (i.e. demonstrating the use of an artifact using detailed examples) [49]. Chapters 1 – 6 advocate for CEADA as a process that focuses on supplementing enterprise architecture approaches with support for executing collaboration dependent tasks during enterprise architecture creation. Chapter 7 discusses the evaluation of CEADA using the analytical, experimental, and observational design evaluation methods. Therefore, in this chapter we find it necessary to give a descriptive evaluation of CEADA. We do this by discussing how CEADA can be used along with an enterprise architecture approach. In doing so, the informed argument (in the perspective of Design Science) that we have adopted is the expertise or practitioners' knowledge documented in the Architecture Development Method (ADM) of The Open Group Architecture Framework (TOGAF).

The descriptive evaluation of CEADA (by illustrating its use in TOGAF ADM) is motivated by the following two factors. First, CEADA is not an enterprise architecture framework/method, thus evaluating it in real situations to find out whether it actually serves its purpose (of supporting the execution of collaboration dependent tasks) implied the need to adopt an enterprise architecture framework. Consequently, TOGAF ADM was adopted and used along with CEADA in an experiment and two field studies. This is presented in chapter 7 (see tables 7.4, table 7.5, table 7.6). Second, we were inspired by the following research efforts. Spewak [121] developed the Enterprise Architecture Planning (EAP) method (discussed in section 2.2.3) and explicitly illustrated its use in the Zachman architecture framework. Also, the ArchiMate Forum developed the ArchiMate architecture modeling language [67], and later demonstrates its use and support in TOGAF (e.g. in [68]). Besides, The Open Group encourages that other approaches (i.e. tools, techniques, methods, frameworks) can be adopted during the execution of steps and guidelines in TOGAF ADM [124].

Thus, this chapter discusses how CEADA can be deployed to support execution of collaboration dependent guidelines in TOGAF ADM. Section 8.2 briefly introduces TOGAF ADM and explains why it was chosen to be used in the (descriptive) evaluation of CEADA. It also discusses how CEADA can be customized to be used along with an enterprise architecture approach during enterprise architecture creation. Sections 8.3 and 8.4 show the collaboration dependent guidelines in TOGAF ADM that can be executed using support from the thinkLets that support activities in CEADA. Section 8.5 discusses lessons learned from the descriptive evaluation of CEADA. Some parts of this chapter are a (slightly) modified version of sections of work in [92].

8.2 TOGAF ADM Phases

TOGAF is a detailed industry-driven approach comprising a set of tools and methods that support enterprise architecture development [124]. TOGAF is an open standard (that can be freely used by an enterprise to develop an enterprise architecture for use within that enterprise) and its ADM provides detailed guidelines for developing enterprise architecture [124]. Also, findings from the exploratory survey that was conducted in this research (as discussed in section 2.3) show that TOGAF was used by at least 67% of the enterprise architects who participated in the survey (see appendix A, table A.10). For these reasons, TOGAF ADM was chosen to be used in the descriptive evaluation of CEADA, which entails showing how CEADA can be embedded or deployed in the first four phases of TOGAF's ADM. These four phases include phase A (i.e. the architecture vision design phase), phase B (i.e. the business architecture design phase), phase C (i.e. the information systems architectures design phase), and phase D (i.e. the technology architecture design phase) [124]. Figure 8.1 shows all the phases of the TOGAF ADM, and highlights these four phases in which CEADA can be deployed. Other phases in figure 8.1 are beyond the scope of this research.

At the initial phase of enterprise architecture development, an enterprise architect chooses an architecture framework and supporting methods and techniques to be used, and adapts them with respect to the situation of an enterprise [124]. Thereafter, phases A – D (see figure 8.1) involve the design of the enterprise architecture vision and domain architectures. In these four highlighted phases in figure 8.1, some ADM guidelines are executed by enterprise architects only, while successful execution of other guidelines requires enterprise architects to collaborate with their clients or organizational stakeholders. In section 1.3 the latter were defined as collaboration dependent guidelines or tasks. Even when using other architecture approaches (other than TOGAF), architecture creation still involves execution of these collaboration dependent tasks. Hence the need to show how CEADA can be deployed along with an enterprise architecture framework during enterprise architecture creation (see figure 8.2).

As shown in figure 8.2, the CEADA process comprises three modules which syner-

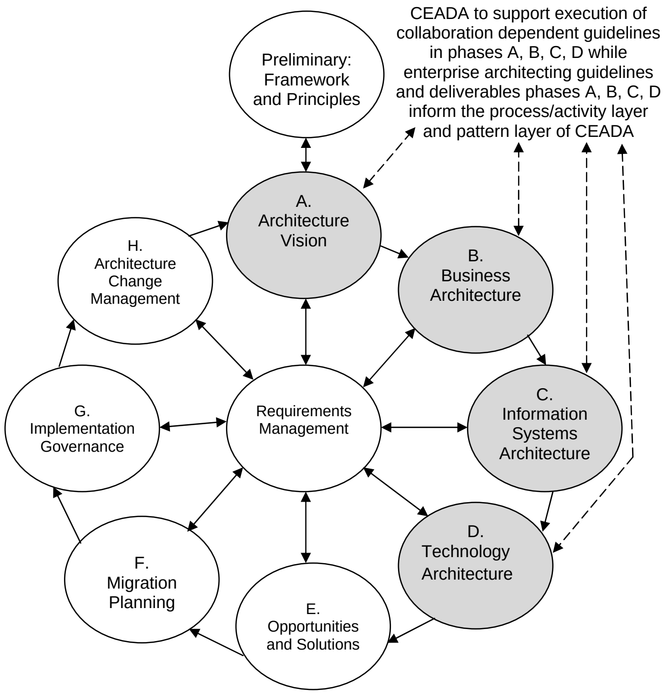

Figure 8.1: *Architecture Development Phases in TOGAF ADM (*Source: [124]*)*

gically address various issues associated with involving client stakeholders during enterprise architecture creation. Each CEADA module comprises activities that yield specific deliverables, several patterns of reasoning or collaboration that stakeholders undergo in order to execute the activities in that module, and thinkLets required to execute those activities. Section 6.4 discusses these as the process layer, pattern layer, and thinkLet layer of each CEADA module. In figure 8.2, the full set of activities for each CEADA module is represented as Aq, the required patterns of reasoning for executing each CEADA activity is represented as $POCAq$, and the thinkLet(s) selected to support execution of each activity is represented as TAq.

Figure 8.2 further shows that for CEADA to be applied in a given enterprise architecture creation effort, its (generic) activities are customized basing on two factors. First, the requirements from an enterprise architecture framework or method that is to be used to guide the architecture development effort. Second, the situational attributes from preliminary discussions with senior officials of a given organization. This results in an enterprise-specific collaboration process for creating an enterprise architecture, which when executed results in identifying strengths and weaknesses of CEADA. The weaknesses are indicators of CEADA aspects that require refinement or further development. Section 8.3 discusses the use of CEADA at the architecture vision development phase of TOGAF ADM.

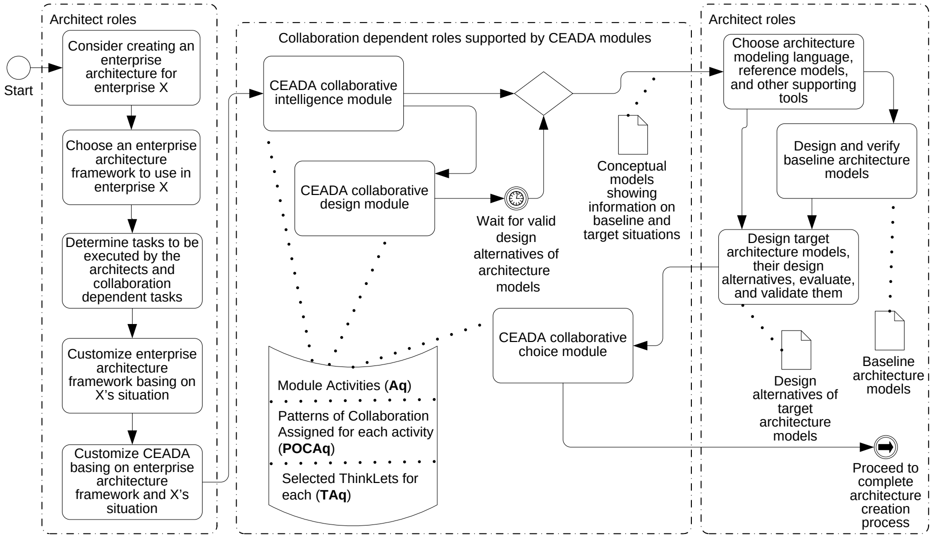

Figure 8.2: *Using CEADA along with an Enterprise Architecture Framework*

8.3 Creating Architecture Vision

According to TOGAF [124], phase A of the ADM is focused on scoping the architecture effort in an organization, identifying key stakeholders, creating the organization's architecture vision, and obtaining approvals (and support and commitment) from corporate and line management. Table 8.1 shows how CEADA has been embedded in this phase. Column 2 of table 8.1 shows TOGAF's ADM guidelines for this phase, which are a summary of the detailed discussion in [124]. Column 3 shows the code (or identification number) of an activity in the process layer of CEADA (e.g. A.1.1.1), whose patterns and thinkLets can offer collaboration support for a given guideline in column 2 of the table. In column 3 of table 8.1, only a code of a CEADA activity is used, and details of the patterns of reasoning and thinkLets (used to facilitate the execution of the activity corresponding to a stated code) are provided in section 6.4 (which offers a summarized view of CEADA) and appendix C (which offers a detailed view of CEADA).

Following is a discussion of the criteria or assumptions used in assigning CEADA activities to the ADM guidelines in table 8.1. In the following discussion, after a code for a given CEADA activity is stated, the output associated with that activity code is provided in brackets. For example, "*A.1.1.1 (baseline processes and their attributes)*" means that the output of A.1.1.1 is the phrase in the brackets. This is done for the purpose of making this chapter readable, in the sense that one does not have to always flip to section 6.4 or appendix C in order to know the aspects associated with a given activity code.

Establish the architecture project in the organization. Guideline 1(a) in table 8.1 involves using accepted practices and existing project management or IT governance frameworks [124]. Such information can be elicited using support for CEADA activities A.1.1.1 (completed and ongoing projects), A.1.4.1 (organization principles and values), and A.1.5 (external constraints and principles from regulatory bodies). Moreover,

Table 8.1: *ADM Guidelines for Phase A and CEADA Activities that can Support Collaboration Dependent Guidelines in Phase A*

#	ADM guidelines for creating architecture vision (TOGAF, 2009)	Supporting activities in CEADA modules
1	a) Plan architecture project using accepted practices and relate it to existing frameworks	Uses output from A.1.1.1, A.1.4.1, A.1.5 in collaborative intelligence
	b) Secure enterprise-wide recognition, endorsement, support, and commitment from corporate and line management	Gradually achieved through A.1.1 – A.2.3 in collaborative intelligence
2	a) Identify key stakeholders, their concerns, and cultural factors so as to determine how to present and communicate the architecture	A.1.9, A.1.4.1, A.2.1 – A.2.3 in collaborative intelligence; and A.3.1 – A.3.3 in collaborative design module
	b) Identify scope boundaries and candidate components of the architecture vision	A.1.8 in collaborative intelligence; and A.5.1 – A.5.8 in collaborative design
	c) Define business requirements that the architecture must address	A.1.3 – A.1.9 in collaborative intelligence; and A.4.1– A.4.6 in collaborative design
	d) Identify the required architecture views and viewpoints	A.5.1 – A.5.8 in collaborative design
3	a) Identify and validate business goals and strategic drivers	A.1.4.2 in collaborative intelligence
	b) Define enterprise-wide and project-specific constraints that the architecture must address	A.1.4.1, A.1.5, A.1.7, A.1.8 in collaborative intelligence; and A.4.1 – A.4.6 in collaborative design
4	a) Seek understanding of baseline and target business capabilities	A.1.6, A.1.8 in collaborative intelligence; A.4.1 – A.4.6, A.5.1 – A.5.8 in collaborative design
	b) Identify options for implementing business capabilities	Beyond the scope of CEADA
5	a) Find out factors for assessing organization's readiness for change	Output from A.1.4 – A.1.6 in collaborative intelligence is used
	b) Evaluate the organization's readiness for change	Beyond the scope of CEADA
6	Define the scope of the enterprise architecture	A.1.1, A.1.8, A.1.9 in collaborative intelligence
7	Review business and architecture principles	A.1.4.1 in collaborative intelligence
8	Create or design high level view models of the baseline and target architectures	Beyond the scope of CEADA, but uses output from collaborative intelligence module and collaborative design module of CEADA
9	a) Define target architecture's business case and value propositions	
	b) Review and agree on these with sponsors and stakeholders	A.7.1 – A.7.4 in collaborative choice
10	Prepare statement of architecture work	Deliverables of CEADA activities are used

in guideline 1(b) in table 8.1, it is advised that enterprise-specific procedures should be conducted in order to secure enterprise-wide support and commitment [124]. Since the enterprise-specific procedures are not defined, the patterns and thinkLets to activities A.1.1 – A.1.9 in the collaborative intelligence module of CEADA can be used.

Identify stakeholders, their concerns, and business requirements. Identifying stakeholders' concerns (see guideline 2(a) in table 8.1) can be done using patterns and thinkLets for CEADA activities A.1.9 (problem owners, solution owners, and decision makers) and A.3.1 – A.3.3 (stakeholders' concerns). In addition, identifying cultural factors and determining how to present and communicate the architecture, can be done using output from activity A.1.4.1 (organization principles and values) and insights given in activities A.2.2 – A.2.3. CEADA activities A.2.2 – A.2.3 involve preparing a detailed execution plan and communication plan, which shows the communication media and communication modes to be used in the subsequent architecture creation tasks. Guideline 2(b) in table 8.1 involves engaging key stakeholders when scoping the architecture and defining its candidate components [124]. This can be executed using support from patterns and thinkLets for CEADA activities A.1.8 (high level solution specifications and scope of architecture effort) and A.5.1 – A.5.8 (solution scenarios).

In addition, guideline 2(c) in table 8.1 involves engaging key stakeholders to define business requirements that must be addressed by the architecture. For defining business requirements, TOGAF recommends the use of business scenarios [9, 124]. However, facilitation support for business scenario workshops is implicit (as discussed in section 2.2.3). Therefore, patterns and thinkLets for CEADA activities A.1.3 – A.1.9 (output from collaborative intelligence module) and A.4.1 – A.4.6 (requirements and quality criteria) can be used to support the (gather, analysis, and review) phases of the business scenario method, or to define the business requirements. In guideline 2(d) in table 8.1, identifying views and viewpoints that address stakeholders' requirements, involves using the agreed on solution scenarios in CEADA activity A.5.1 – A.5.8 (solution scenarios). Output of ADM guidelines 2(a) – 2(d) (in table 8.1) is a stakeholder map for the architecture effort (that shows the stakeholders involved, their level of involvement, and their concerns) and relevant architecture views and viewpoints [124]. Thus, CEADA activities A.1.9 (problem owners, solution owners, and decision makers), A.3.1 – A.3.3 (stakeholders' concerns), and A.5.1 – A.5.8 (solution scenarios) help to elicit information that can be used in designing the stakeholder map.

Confirm and elaborate business goals, drivers, and constraints. In guideline 3(a) in table 8.1, the validation of business goals and strategic drivers can be done using support from patterns and thinkLets for CEADA activity A.1.4.2 (strategy and goals). Enterprise-wide and project-specific constraints can be drawn from the business and architecture principles [124]. Thus, guideline 3(b) in table 8.1 can be executed using patterns and think-Lets of CEADA activities A.1.4.1 (organization principles and values), A.1.5 (external constraints and principles from regulatory bodies), A.1.7 (purpose of architecture), and A.1.8 (high level solution specifications and scope of architecture effort). Since the purpose of architecture determines the nature of results required [96], output from activity A.1.7 (purpose of architecture) is vital for guideline 3(b). In addition project specific constraints can be obtained from output of CEADA activities A.4.1 – A.4.6 (requirements and quality criteria).

Evaluate business capabilities of the organization. Since a business capability is essentially a macro-level business function, business capability assessment involves defining the capabilities that an organization will need in order to fulfill its business goals and strategic drivers [124]. Thus, in guideline 4(a) in table 8.1, the creation of a shared understanding of the baseline and target business capabilities, can be achieved by using support from patterns and thinkLets for CEADA activities A.1.6 (appropriate business solution alternative), A.1.8 (high level solution specifications and scope of architecture effort), A.4.1 – A.4.6 (requirements and quality criteria), and A.5.1 – A.5.8 (solution scenarios). Output from these CEADA activities is useful in guideline 4(b) in table 8.1, which is considered to be an architect role. Since CEADA deals with collaboration dependent guidelines, support for guideline 4(b) is beyond the scope of CEADA.

Assess the organization's readiness to undergo a transformation. Guideline 5 in table 8.1 involves identifying (and analyzing and prioritizing) readiness factors for assessing the organization's readiness for change, and then assessing the organization using those factors [124]. Although this guideline uses output from CEADA activities A.1.4 – A.1.6, the aspects it deals with are beyond the scope of CEADA (as indicated in table 8.1).

Define scope of enterprise architecture. This mainly involves specifying the breadth of coverage of the organization, the parts that the architecture effort should focus on, the architecture domains that the architecture effort should cover, the level of detail that should be considered in the architecture, and the expected duration of the architecture effort [124]. As indicated in table 8.1, these aspects can be defined using support from patterns and thinkLets assigned to CEADA activities A.1.1 (existing processes and their attributes and problems faced) and A.1.8 (high level solution specifications and scope of architecture effort). In activity A.1.1, information on completed and ongoing projects and programs gives insights into which information resources or assets can be reused during architecture creation. Also, output of CEADA activity A.1.9 (problem owners, solution owners, and decision makers) can be useful in this guideline of defining scope of the architecture. Thus, output from activity A.1.9 gives insight into the organization units that need to be covered in the architecture, the required architecture domains, and the required level of detail of in the architecture.

Confirm and elaborate business and architecture principles. There is need to validate definitions of the already existing business and architecture principles (to ensure that they are current and unambiguous) or if they do not exist, to define and ensure that they are approved by corporate management [124]. As indicated in table 8.1, this can be accomplished using support of patterns and thinkLets for CEADA activity A.1.4.1 (organization principles and values).

Develop a high level view of baseline and target architectures. An organization's architecture vision is the first-cut and high level description of the organization's baseline and target architectures, specifying the business, data, application, and technology aspects of the organization [124]. As shown in table 8.1, the actual *design* of baseline and target architecture models is beyond the scope of CEADA. The translation of output from the collaboration dependent tasks into enterprise architecture models is beyond the scope of CEADA, since this task is considered to be an architect role and architecture modeling methods or languages (see section 2.2.3) richly support it. However, the architecture vision models are created using information such as stakeholders' concerns, business capability requirements, scope, constraints, and principles [124].

Therefore, output from activities in the collaborative intelligence module of CEADA is vital for formulating high level views of baseline architecture models, and output from activities in the collaborative design module of CEADA is vital for formulating high level views of target architecture vision models. Moreover, in the experiment and field study evaluation iterations (discussed in sections 7.5 – 7.6.2), the use of CEADA modules in supporting collaboration dependent tasks in TOGAF ADM mainly focused on gathering information for developing high level views of baseline and target architectures. In [93, 94] we discuss customized CEADA processes that provide details of how particular CEADA activities are used to elicit information relevant for designing baseline and target architectures. To obtain these customized CEADA processes, we follow the situational factors of CEADA that are discussed in section 6.6. For example, in the customized CEADA process for defining baseline architectures [93], we eliminate activities that involve defining target or solution aspects from the generic CEADA modules that are discussed in section 6.4. Also, in the customized CEADA process for defining target architectures [94], we eliminate *some* activities that involve defining baseline or problem aspects from the generic CEADA modules that are discussed in section 6.4. However, incase the enterprise has no documentation available, the customized CEADA process for defining target architectures may include some activities associated with defining baseline aspects.

Define business case and value propositions for target architecture. Guideline 9(a) involves defining a business case for the target architecture, and the associated procurement requirements, performance metrics, and value propositions for each stakeholder group [124]. Although some aspects in this guideline require involvement of some stakeholders, the execution of this guideline is beyond the scope of CEADA (as indicated in table 8.1). However, output from this guideline is vital when discussing the positive and negative implications of possible enterprise architecture design alternatives in the collaborative choice module of CEADA. In addition, guideline 9(b) involves ensuring that stakeholders and sponsors agree with aspects in 9(a) [124]. Thus, execution of guideline 9(b) can be supported by patterns and thinkLets for CEADA activities A.7.1 – A.7.4 (appropriate enterprise architecture design alternative).

Prepare statement of architecture work. To complete the architecture vision phase, there is need to identify business transformation risks that are associated with the architecture vision (their frequency and the risk mitigation strategy) and to develop the statement of architecture work and secure its approval [124]. The details of this guideline are beyond the scope of CEADA. However, shallow discussions on risks and risk mitigation may arise during the evaluation of enterprise architecture design alternatives. Thus, patterns and thinkLets for CEADA activities A.7.1 – A.7.4 can be used to support execution of this guideline. In addition, as shown in table 8.1, the statement of architecture work comprises output from activities in all the three modules of the CEADA process.

8.4 Creating Domain Architectures

According to TOGAF [124], the business, data, application, and technology aspects of the organization's architecture vision are developed further in the following phases of the ADM:

1. Phase B aims at developing a business architecture that will support the architecture vision.

2. Phase C aims at developing target architectures that cover either or both of the data and application systems domains, thus it is known as information systems architectures and is divided into data architecture (which defines major types and sources of data that are vital for supporting the business) and application architecture (which defines major kinds of application systems that are vital for processing data and supporting the business).

3. Phase D aims at mapping application components (defined in the application architecture) into a set of technology (i.e. software and hardware) components which are either available on market or configured in the organization.

Table 8.2 shows how CEADA has been embedded in phases B, C, and D. Column 2 of table 8.2 shows the TOGAF ADM general guidelines for these three phases, which are a summary of the detailed discussion in [124]. Since phases B, C, and D are all domain architectures, their guidelines are somewhat similar and differ in a few aspects. Thus, in column 2 of table 8.2 the name of each of these phases is enclosed in the square brackets, and separated from another using an "or" (forward slash) symbol. Column 3 table 8.2 shows the code of an activity in the process layer of CEADA, whose patterns and thinkLets can offer collaboration support for a guideline in column 2 of the table. Details of the patterns of reasoning and thinkLets (used to facilitate the execution of the activity corresponding to a stated code) are provided in section 6.4 and appendix C. Following is a discussion of the criteria or assumptions used in assigning CEADA activities to the ADM guidelines in table 8.2. Like in section 8.3, for readability purpose, after a code for a given CEADA activity is stated, the output associated with that activity code is provided in brackets.

Table 8.2: *ADM Guidelines for Phases B, C, D and CEADA Activities that can Support Collaboration Dependent Guidelines in Phases B, C, D*

#	ADM guidelines for developing [business/data/application/technology] architecture (TOGAF, 2009)	Supporting activities in CEADA modules
1	a) Review and validate a set of [data/application/technology] principles	A.1.4.1 in collaborative intelligence
	b) Select relevant [business/data/application/technology] reference models and other resources from the architecture repository	A.1.1.1, A.1.4.2 in collaborative intelligence; A.3.1 – A.3.3, A.4.1 – A.4.6 in collaborative design
	c) Select relevant [business/data/application/technology] architecture viewpoints	A. 5.1 – A.5.8 in collaborative design
	d) Identify appropriate tools and techniques for modeling selected viewpoints	Beyond the scope of CEADA, but uses output from A.1.4.1 and A.5.1 – A.5.8
2	Develop baseline [business/data/application/technology] architecture to an extent necessary to support its respective target architecture	A.1.1, A.1.2, A.1.4.1, A.1.9 in collaborative intelligence; A.3.1 – A.3.3 in collaborative design
3	Develop a target description for [business/data/application/technology] architecture to the extent necessary to support the architecture vision	A.1.3 – A.1.9 in collaborative intelligence; A.3.1 – A.3.3, A.4.1 – A.4.6, A.5.1 – A.5.8 in collaborative design
4	a) Perform trade-off analysis to resolve any conflicts among different views	Beyond the scope of CEADA, but uses output from the collaborative intelligence module and collaborative design module, but the output from executing these guidelines is useful in CEADA activities A.7.1 – A.7.4 of the collaborative choice module
	b) Validate the models against principles, objectives, and constraints	
	c) Identify gaps between baseline and target domain architectures	
5	Define a roadmap that prioritizes activities over the coming phases	
6	Assess wider impacts of [business/data/application/technology] architecture	
7	Conduct formal stakeholder review of the domain architectures	A.7.1 – A.7.4 in collaborative choice

Select reference models, viewpoints, and tools. Guideline 1(a) in table 8.2 involves revisiting the architecture principles to review the data and application principles (when developing information systems architectures), or technology principles (when developing technology architecture) [124]. This can be accomplished using support of patterns and thinkLets for CEADA activity A.1.4.1 (organization principles and values). In guideline 1(b), the selection of relevant resources from the architecture repository is done basing on business drivers and stakeholders' concerns [124]. Although this is to a large extent the role of architects, there is need to use output of CEADA activities A.1.4.2 (business strategy and goals), A.1.1.1 (completed and ongoing projects), A.3.1 – A.3.3 (stakeholders' concerns), A.4.1 – A.4.6 (requirements and quality criteria). Thus, the patterns and thinkLets assigned to these CEADA activities can be used to generate output required to execute guideline 1(b).

Guideline 1(c) in table 8.2 involves selecting relevant viewpoints that demonstrate how stakeholders' concerns are to be addressed in the business, data, application, and technology architectures of the organization [124]. Although this is to a large extent the role of architects, there is need to use output from CEADA activities A.5.1 – A.5.8 (solution scenarios). This is because the valid solution scenarios somewhat represent the valid concerns and requirements. For example, TOGAF [124], the viewpoints for business architecture show concerns associated with business functions (e.g. operations management, financial management), viewpoints for data architecture show concerns associated with data (e.g. stakeholders of the data, time dimensions, locations, and business processes using the data), and viewpoints for the applications architecture show concerns associated with applications (e.g. users' applications). Thus, assuming stakeholders concerns, requirements, and business capabilities were defined in phase A of the ADM, guideline 1(c) would need output from CEADA activities A.5.1 – A.5.8. Otherwise, the patterns and thinkLets for CEADA activities A.1.1.2 (problems and concerns), A.3.1 – A.3.3 (stakeholders' concerns), A.4.1 – A.4.6 (requirements and quality criteria), and A.5.1 – A.5.8 (solution scenarios) can be used to generate output required to execute guideline 1(c).

According to TOGAF [124], guideline 1(d) involves identifying appropriate tools and techniques for capturing, modeling, and analyzing the selected viewpoints. This guideline is essentially an architect's role. For example, to model the business architecture, architects decide whether to use activity models, business process models, use-case models; or to model the data architecture, architects decide whether to use entity relationship diagrams, class diagrams, object role modeling [124]. However, guideline 1(d) also uses output from CEADA activities A.1.4.1 (organization principles and values) and A.5.1 – A.5.8 (solution scenarios), as indicated in table 8.2. This is because it is recommended that for each viewpoint, architects need to ensure that all stakeholders' concerns are covered by selecting models that support the required views (using the selected tool or method) and creating new models or augmenting existing ones so as to address uncovered concerns [124]. In guideline 1(d), output from CEADA activity A.1.4.1 (organization principles and values) informs the architect on which tools or methods are acceptable in the client organization, while output from CEADA activities A.5.1 – A.5.8 (solution scenarios) informs the architect on the required views. In addition, guideline 1(d) also requires architects to define the requirements for implementing the target (business, data, application, or technology) architectures [124]. Although this task is also considered an architect's role, its results can be used in CEADA activities A.7.1 – A.7.4 (appropriate enterprise architecture design alternative).

Develop baseline architecture description. This involves developing a description of the baseline (business, or data, or application, or technology) architectures to the extent that is detailed enough to support the development of the target (business, or data, or application, or technology) architectures [124]. As shown in table 8.2, the execution of this guideline can be supported by patterns and thinkLets for CEADA activities A.1.1 (existing processes and their attributes and problems faced), A.1.2 (organization's problem scope), A.1.4.1 (organization's principles and values), A.1.9 (problem owners, solution owners, and decision makers), and A.3.1 – A.3.3 (stakeholders' concerns). This is because output from these activities provides information (on the existing enterprise situation) that can be used to develop the baseline architectures.

Moreover, the necessary scope and level of detail of the baseline architectures depends on the extent to which existing (business, or data, or application, or technology) elements are likely to be carried over into the target (business, or data, or application, or technology) architectures [124]. This explains why also output from CEADA activity A.1.8 (high level solution specifications and scope of architecture effort) is needed when executing this guideline. Guideline 3 in table 8.2 also involves identifying (from the architecture repository) the relevant architecture building blocks for the target (business, or data, or application, or technology) architectures, and ensuring that the models fully capture the concerns and contents of the baseline (business, or data, or application, or technology) architectures [124]. This indicates the relevance of output from CEADA activities A.3.1 – A.3.3 (stakeholders' concerns). Also, output from CEADA activity A.1.1.1 (completed and ongoing projects) gives insight into relevant building blocks for the baseline architecture. In [93] we discuss a customized CEADA process that provides details of how the CEADA activities (that are assigned to support this ADM guideline) are used to elicit information relevant for designing baseline architectures.

Develop target architecture description. This involves developing a description of the target (business, or data, or application, or technology) architectures to the extent that is detailed enough to support the development of the architecture vision and other target domain architectures [124]. As indicated in table 8.2, the execution of this guideline can be supported by patterns and thinkLets for CEADA activities A.1.3 – A.1.9 (output from the collaborative intelligence module of CEADA), A.3.1 – A.3.3 (stakeholders' concerns), A.4.1 – A.4.6 (requirements and quality criteria), and A.5.1 – A.5.8 (solution scenarios). Output from these activities is useful in gathering information that is relevant when designing target domain architectures.

The scope and level of detail required depends on the relevance of particular (business, or data, or applications, or technology) elements in attaining the target architecture vision, and other domain architectures [124]. This is why this guideline requires output from CEADA activity A.1.8 (high level solution specifications and scope of architecture effort). Output from CEADA activity A.1.1.1 (completed and ongoing projects) helps to give insight on existing building blocks that can be reused when designing the target architectures. This is because the development of target domain architectures also involves identifying (from the architecture repository) the relevant architecture building blocks for the target (business, or data, or application, or technology) architectures, and ensuring that the designed models fully capture the concerns and requirements of the target (business, or data, or application, or technology) architectures [124]. This indicates the relevance of output from CEADA activities A.3.1 – A.3.3, A.4.1 – A.4.6, and A.5.1 – A.5.8 (stakeholders concerns, business requirements, quality criteria, and solution scenarios). In [94] we discuss a customized CEADA process that provides details of how the CEADA activities (that are assigned to support this ADM guideline) are used to elicit information relevant for designing target architectures.

Perform gap analysis, define architecture roadmap, and determine wider impact. Table 8.2 shows that these guidelines are considered to be beyond the scope of CEADA. This is mainly because aspects that this guideline addresses mainly relate to the roles of the architect. For example, according to TOGAF [124], this guidelines involves verifying target architecture models for internal coherency and accuracy, performing trade-off analysis of architecture models to resolve any conflicting views, validating models to ensure that they support principles (and requirements and constraints), identifying gaps between baseline and target domain architectures, devising a roadmap that prioritizes upcoming activities for the domain architecture efforts, and determining possible implications of the domain target architectures. However, executing these guidelines requires output from the collaborative intelligence module and collaborative design module of CEADA. Also, as indicated in table 8.2, output from executing these guidelines is useful in the collaborative choice module of CEADA.

Conduct formal stakeholder review and create the architecture description document. According to TOGAF [124], this involves architects allowing stakeholders to review the appropriateness of the proposed (business, or data, or application, or technology) target architectures, finalizing them by selecting standards for their building blocks (and fully documenting the building blocks), and documenting the rationale of the target domain architectures by creating sections for them in the architecture description document. As shown in table 8.2, this formal stakeholder review can be done using support from patterns and thinkLets for CEADA activities A.7.1 – A.7.4 (appropriate enterprise architecture design alternative).

8.5 Summary on CEADA in TOGAF ADM

The preliminary phase of architecture development in TOGAF ADM involves adapting the ADM to fit the needs in a client organization [124]. In the eight enterprises in which CEADA (and its use to support collaboration dependent tasks in TOGAF ADM) was evaluated (see sections 7.6.1 and 7.6.2), some activities in the collaborative intelligence module of CEADA were executed in order to gather information that was used to customize the TOGAF ADM architecture vision phase to suit the situation of each enterprise that participated. Other activities in the collaborative intelligence module, and activities in the collaborative design and collaborative choice modules of CEADA then supported the execution of collaboration dependent tasks that occur when creating an architecture vision. From this (descriptive) evaluation of CEADA, the following lessons were learned.

In tables 8.1 and 8.2 which show how CEADA can support TOGAF ADM guidelines, a set of CEADA activities is assigned to support a given ADM guideline. This is because for some ADM guidelines, one specific CEADA activity cannot be executed in isolation, since to use a thinkLet of a particular CEADA activity there may be some thinkLets that have to be first used in order to obtain information that is used as input for another thinkLet to be used. Examples of CEADA activities that are executed in form of clusters include specifying stakeholders' problems and concerns (activities A.1.1.2, A.3.1 – A.3.3), defining business requirements (A.4.1 – A.4.4), specifying quality criteria (A.4.4 – A.4.6), and formulating solution scenarios (A.5.1 – A.5.8).

In addition, as tables 8.1 and 8.2 show, in each of TOGAF ADM architecture creation phases (i.e. A, B, C, and D), all activities in the CEADA modules can be applied to support particular guidelines in each phase. This is mainly because collaboration dependent tasks recur in the enterprise architecture creation phases of the TOGAF ADM. This recurring pattern of collaboration dependent tasks during architecture creation, further justifies the need for a flexible and explicit way of executing these tasks.

Chapter 9

Conclusions

Creating an enterprise architecture involves two types of tasks, i.e. (a) architect-specific tasks – those to be executed by an enterprise architect, and (b) collaboration dependent tasks – those whose proper execution requires an enterprise architect to collaborate with stakeholders. Proper execution of collaboration dependent tasks has several benefits but involves several challenges. An example of the key benefits is the possibility of (fairly) overcoming resistance from some stakeholders who are comfortable with the baseline situation of an organization [8]. Examples of the main challenges encountered include ineffective communication, lack of a shared vision, social complexity, lack of supporting tools and techniques (these are discussed in section 2.3.3). Since enterprise architecture frameworks and methods richly inform the execution of architect-specific tasks (as discussed in section 2.2.3), this research was motivated to provide insights into the execution of collaboration dependent tasks.

The basic idea in executing collaboration dependent tasks during enterprise architecture creation is to ensure that stakeholders make collaborative decisions on problems (or concerns) and requirements that the enterprise architecture must address. In doing so, stakeholders and architects acquire a shared understanding of the problems in the baseline situation and the requirements associated with the target situation of the enterprise (as discussed in section 4.2.2). We assume that this results in increased awareness (among stakeholders) of the enterprise architecture creation process, creates a sense of ownership of the architecture creation results, and leads to collaborative organizational change or transformation.

This chapter presents a recap of what this research promised to deliver, the efforts that were undertaken towards delivering the promise, and what was achieved. It also gives insights into what can still be done to improve what has been achieved. Thus, section 9.1 presents a summary of the key research contributions. Section 9.2 discusses the strengths and weaknesses of the resultant artifact from this research (i.e. CEADA). Section 9.3 provides insights into future research directions towards realizing Collaborative Decision Making (CDM) in enterprise architecture creation.

9.1 Key Research Contribution

Enterprise architecture creation is a recurring initiative to an enterprise architect. Therefore, we found it necessary to devise an explicit and flexible way that enterprise architects can use to manage or facilitate the execution of collaboration dependant tasks without depending on the presence of a professional facilitator. This was mainly motivated by two factors. First, the lack of explicit and flexible operational guidelines that provide details of how enterprise architects can collaborate with stakeholders during enterprise architecture creation (see section 1.3). Second, the call for devising facilitation support (for *high-value recurring mission-critical tasks*) that is sustainable and affordable, in the sense that its success does not entirely depend on the presence of a professional facilitator [130, 14, 129]. In this research we responded to this call in the context of enterprise architecture creation, since it is a high-value recurring mission-critical task to an enterprise architect. Therefore, for an architect not to be dependent on a professional facilitator, there is need for some kind of process with explicit and flexible guidelines for executing collaboration dependent tasks. To develop the design of such a process, a Design Science approach was required.

We therefore adopted the Design Science research methodology to develop an artifact (a collaboration process per se) that enterprise architects can use to facilitate the execution of collaboration dependent tasks during enterprise architecture creation. Table 9.1 gives an overview of what we promised to do and what we have delivered.

Table 9.1: *Key Research Results*

#	Research Question	Research Objective	Research Results
1	Which tasks during enterprise architecture creation are collaboration dependent?	To determine tasks that are collaboration dependent	A synergy of collaboration dependent tasks (discussed in chapter 5)
2	What are the challenges that enterprise architects face when executing collaboration dependent tasks during enterprise architecture creation?	To investigate challenges that enterprise architects face when executing collaboration dependent tasks	A taxonomy of problems faced when stakeholders are involved in enterprise architecture creation, and a taxonomy of recommendations for addressing those problems (discussed in chapter 2)
3	What are the essential phenomena in the execution of collaboration dependent tasks, and the interrelationships among those phenomena?	To determine essential phenomena associated with executing collaboration dependent tasks, and formulate a theory that explains these phenomena and the interrelationships among them	Theory on Collaborative Decision Making (CDM) in enterprise architecture creation that explains interrelationships among phenomena associated with executing collaboration dependent tasks (discussed in chapter 4)
4	How can Collaboration Engineering and SSM be adopted to provide an explicit and flexible procedure that addresses the challenges associated with the essential phenomena in executing collaboration dependent tasks?	To investigate the application of Collaboration Engineering and SSM in enterprise architecture creation by adopting them to design a process that offers detailed guidelines for executing collaboration dependent tasks	CEADA, a collaboration process with three modules and various flavors of diagram templates used in the modules (discussed in chapter 6)
			Taxonomy of CDM approaches relevant in architecture creation (chapter 3)
		To evaluate and validate the resultant process or artifact	Findings from the evaluation of CEADA (discussed in chapters 7 and 8)
	General research question: How can a process for executing collaboration dependent tasks during enterprise architecture creation be structured?	**General research aim:** to design and evaluate a process that provides clear and flexible support for executing collaboration dependent tasks during enterprise architecture creation	**Resultant artifact:** CEADA, to provide a flexible and structured way of executing collaboration dependent tasks during enterprise architecture creation

Columns 2 and 3 of table 9.1 give the research questions and research objectives from sections 1.5 and 1.6 respectively. Column 4 of table 9.1 shows the research results. The research results can be classified into two, i.e. research motivating factors and the solution synthesis. This classification is shown in figure 9.1. The boxes in figure 9.1 represent

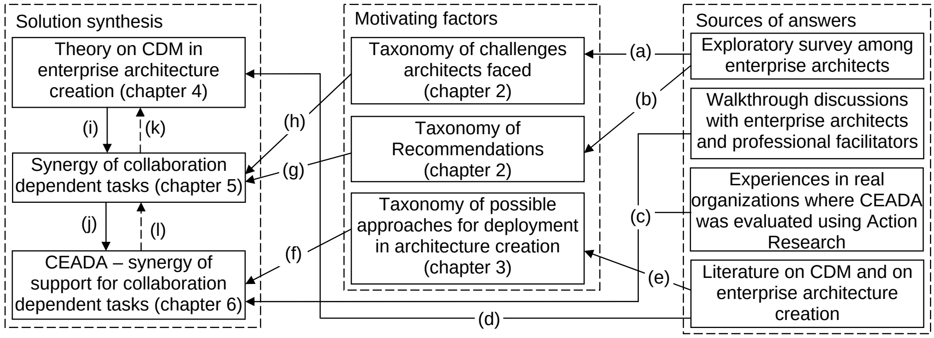

Figure 9.1: *Classification of Research Results*

particular aspects associated with the research results or sources of information in this research. The lines labeled (a) – (j) in figure 9.1 indicate that the aspect at tail of the line is a source of information used in the formulation of the aspect at the arrow head of the line. The lines labeled (k) and (l) in figure 9.1 indicate that refinements in the aspect at the tail of a line imply refinements in the aspect at the arrow head of the line.

In figure 9.1 lines labeled (a), (b), and (e) show that the research motivating factors were derived from findings from the exploratory survey that we conducted among enterprise architects (see section 2.3) and from existing literature on approaches that support CDM. Thus, as shown in the middle part of figure 9.1, research motivating factors include (1) the taxonomy of challenges architects face when they involve stakeholders in enterprise architecture creation (this is based on survey findings), (2) taxonomy of recommendations to address the challenges faced (this is based on survey findings), and (3) taxonomy of possible approaches for deployment in enterprise architecture creation so as to address the challenges or to implement the recommendations (this is based on CDM literature).

As shown in the left part of figure 9.1, solution synthesis includes (1) the theory on CDM in architecture creation, (2) the synergy of collaboration dependent tasks, and (3) the synergy of detailed guidelines for executing collaboration dependent tasks. The solution synthesis is refined based on findings from the evaluation of CEADA (this is indicated by the line labeled (c) in figure 9.1 and the upward facing dashed lines in the left part of figure 9.1). Figure 9.1 and column 4 of table 9.1 show the chapters in this thesis where the research results are discussed in detail.

As shown in column 4 of table 9.1, the research results offer answers to the research questions and objectives (see section 9.1.1), and answers to specific aspects in the taxonomies of problems and recommendations that were elicited from the survey (see section 9.1.2). Aspects presented in table 9.1 and figure 9.1 are elaborated in sections 9.1.1 and 9.1.2 below.

9.1.1 Answers to Research Questions and Objectives

This section summarizes answers to the research questions and research objectives). Thus, it presents a summary on collaboration dependent tasks (i.e. answer to research questions and objectives (1) and (3) in table 9.1), a summary on challenges faced during execution of such tasks (i.e. answer to research question and objective (2) in table 9.1), and a summary on CEADA (i.e. answer to research question and objective (4) in table 9.1).

9.1.1.1 Summary on Collaboration Dependent Tasks

Key phenomena in executing collaboration dependent tasks. In this research we formulated the theory on CDM in enterprise architecture creation. It is made up of eleven notions named A – K (discussed in section 4.2.2), each comprising three nuggets i.e. axiom, proposition, and elaboration.

- Axiom is an assumption based on literature about phenomena of interest or relation between two or more phenomena of interest in this research.
- Proposition is an argument or prediction (based on a given axiom and/or on literature) that was considered in the formulation of the synergy of collaboration dependent tasks, or in the adoption of techniques that constitute CEADA.
- Elaboration is an explanation of a given proposition with respect to one or more axioms or other propositions.

The core notion of the theory asserts that the main parameters for achieving **C**ollaborative **E**valuation of (**E**nterprise) **A**rchitecture **D**esign **A**lt-ernatives (i.e. CEADA) are effective communication, negotiations, and a shared understanding of baseline and target aspects among enterprise architects and stakeholders. This notion has been supported by findings from evaluating CEADA in a fictitious setting and various real settings. The phenomena represented in the theory and their interrelations are entirely based on existing literature. The theory was formulated by adopting the guidelines of theory-driven design of collaboration systems [12] and the cause-effect analysis concept [45]. Details on the theory are discussed in section 4.2.2.

We also formulated a roadmap that defines the steps we took to move from the theory on CDM in enterprise architecture creation to the desired artifact, i.e. CEADA process. Following the steps in the theory-to-process roadmap (discussed in section 4.3), we adopted architecture communication guidelines in Proper et al. [104] to design a framework for coordinating conversations (among stakeholders and architects) that occur during the execution of collaboration dependent tasks (see section 4.4). Section 4.4 also discusses how the theory on CDM in enterprise architecture creation was used as a basis for (a) adopting approaches that were used to formulate the synergy of collaboration dependent tasks, and (b) adopting techniques that were relevant in the design of CEADA.

Synergy of collaboration dependent tasks. Basing on notions of the theory on CDM in enterprise architecture creation, we formulated the synergy of collaboration dependent tasks in enterprise architecture creation. In the synergy, we structured collaboration dependent tasks into three sessions, i.e. collaborative intelligence, collaborative design, and collaborative choice. Details of tasks executed in each session are presented in chapter 5. The formulated synergy of collaboration dependent tasks is mainly based on (a) two task structuring approaches – the generic decision making process [118] and the multilevel thinking technique [22]), and (b) enterprise architecture creation literature. In addition, the theory notions were used to provide insights into addressing challenges and recommendations from the exploratory survey that we conducted among enterprise architects. These insights were also incorporated into the synergy of collaboration dependent tasks.

Since Checkland [22] warns that unorganized communications or expressions is one of the core causes of unsuccessful human conversations, we devised this synergy to serve as a springboard for structuring conversations on architecture creation or structuring the execution of collaboration dependent tasks.

9.1.1.2 Challenges Faced in Executing Collaboration Dependent Tasks

In the exploratory survey enterprise architects reported challenges they face when they involve stakeholders in architecture creation. From these, we formulated we formulated two taxonomies (as shown in table 9.1 and figure 9.1). First is a taxonomy of problems faced when executing collaboration dependent tasks. It includes ineffective communication, lack of a shared understanding and shared vision or strategy, social complexity, lack of long term planning, lack of a clear decision making process or unit in the organization and architecture governance, lack of supporting tools and techniques for executing collaboration dependent tasks, and other. Second is a taxonomy of recommendations (given by enterprise architects) for addressing the problems they face. It includes explicitly defining the purpose of enterprise architecture creation, collaborating with the right people, communicating clearly and regularly, ensuring an establishment of a clear decision making process and governance framework, and other. As shown in column 4 of table 9.1, these taxonomies are discussed in section 2.3.3. Section 9.1.2 shows which aspects in these taxonomies were addressed in this research, and those that were not addressed.

9.1.1.3 Summary of CEADA

This research has resulted in CEADA, a collaboration process with three modules that provide details on how enterprise architects can facilitate the execution of activities that constitute the synergy of collaboration dependent tasks. In developing CEADA, we investigated the applicability of Collaboration Engineering and Soft Systems Methodology (SSM) into enterprise architecture creation. This investigation triggered the adoption of other types of approaches (i.e. techniques, theories, methods) that support task execution during collaborative problem solving and decision making. Examples of such include, Single Negotiating Texts (SNTs) [107], Ishikawa diagram technique [56], causal loop diagram [103], VPEC-T communication framework [44], and techniques of maximizing group labour (i.e. committees, subcommittees [107], take-a-panel, share-a-panel [51]). Chapter 6 provides a detailed discussion on how these approaches were adopted along with Collaboration Engineering and SSM. The key contribution of CEADA to each of the core adopted approaches is discussed below.

Collaboration Engineering in Architecture Creation. In this research we test and report the applicability of Collaboration Engineering in enterprise architecture creation. This was done by adopting the design approach of collaboration processes by Kolfschoten and Vreede [62] to define execution details of the synergy of collaboration dependent tasks. The benefit of this (to both academia and industry) is two-fold. First, it shows that the enterprise architecture creation methodology can be enhanced by deploying Collaboration Engineering. This can raise further research initiatives geared towards enriching collaboration support in the enterprise architecture creation methodology, and thereby practitioners (i.e. enterprise architects) and their client organizations can greatly benefit. Second, it shows that the application areas of Collaboration Engineering extend to the enterprise architecture field. Accordingly, this gives insight into research demands that arise from the challenges that collaboration dependent tasks in enterprise architecture creation place on Collaboration Engineering thinkLets. More on this is provided in section 9.3.

SSM in Architecture Creation. In this research we test and report the applicability of SSM in enterprise architecture creation. This was done by adopting the techniques used in SSM by Checkland [22], i.e. Rich Picture, Analysis One Two Three, Root Definitions, CATWOE analysis, and activity models. On the one hand, these techniques were adopted to formulate diagram templates that were used to gather baseline and target information on an enterprise. In addition, the diagram templates that were formulated based on these SSM techniques helped to enhance the execution of collaboration dependent tasks that require classification of brainstormed aspects on baseline and target information on an enterprise. Such tasks are perceived as to as convergence tasks in Collaboration Engineering (see e.g. [26]). Chapter 6 provides a detailed discussion of these aspects. On the other hand, SSM debates or deliberations on activity models (and Root Definitions and CATWOE analysis) can be facilitated using thinkLets in Collaboration Engineering. Specifically, this thesis shows how the LeafHopper, FreeBrainstorm, and FastHarvest thinkLets can be used to gather information that is used in the formulation of SSM deliverables (i.e. the Rich Picture, Analysis One Two Three, Root Definitions, CATWOE analysis, and activity models). Thus, to both academia and industry, the benefit of this research is that it shows how the enterprise architecture creation methodology and Collaboration Engineering can both benefit from SSM, and how SSM can benefit from Collaboration Engineering. Thereby, research initiatives on further investigation into these two directions can be undertaken. More on this is provided in section 9.3.

Collaboration Engineering and SSM in Architecture Creation. In this research Collaboration Engineering was adopted to design CEADA, while SSM was adopted to supplement thinkLets that constitute CEADA with support for visualization, categorization, and organization of aspects during execution of collaboration dependent tasks. Thus, CEADA is an orchestration of thinkLets selected to enable architects to manage stakeholder involvement in enterprise architecture creation during the execution of collaboration dependent tasks. CEADA uses a set of eight thinkLets, i.e. LeafHopper, DealersChoice, FreeBrainstorm, FastHarvest, Concentration, ReviewReflect, StrawPoll, and CrowBar. Reasons why these thinkLets were chosen are provided in section 6.5. In addition, CEADA uses a set of at least seven diagram templates i.e. the diagram template for process attributes, symbol set for Rich Picture, diagram template for problem analysis, diagram template for Analysis One Two Three, diagram template for requirements elicitation, diagram template for requirements elaboration or scenarios formulation, and diagram template for purpose of architecture effort. These templates are discussed in sections 6.2.2 and 6.2.3. CEADA's thinkLet notation model (in appendix C) shows how diagram templates can be used along with the LeafHopper, DealersChoice, FreeBrainstorm, FastHarvest, Concentration, and ReviewReflect thinkLets.

9.1.1.4 Summary on CEADA Evaluation

The design of CEADA has been evaluated using the analytical evaluation method, experiment evaluation method, and Action Research method in at least eight enterprises. Section 7.2 discusses why these evaluation methods were used, and section 1.8.1 specifically discusses the reason why in this research we adopted both Design Science and Action Research. Findings from each evaluation method led to refinements in the earlier versions of CEADA. The theory on CDM in enterprise architecture creation helps to explain some incidences associated with the performance of CEADA in the experiment and in the real enterprises in which CEADA was evaluated (as discussed in section 7.7 – 7.9). Chapter 7 discusses details of CEADA's evaluation and performance, but below we give a key highlight thereof.

Key attributes of a collaboration process are repeatability, predictability, and transferability [12, 14, 130]. Based on evaluation findings on CEADA's performance in eight real enterprises (discussed in sections 7.8 and 7.9), it can be claimed that CEADA is a repeatable and predictable process for supporting the execution of collaboration dependent tasks. This is discussed in section 7.10. CEADA is repeatable because when it is used in different enterprises (to support the execution of collaboration dependent tasks during enterprise architecture creation), the patterns of reasoning it creates in those enterprises are somewhat alike. This is indicated by the mean scores of CEADA under particular evaluation goals (as discussed in the evaluation results in sections 7.8 and 7.9). In addition, although the use of CEADA in each enterprise requires customization (which can be done basing on the clues provided in section 6.6), it is predictable in supporting the execution of collaboration dependent tasks (as discussed in sections 7.8 and 7.9).

This research generally attempted to strengthen enterprise architecting guidelines with support for collaboration dependent tasks, so as to achieve CDM in enterprise architecture creation. This support has been packaged in CEADA. Chapter 8 discusses an example of how CEADA supplements existing enterprise architecture approaches with support for executing collaboration dependent tasks. The example in chapter 8 shows the use of CEADA in the Architecture Development Method (ADM) of the The Open Group Architecture Framework (TOGAF). In this example, CEADA is visualized as a potential plug-in for enterprise architecture frameworks.

9.1.2 Answers to Some of the Survey Findings

CEADA is an effort towards resolving challenges in enterprise architecting that are encountered when enterprise architects involve organizational stakeholders in enterprise architecture creation. Table 9.2 gives an overview of how CEADA responds to aspects on problems and recommendations that were reported in the survey (see section 2.3.3). Column 2 of table 9.2 shows the problem categories that were obtained by classifying the challenges that enterprise architects reported in the survey. Column 3 of table 9.2 shows the recommendation categories that were obtained by classifying the recommendations (given by enterprise architects in the survey) on how the problems they reported could be addressed. This research has addressed some aspects in each of these categories, as shown in column 4 of table 9.2. Below we discuss how specific aspects under each category (in table 9.2) were addressed. Specific issues from the survey that were not addressed are given in section 9.3.

On addressing ineffective communication. From section 2.3.3, specific aspects under this problem are listed below (in italics) along with an indication of how CEADA addresses each.

- *Limited awareness of architecture among stakeholders.* As shown in row 2 of table 9.2, CEADA addresses this by providing explicit details on what, when, how, and why to communicate (and the audience to communicate to). This is discussed in the design of the three CEADA modules in section 6.4.

Table 9.2: *CEADA's Attempt to Addresses Aspects from the Survey*

#	Problem category from the survey	Recommendation category from the survey	CEADA's attempt to address a given challenge or recommendation from the survey
1	Ineffective communication	Communicate clearly and regularly	CEADA process design indicates what can be communicated and when (signified by the structure of the execution plan or agenda), how it can be communicated (tools or media to be used), why (purpose of communication), and to who (audience or type and number of stakeholders).
2	Lack of a shared understanding and shared vision or strategy	Explicitly define purpose of enterprise architecture creation	In CEADA we adopted various techniques which we used to formulate diagram templates that can be populated with data and then discussed to increase stakeholders' understanding of the baseline and target situation.
			In CEADA we adopted techniques for maximizing group labour which we used to devise four ways of dividing stakeholders into small groups so as to enhance communication, interactions, and negotiations.
3	Social complexity	Collaborate with the right people	In CEADA we indirectly address some aspects on this problem to some extent through providing support for creating a shared understanding. Notion H of the theory on CDM in architecture creation states that an increase in shared understanding leads to an improvement in priorities of stakeholders.
			The labour division flavors in CEADA enable flexible collaboration with stakeholders. Thus, group sessions can be separately organized with stakeholders in a given type of division. In CEADA interviews and group sessions are used in a complementary way.
4	Lack of a clear decision making procedure in the organization	Establish a clear decision making process and architecture governance framework	In the collaborative intelligence session of CEADA, current and possible problem owners and solution owners are identified, members of architecture board are chosen, and roles of the architecture board and the problem and solution owners in the architecture creation effort are defined.
5	Lack of long term planning		CEADA attempts to be exhaustive in analyzing the baseline and target situations by using its various diagram templates.
6	Lack of supporting tools and techniques for executing collaboration dependent tasks	Other	CEADA provides detailed operational guidelines of using two methods that are widely used in practice to support execution of collaboration dependent tasks, i.e. the interview method and the workshop method.
7	Other		

- *Difficulty in using a language that is understandable by every stakeholder.* To address this, CEADA adopts the VPEC-T (i.e. Values Policies Events Content Trust) vocabulary in the formulation of topics for discussion regarding the baseline or target situation of the enterprise. This adoption is discussed in section 6.2.3. Also, examples of topics of discussion formulated based on VPEC-T framework are provided in appendix C.

- *Difficulty in making a short and clear presentation about the architecture that leads to decision making and hides unnecessary details.* In addressing this, CEADA has various diagram templates where one can choose those that are opportune for guiding a focused discussion among stakeholders. The discussion of architecture models then focuses on showing how aspects in the selected diagram templates are catered for in the architecture models, and the positive and negative implications of design options in the architecture models. This is discussed in section 6.4.3.

On addressing lack of shared understanding. From section 2.3.3, specific aspects under this problem are listed below (in italics) along with an indication of how CEADA addresses each.

- *Lack of a shared understanding among stakeholders and difficulty in reaching compromise/agreement on crucial aspects.* As shown in table 9.2, CEADA addresses this by using a set of diagram templates (which are discussed in sections 6.2.2 and

6.2.3). In addition, table 9.2 shows that CEADA uses four ways of dividing stakeholders, i.e. specialization-driven division, task-driven division, interest-driven division, and governance-driven division. These ways of dividing group labor are discussed in section 6.2.3. Dividing stakeholders into small groups during the execution of collaboration dependent tasks (that involve converging and organizing brainstormed aspects) helps to increase shared understanding of particular aspects among stakeholders. This is discussed in sections 7.8 and 7.7.

- *Lack of documentation of knowledge in the organization.* CEADA diagram templates provide means for gathering undocumented enterprise information (e.g. operational processes, information exchanges, partnerships, problems faced) regarding the baseline and the target situation.

- *It is difficult to bridge the gap between abstract long term consequences and concrete examples that stakeholders can understand.* To address this, CEADA supports the formulation of solution scenarios (also perceived as detailed business requirements) using the diagram template for scenarios formulation (or requirements elaboration). This template helps stakeholders to give concrete examples or operation incidences regarding the baseline situation and target situation. From these incidences, long term consequences of particular design options or transformation options can be determined and assessed. This is discussed in section 6.4.2.

On addressing social complexity. In section 2.3.3, specific aspects under this problem are listed below (in italics) along with an indication of how CEADA addresses each.

- *Conflicting stakeholders' interests and differences in perception.* Table 9.2 shows that this research does not directly address this problem but indirectly addresses it basing on notion H of the CEADA theory.

- *Key stakeholders have no/insufficient time (or low priority) for participating in collaborative tasks, which causes delays in the architecture architecture project time schedule.* As shown in table 9.2, the four ways of dividing group labour encourage the complementary use of interviews and group sessions in CEADA. This then enables one to schedule short exploratory interview sessions, validation interview sessions, exploratory group sessions, and validation group sessions based on a given division. These types of sessions enable stakeholders who are not part of a given type of subgroup not to attend a given group session or interview session. This is discussed in sections 6.6, 7.6.1, and 7.6.2.

- *Biased scores or judgments due to personal preferences, agendas, visions, or the "Not Invented Here" syndrome among stakeholders.* In CEADA we adopted the SNT technique, where we treat diagram templates and architecture models as SNTs that are critiqued by stakeholders until acceptable representations are obtained. As shown in table 9.2, notion H of the theory on CDM in architecture creation shows how CEADA attempts to partially addresses this issue. CEADA also elicits information on cultural factors in an organization using the diagram template for Analysis One Two Three (see section 6.2.2). Studying cultural factors helps the architect to make architecture design decisions that are in line with the organization's norms and values. These aspects are discussed in section 6.4.

On addressing lack of a clear decision making process and lack of long term planning. In section 2.3.3, specific aspects under these problems are listed below (in italics) along with an indication of how CEADA addresses each.

- *Lack of commitment from people who were not earlier involved in the architecture process, or in other cases concerns arise from other stakeholders who were not seen as key stakeholders before.* As shown in table 9.2, CEADA avoids this by prompting an exhaustive identification of current and possible problem or solution owners, and members of the architecture board. This is done by using a variety of techniques that enable a thorough analysis of the baseline situation, e.g. the diagram template for problem analysis, diagram template for Analysis One Two Three, the causal loop diagram. These templates provide insights into the current and possible problem and solution owners, and the cultural and political factors. These templates are discussed in section 6.2.2 and details of when and how they are used are discussed in section 6.4.
- *Lack of a clear decision making process results in stakeholders not being accountable for their decisions.* CEADA attempts to address this by ensuring that members of the architecture board are selected in the collaborative intelligence session, and these are responsible for all decisions made during enterprise architecture creation. This is discussed in section 6.4.1.
- *Since architecture is often perceived to be about only technology, some organizations lack a governance process for ensuring architecture compliancy.* In the collaborative intelligence session of CEADA, the architecture board is selected and one of the purposes it serves is to be a governance body that ensures architecture compliance.

On addressing the lack of supporting tools and techniques for executing collaboration dependent tasks. As shown in the last row of table 9.2, CEADA attempts to address this by providing detailed operational guidelines of how enterprise architects can use interviews and workshops in a complementary way to manage the execution of collaboration dependent tasks during architecture creation. The interview and workshop methods were considered because they are widely used in practice to support execution of collaboration dependent tasks (as indicated in the survey results in section 2.3.3).

9.2 Reflection

The major strengths and weaknesses of CEADA are summarized in sections 9.2.1 and 9.2.2 below.

9.2.1 Strengths of CEADA

Through the adoption of Collaboration Engineering, SSM, and several other concepts and techniques discussed in sections 6.2.3 and 3.9, the developed CEADA has the following strengths.

CEADA's selected set of thinkLets. CEADA comprises three modules, i.e. collaborative intelligence, collaborative design, and collaborative choice. In these modules it uses nine thinkLets, seven of which are frequently reused. The reused thinkLets include

LeafHopper, FreeBrainstorm (in tasks that involve brainstorming of aspects), FastHarvest, Concentration, ReviewReflect (in tasks that involve converging of brainstormed aspects), StrawPoll, and CrowBar (in tasks that involve evaluating aspects by prioritizing, ranking, rating, or voting). Reasons why these thinkLets were chosen and are frequently reused in CEADA are given in section 6.4. The other two selected thinkLets that are used once in CEADA are DealersChoice and MultiCriteria.

CEADA's set of diagram templates. CEADA's thinkLet layer is enriched with diagram templates that were formulated based on SSM techniques and other techniques. These diagram templates are used to (a) trigger compound questions that enable focused brainstorming and discussions on baseline and target aspects of the enterprise, (b) guide the reduction, clarification, and organization of brainstormed aspects, and (c) provide support for visualization of aspects during execution of collaboration dependent tasks that involve the convergence pattern of reasoning. CEADA's set of diagram templates includes the diagram template for process attributes, symbol set for Rich Picture, diagram template for problem analysis, diagram template for Analysis One Two Three, diagram template for requirements elicitation, diagram template for requirements elaboration or scenarios formulation, and diagram template for purpose of architecture effort.

CEADA's four flavors of dividing group labour. CEADA uses four ways of dividing stakeholders so as to (a) enable effective communication, increase interactions, and enhance negotiations when executing collaboration dependent tasks, and (b) make use of the limited time that stakeholders have. These four ways include the governance-driven division, specialization-driven division, task-driven division, and interest-driven division. These divisions are discussed in section 6.2.3. When any of the four types of division is invoked, one can schedule short exploratory interview sessions, validation interview sessions, exploratory group sessions, and validation group sessions (as discussed in section 6.6). With these schedules, stakeholders that belong to particular subgroups can be invited to the interview session or group session where their skills are considered relevant. This explains why CEADA enables the supplementary use of interviews and workshops, such that the weaknesses associated with using only interviews are somewhat overcome by the strengths of using workshops (and the weaknesses associated with using only workshops are somewhat overcome by the strengths of using workshops).

9.2.2 Weaknesses of CEADA

The following are the key issues that are still missing in CEADA.

CEADA has not addressed some issues associated with social complexity that were reported by enterprise architects who participated in the exploratory survey (which is discussed in section 2.3.3). Two key issues under social complexity remain unaddressed by CEADA. First, stakeholders climbing the ladder of inference, i.e. overreacting or quickly drawing conclusions based on personal beliefs and insecurities. Second, organization politics and hidden agendas, which often result in a fuzzy decision making procedure and block long term visions to achieve short term and selfish needs. CEADA only supports the identification and assessment of political factors by adopting the Analysis One Two Three technique of SSM (see section 6.2.2). It does not provide details of how to overcome these factors. In section 2.2.3, addressing organization politics was declared to be beyond the scope of this research. However, organization politics is a potential risk in modern business environments that can fix an organization into a rigid posture [102].

Ideas in, e.g. [121], need to be adopted and enhanced in order to overcome hindrances caused by organization politics during enterprise architecture creation.

In addition, CEADA has not addressed issues that are associated with enhancing the creativity of stakeholders during architecture creation. Despite, notions J and K of the formulated theory on CDM in enterprise architecture creation, there is still need to investigate ways of enhancing creativity during the execution of collaboration dependent tasks associated with creating target architectures. Moreover, there is need to investigate whether CEADA's diagram templates do not limit group creativity.

Also, CEADA only considers same-time-same-place type of meetings when executing collaboration dependent tasks during enterprise architecture creation. Yet from the discussions in sections 7.6.1 and 7.6.2, the issue of stakeholders having insufficient time to attend group sessions has not been fully addressed. There is need to, for example, adopt ways of having distributed group sessions so as to involve stakeholders who can not attend a given group session at a given time. This is because some architecture creation aspects can not be efficiently executed by the supplementary use of interview sessions and group sessions (as proposed in this research). Thus, CEADA needs to cater for possibilities of supporting settings where collaboration dependent tasks are executed using other types of meetings, i.e. same-time-different-places, different-time-different-places, different-time-same-place types of meetings (which are discussed in section 3.5.2).

9.3 Future Research

The weaknesses explained in section 9.2.2 imply the following avenues for future research.

On further evaluation of CEADA. This far CEADA has been evaluated in settings where researchers are actively involved in the facilitation of its modules (see chapter 7). There is now need to explore and evaluate CEADA's transferability by evaluating it in settings where practitioners (real enterprise architects) use CEADA with their clients. In the further evaluation of CEADA other evaluation goals include the following.

1. On support for effective communication. How can effective communication be achieved when organizational stakeholders fully participate in the creation of an enterprise architecture? This is because CEADA still scores low under the subgoal of "understanding reasons why my concerns could not be satisfied or voted by others".

2. On support for shared understanding. In this research we provided insights into how stakeholders and enterprise architects can reach a shared conceptualization and understanding of the problem and solution aspects relating to the creation of an enterprise architecture in the organization, and how they can reach consensus on the requirements, quality criteria, and solution scenarios that must be addressed by the architecture of their organization. However, there is need to investigate whether it is possible to achieve or create a complete shared understanding of these solution aspects among stakeholders.

3. On evaluating enterprise architecture design alternatives. So far we have provided insights into how can enterprise architects and organizational stakeholders collab-

oratively select an appropriate (or effective[1], efficient[2], and feasible) enterprise architecture design alternative for the organization. However, we do not go into details of enhancing the evaluation and selection of design alternatives by conducting simulations (in a collaborative setting) with respect to components or architecture decisions associated with the enterprise architecture design alternatives. Applying additional approaches to aid this simulation would be appropriate. Such approaches may include System Dynamics modeling (qualitative and quantitative), discrete event simulation. Existing work on simulations in enterprise architecture development can be found in [57].

Also, CEADA's support for evaluating enterprise architecture design alternatives and selecting an appropriate one can be properly evaluated if an EMS is used in CEADA sessions. This is because an EMS enables quick processing of scores of design alternatives. Further investigation of into the use of EMSs and diagram templates may result into insights for improving CEADA.

4. At times the selection of an appropriate target architecture design alternative involves making decisions under uncertainty. According to Raiffa et al. [107], decision making under uncertainty involves examining each decision alternative so as to understand its associated risk profile and implied risk analysis (i.e. risk assessment of the uncertainties, risk evaluation of consequences, and risk management). In CEADA we do not go into details of risk assessment during the evaluation of alternatives in the collaborative choice session. Techniques need to be adopted that can enable collaborative risk analysis of enterprise design alternatives.

5. There is need to look into other factors that cause "satisfaction with the outcome" of CEADA modules. In section 7.4.1 we only considered that "satisfaction with the process" is associated with "satisfaction with the outcome". However other aspects need to be looked into. According to Briggs et al. [18], these factors may include perceived net goal attainment, perceived costs of goal fulfillment attempt, and perceived benefits of goal fulfillment attempt.

6. On Support for creating commitment. Support for creating commitment among stakeholders towards the success of the architecture creation effort. Support for creating or enhancing stakeholders' commitment was determined by stakeholders' dedication to accomplishing the activities in the CEADA process. Stakeholders' dedication takes into account their attendance of the CEADA sessions and willingness to participate and make contributions towards the success of the enterprise architecture creation effort. In this, the performance indicator(s) for this evaluation goal can be determining the number of people who are invited to a meeting compared to those who turn up for the meeting and those who leave the meeting before it ends. Also the number of people who actually make contributions and those who abstain from making contributions.

[1] Effective in this case is concerned with the possibility that (or extent to which) a given architecture design alternative will achieve its planned purpose, without clashing with the organization's rules and conventions.

[2] Efficient in this case is derived from [96], and is concerned with the possibility that (or extent to which) a given architecture design alternative addresses stakeholders' concerns

On CEADA's support for creating baseline architectures. During the problem analysis activity in CEADA's collaborative intelligence, stakeholders are not involved in the formulation of causal loop diagrams, they only discuss aspects represented in those diagrams. There is need to design a group model building script that can guide the collaborative formulation of causal loop diagrams during problem analysis (when compound and nested causes of problems can not be properly represented on CEADA's diagram template for problem analysis). Causal loop diagrams help to clarify fuzzy issues during problem analysis or baseline situation analysis, and may be used as reference points to show the significance of particular business requirements, strategies, goals, principles, and other aspects considered during the evaluation of architecture design alternatives. The relevance of causal loop diagrams in baseline situation analysis is discussed in section 7.9.

On CEADA's support for creating target architectures. As mentioned in section 9.2.2, there is need to investigate ways of enhancing creativity and group productivity during the design of target architectures.

On solving unaddressed issues from the exploratory survey. Below are the issues that were reported in the survey by enterprise architects, but have not been addressed in this research. Further research efforts can be undertaken towards addressing them.

- The two social complexity issues explained in section 9.2.2.
- The time constraint during enterprise architecture creation. From section 9.2.2, in order to have distributed group sessions on conversations in architecture creation, there is need to explore the execution of collaboration dependent tasks using other types of meetings (rather than same-place-same-time meeting). Approaches that support other types of meetings (such as support same-time-different-places, different-time-different-places, different-time-same-place) are available (see section 3.5.2) but their deployment into enterprise architecture creation needs to be made explicit.

On adopting Situational Method Engineering in CEADA. The complementary adoption of Collaboration Engineering and SSM into enterprise architecture creation triggered the adoption of several techniques and fragments of methods. Thus, there is need to adopt Situational Method Engineering [48, 108] such that a situational method can be assembled, that addresses the full breadth and depth of issues associated with achieving collaborative decision making during enterprise architecture creation.

Appendix A Exploratory Survey Details

This appendix first presents the first version of the self administered questionnaire that was pretested among fourteen enterprise architects (see figure A.1). The first version was then refined to obtain the final questionnaire that was used in the survey. This appendix presents a sample of the self administered questionnaire that was used in the exploratory survey (see figures A.2 – A.4), as discussed in section 2.3.2. It also presents tables of results obtained from the exploratory survey (see tables A.1 – A.10), that indicate percentages of enterprise architects who reported particular issues that are discussed in section 2.3.3.

Exploratory survey on Collaborative Aspects in Enterprise Architecture Creation

The aim of this survey is to investigate problematic issues that occur when (enterprise) architects collaborate with organization stakeholders during the architecture development process.

Questions

1. Which architecture method are you currently using (e.g. TOGAF, IAF, DYA etc)?
   ……………………………………………………………………………………………………
2. Do you consider the architecture development process to be collaborative in nature?
   YES NO

If YES to (2) above, please answer questions 3-13; If NO to (2) above, please jump to questions10-13

3. How do you manage collaborative tasks during the architecture creation process?
   A. Conducting interviews with stakeholders
   B. Conducting workshops with stakeholders
   C. Using Group support system software in the workshops: Please mention the software used ……………………………………………………………………………...................
   D. Other method, please specify…………………………………………………………………
4. Please mention a strength and/or weakness of the approach you have mentioned in (3) above.
   ……………………………………………………………………………………………………
5. What are the factors that hinder effective collaboration between architects & key stakeholders during the architecture development process?
   ……………………………………………………………………………………………………
6. Do you also engage organisation stakeholders during the evaluation of architectural designs alternatives? YES NO
7. If YES to (6) above, what type of organisation stakeholders do you engage in the evaluation of architectural design alternatives?
   ……………………………………………………………………………………………………
8. If YES to question (6) above, what challenges do you face during the evaluation of architecture design alternatives?
   ……………………………………………………………………………………………………
9. If YES to (6), which method do you use to conduct the task of evaluating architectural design alternatives together with stakeholders?
   ……………………………………………………………………………………………………
10. Do you face any challenges related to acceptance of the products you deliver after the architecture creation process? YES NO
11. If YES to (9) above, please give some example(s) of such challenges.
    ……………………………………………………………………………………………………
    ……………………………………………………………………………………………………
12. From your experience, which factors have affected the overall success of the architecture creation process?
    ……………………………………………………………………………………………………
13. We are developing a method to manage collaborative tasks in enterprise architecture. We will be conducting another questionnaire survey with the aim of validating the design of the method. Would you be interested in participating in the second survey?
    NO YES (please provide your contact)…………………………………..
14. We will also carry out an experiment on the designed method, would you be interested to participate in the validation experiment of such a method?
    NO YES (please provide your contact)…………………………………..

Thank you very much for your cooperation

Figure A.1: *First Version of the Questionnaire for the Survey*

Table A.1: *Enterprise architecture creation vs. acceptance of its products*

Question posed to the enterprise architect		Facing any challenges related to acceptance of products from enterprise architecture creation?	
		Yes	No
Do you consider enterprise architecture development collaborative in nature?	Yes	90%	10%
	No	100%	0%

Table A.2: *Challenges enterprise architects face that are related to acceptance of the products they deliver after architecture creation*

#	**Example of acceptance-related challenge faced**	**Architects facing this challenge**
1	Lack of a clear decision making unit in the organisation, leading to several applauses but no actions	44%
2	Lack of a governance process to ensure architecture compliancy, since architecture is perceived to be about only technology	44%
3	Architecture conclusions may sometimes conflict with personal ambitions or agendas	37%
4	Changes in business plans of the client organisation	37%
5	Using the right language for every stakeholder to understand the architecture	34%
6	Architecture may be too complex for the decision making unit or organisation maturity level	29%
7	Lack of commitment from people who were not earlier involved in the architecture process	24%
8	Concerns of other stakeholders who were not seen as stakeholders before	21%
9	Translation of enterprise architecture products to program start architectures	17%
10	Making a short and clear description of the architecture to all stakeholders within the limited time	13%
11	Products do not often deliver what has been promised or what was required	11%
12	Other examples (i.e. organisation stakeholders who do not want to, or are not able to, follow that advised architecture; when the created architecture shows that the impact of the organisation initiative is higher than anticipated)	3%

<u>Exploratory survey on Collaborative Aspects in Enterprise Architecture Creation</u>

The aim of this survey is to investigate problematic issues that occur when (enterprise) architects collaborate with organization stakeholders during the architecture development process.

1. Which architecture method(s) are you currently using?
   a) TOGAF
   b) DYA
   c) IAF
   d) ArchiMate
   e) Zachman
   f) GEA (General Enterprise Architecturing)
   g) Panfox (Infra structural approach)
   h) Other method (please specify) …………………………………..

2. Do you consider the architecture development process to be collaborative in nature?
   a) YES b) NO

3. If YES to (2) above, which method do you use to manage collaborative tasks during architecture creation?
   a) Interviews with stakeholders
   b) Traditional workshops with stakeholders
   c) Use of group support systems in workshops with stakeholders
   d) Capgemini accelerators like Accelerated Solutions Environment (ASE) and Innovate
   e) Desk research and modeling
   f) Gaming
   g) Rapid design workshops (facilitated workshops)
   h) Other method (please specify) ………………………………………..

4. Please give a strength and/or weakness of the collaboration management method(s) that you use during architecture creation ……………......………………………………………………………………………………….

5. Which factors hinder effective collaboration between architects and key stakeholders during architecture creation?
   a) Time constraints i.e. unavailability of key stakeholders because they have no time or priority to collaborate, and unrealistic project time schedules
   b) Project budget constraints
   c) Lack of long term planning e.g. long term effects may not be considered as part of business case or project goal, project managers are assigned late when projects are already on critical path
   d) Difficulty in truly understanding and communicating with stakeholders, where architects mainly talk about abstract concepts while stakeholders use words that do not have the same meaning for everyone
   e) Conflicting agendas or interests
   f) Organisation politics, hidden agendas (where short term needs of stakeholders block a longer term vision), prima donna behaviors (self-centeredness) of some stakeholders, and cases where people or organization do not want clear decision making
   g) Limited awareness of the need for architecture and stakeholders' opinion about architecture
   h) Lack of documentation of knowledge in the organization
   i) Lack of methods, tools, and techniques
   j) Lack of a well founded and shared vision on enterprise architecture and the consequences of this on sub levels, since some people find it difficult to imagine a new situation
   k) The old fashioned distinction between business and IT
   l) The 100% syndrome of the architect
   m) Not invented here syndrome
   n) Other factors (please specify) …………………………………………………………..

6. Do you also engage organisation stakeholders during the evaluation of architecture design alternatives?
   a) YES b) NO

7. If YES to question (6) above, which type of organisation stakeholders do you engage in the evaluation of architecture design alternatives?
   a) Sponsor or principal of the program or project
   b) Management team of business line or whole company (e.g. CEO, CFO, CIO, COO)
   c) Project manager or project/program director or project leader
   d) The people needed to make the solution work e.g. IT subject matter experts (specialists) and users
   e) Domain owners (system owners), business process owners or directors, data owners, staff experts of all relevant architecture disciplines (i.e. business, enterprise, domain, infrastructure, legal, security, quality etc), and project designers and developers
   f) Board level and one level below
   g) All levels of stakeholders interested in the architecture or depending on size and impact of the project.
   h) Other stakeholders (please specify) ……………………………………..

Figure A.2: *Refined Questionnaire for the Survey (Page One)*

8. Which method do you use to evaluate architecture design alternatives with stakeholders?
   a) Interviews with owners, directors, and sponsors, in order to compare the overall direction of alternatives
   b) Traditional workshop meetings (with fellow architects and subject matter experts) or walkthrough-like workshops, involving presentations and review of documents
   c) Rapid design workshops (facilitated workshops)
   d) Define criteria, assign weights or priorities to criteria, and score each alternative against the criteria (where scores of alternatives are based on their strengths and weaknesses)
   e) Stakeholders give their evaluation of the alternatives in formal written reviews (depending on project sensitivity and need for commitment)
   f) Using gaming or simulation e.g. case or scenario descriptions, role playing, and scenario analysis
   g) No formal policy or procedure is in place over which method to use
   h) Other method (please specify) …………………………………………..
9. Which challenges do you face during the evaluation of architecture design alternatives?
   a) Making a very good presentation that leads to decision making; and is very clear, only containing the essentials and alternatives, and prevents discussions of too much detail
   b) Biased scores due to personal preferences, agendas, and visions; or not invented here syndrome
   c) Lack of a truly shared vision and strategy by all stakeholders
   d) Lack of shared agreement. It is hard to reach a compromise or to get everyone to agree with the same result due to conflicting agendas
   e) Organisation politics
   f) Stakeholders have limited knowledge of content, goals, or how to read an architecture document or view
   g) Time or budget constraints rarely allow continued interactions with stakeholders, so as to break the complexity involved in evaluation of alternatives
   h) Lack of a clear decision making unit in the organisation
   i) Its hard to quantify advantages and disadvantages of alternatives
   j) Bridging the gap between the abstract long term consequences and the more concrete examples that stakeholders can understand
   k) Other challenges (please specify) …………………………………………..
10. Do you face any challenges related to acceptance of the products you deliver after architecture creation?
   a) YES b) NO
11. If YES to question (10) above, which of the following are examples of such challenges?
   a) Often products do not deliver what has been promised or what was required
   b) Changes in business plans of the client organisation
   c) Concerns of other stakeholders that were not seen as stakeholders before
   d) Sometimes architecture conclusions may conflict with personal ambitions or agendas
   e) Lack of a clear decision making unit in the organisation, leading to several applauses but no actions
   f) Architecture may be too complex for the decision making unit or organisation maturity level
   g) lack of a governance process to ensure architecture compliancy, since architecture is perceived to be about only technology
   h) Lack of commitment from people who were not earlier involved in the architecture process
   i) Making a short and clear description of the architecture to all stakeholders within the limited time
   j) Using the right language for every stakeholder to understand the architecture
   k) Translation of enterprise architecture products to program start architectures
   l) Other examples (please specify) ……………………………………………

Figure A.3: *Refined Questionnaire for the Survey (Page Two)*

12. From your experience, which of the following do you consider as success factors for architecture creation?
   a) First create a vision of the enterprise architecture which is shared by top management
   b) Get the business goals clear i.e. know the reasons for creating the architecture or which organisation problems should be solved by creating the architecture
   c) Select the right stakeholders and get involved with them early in the process
   d) Good collaboration with owners or subject matter experts
   e) Create a situation where all stakeholders experience the development process e.g. schedule short group sessions that fit in the schedules of key stakeholders early in the process
   f) Architects, project manager(s), and business executive(s) need to respect each others' roles
   g) Quality of architecture team and the level of collaboration between/among architects
   h) A clear and effective organization of the architecture function
   i) Start on architecture creation as soon as possible and deliver results to key stakeholders in the shortest possible time
   j) Other factors (please specify) ……………………………………………
13. We are developing a method to manage collaborative tasks in enterprise architecture. We will be conducting another questionnaire survey with the aim of validating the design of the method. Would you be interested in participating in that survey?
   a) NO b) YES (please give your contact) ……………………………..
14. We will also carry out an experiment on the designed method, would you be interested in participating in the validation experiment of such a method?
   a) NO b) YES (please give your contact) ……………………………

Figure A.4: *Refined of the Questionnaire for the Survey (Page Three)*

Table A.3: *Factors hindering effective collaboration between architects and organizational stakeholders during the architecture creation process*

#	Factors hindering effective collaboration between architects and organizational stakeholders during the architecture creation process	Architects facing this problem
1	Time constraints i.e. unavailability of key stakeholders because they have no time or priority to collaborate, and unrealistic project time schedules	77%
2	Organisation politics, hidden agendas (where short term needs of stakeholders block a longer term vision), prima donna behaviors (self-centeredness) of some stakeholders, and cases where people or organization do not want clear decision making	56%
3	Difficulty in truly understanding and communicating with stakeholders i.e. architects mainly talk about abstract concepts; they are unable to explain the true value of architecture in a language that the key decision makers understand, while stakeholders use words that do not have the same meaning for everyone.	50%
4	Lack of a well founded and shared vision on the business itself, its future development, its enterprise architecture, and the consequences of the architecture on the organization's sub levels, since some people find it difficult to imagine a new situation	47%
5	Lack of architecture governance and a strong decision making process which leads to stakeholders not taking responsibility for their decisions	47%
6	Limited awareness of (infrastructure) architecture or the need for architecture, stakeholders' perception about architecture (e.g. architecture is perceived to be about only technology), and the gap between (business) operations and enterprise architecture	44%
7	Lack of long term planning e.g. long term effects may not be considered as part of business case or project goal, lack of knowledge of architecture project members (i.e. business and IT staff), project managers are assigned late when projects are already on critical path	42%
8	Social complexity of an organization, conflicting agendas or interests of stakeholders, differences in stakeholders' perception about ambition levels, and ladder of inference (i.e. where conclusions are quickly drawn based on personal beliefs or overreactions)	40%
9	Lack of documentation of knowledge in the organization	31%
10	The old fashioned distinction between business and IT	30%
11	Not invented here syndrome	27%
12	Project budget constraints	24%
13	Lack of methods, tools, and techniques	17%
14	The 100% syndrome of the architect	16%
15	Other factors (i.e. stakeholders are unqualified for tasks assigned to them, stakeholders having an attitude of "the outsider is the expert but the outsider does not understand our situation")	3%

Table A.4: *Existing methods that architects use to manage collaboration with stakeholders*

#	Method Used to Manage Collaboration with Stakeholders	Architects who use it
1	Interviews with stakeholders	90%
2	Traditional workshops with stakeholders	83%
3	Desk research and modeling	53%
4	Rapid design workshops (facilitated workshops)	24%
5	Accelerated Solutions Environment (ASE) and Innovate	13%
6	Use of group support systems in workshops with stakeholders	13%
7	Gaming	9%
8	Other methods (i.e. massive emailing, eXtreme architecting, General Enterprise Architecting (GEA), IMPROVE, thematic workgroups, planning game for XP, peer reviews, elaborate-review cycles or sessions, weekly design authority, crowd sourcing or co-creation methodologies)	16%

Table A.5: *Stakeholder involvement during evaluation of alternatives vs. acceptance of products*

Question posed to the enterprise architect		Facing any challenges related to acceptance of products from enterprise architecture creation?	
		Yes	No
Do you involve stakeholders when evaluating architecture design alternatives?	Yes	91%	9%
	No	67%	33%

Table A.6: *Stakeholders that are often involved in the evaluation of alternatives*

#	Stakeholders involved during evaluation of design alternatives	Architects who involve them
1	The people needed to make the solution work e.g. IT subject matter experts (specialists), operational level workers, and user representatives	73%
2	Project manager or project/program director or project leader	67%
3	Domain owners (system owners), business process owners or directors, data owners, staff experts of all relevant architecture disciplines (i.e. business, enterprise, domain, infrastructure, legal, security, quality etc), and project designers and developers	61%
4	Sponsor or principal of the program or project	57%
5	Management team of business line or whole company (e.g. CEO, CFO, CIO, COO)	47%
6	Stakeholders' involvement depends on the purpose, size, and impact of the architecture project e.g. all levels of stakeholders interested in the architecture are involved, where some stakeholders are only informed, while others participate actively.	41%
7	Board level and one level below	19%
8	Other stakeholders (i.e. partners and suppliers, outsourcing equivalent people)	3%

Table A.7: *Methods used during the evaluation of alternatives with stakeholders*

#	Method used during evaluation of design alternatives	Architects who use it
1	(Traditional) workshop meetings (with fellow architects and subject matter experts) or walkthrough-like workshops, involving presentations and (informal) review of documents	71%
2	Interviews with owners, directors, and sponsors, in order to compare the overall direction of alternatives	63%
3	Define criteria (e.g. budget, key technical constraints, and business priorities), assign weights or priorities to criteria, impact analyses by affected product and services owners, and score each alternative against the criteria (where scores of alternatives are based on their strengths and weaknesses)	46%
4	Stakeholders give their evaluation of the alternatives in formal written reviews (depending on project sensitivity and need for commitment)	31%
5	No formal policy or procedure is in place over which method to use	23%
6	Rapid design workshops (facilitated workshops)	11%
7	Using gaming or simulation e.g. case or scenario descriptions, role playing, and scenario analysis	9%
8	Other methods (i.e. GEA; in front of the whiteboard along with XP planning game; peer reviews by fellow architects who are technically not stakeholders, but are contacted for their experience; Prince II change management process)	4%

Table A.8: *Challenges faced during the evaluation of alternatives with stakeholders*

#	Challenge faced during evaluation of design alternatives	Architects who face it
1	Lack of a truly shared vision and strategy by all stakeholders	53%
2	Organisation politics	40%
3	Making a very good presentation that leads to decision making; and is very clear, only containing the essentials and alternatives, and prevents discussions of too much detail	39%
4	Lack of shared agreement. It is hard to reach a compromise or to get everyone to agree with the same result due to conflicting agendas	36%
5	Lack of a clear decision making unit in the organisation	36%
6	Biased scores due to personal preferences, agendas, and visions; or not invented here syndrome	34%
7	Stakeholders have limited knowledge of content, goals, or how to read an architecture document or view	31%
8	Bridging the gap between the abstract long term consequences and the more concrete examples that stakeholders can understand	31%
9	Time or budget constraints rarely allow continued interactions with stakeholders, so as to break the complexity involved in evaluation of alternatives	24%
10	Its hard to quantify advantages and disadvantages of alternatives	23%
11	Other challenges (i.e. lack of knowledge about architecture as a discipline, over estimation of the change capacity of the organisation - notably IT department)	1%

Table A.9: *Success factors for enterprise architecture creation*

#	Success Factor For Enterprise Architecture Creation	Architects who defend it
1	Get the business goals clear i.e. know the reasons for creating the architecture or which organisation problems should be solved by creating the architecture	72%
2	Select the right stakeholders and get involved with them early in the process	71%
3	Good collaboration with owners or subject matter experts in order to create a strong sense of cooperation and shared objectives. This involves regular communication between architects and stakeholders to keep everyone on track	66%
4	An effective (i.e. understood by and visible to all stakeholders) translation of business goals and interests into the actual architecture, because enterprise architecture is merely a means by which an organisation can achieve its goals, and is not a purpose in itself to have something. Architecture concerns assessment between governorship, guidance and growth.	51%
5	A clear and strong decision making process or architecture board which can make decisions, and a clear mandate for enterprise architects to make decisions within agreed boundaries	48%
6	First create a vision of the enterprise architecture which is shared by top management	48%
7	Start on architecture creation as soon as possible and deliver results to key stakeholders in the shortest possible time	47%
8	Quality of architecture team and the level of collaboration among architects	46%
9	Architects, project manager(s), and business executive(s) need to respect each others' roles	34%
10	A clear and effective organization of the architecture function that is linked to other management frameworks in the organisation	31%
11	Create a situation where all stakeholders experience the development process e.g. schedule short group sessions that fit in the schedules of key stakeholders early in the process	24%
12	Other factors i.e. project principals and their managers should also be evaluated on long term contribution instead of just time and budget as is normal practice; Show short-term benefits of architecture, develop architecture roadmap that fits to the organization's overall maturity, ambitions levels and change proficiency (little steps at a time, slow change management approach); start small, quick wins	4%

Table A.10: *Architecture methods used in practice*

#	Architecture method used	Architects who use it
1	TOGAF	67%
2	ArchiMate	41%
3	DYA	34%
4	IAF	30%
5	Zachman	10%
6	Panfox (Infra structural approach)	7%
7	GEA (General Enterprise Architecturing)	4%
8	Other methods (i.e. IEEE 1471; Archimedes; CITA; IFSA; Atos Consulting; ENEXIS – a variant of working under architecture; Project Start Architectures – inspired by DYA; EAM Pattern catalog; extreme programming; ING ICE; MArch – the more or less outdated method of PinkRoccade; NORA GEMMA; NORA; MARIJ; novius; organisation-specific method; application of different parts of existing methods, depending on the kind of project or as required by the customer)	19%

Appendix B Earlier Versions of CEADA

This appendix presents some of the earlier versions of CEADA (process) models. It specifically presents versions I – II. Version I includes figures B.1 and B.2 and table B.1, and these models were the inputs for the first analytical evaluation iteration. Version I.I includes figures B.3, B.4, B.5 and table B.4, and these models were the inputs to the second analytical evaluation iteration. This appendix also presents summarized notes from each of the six walkthrough sessions that were conducted in the analytical evaluation of the CEADA (process) models. Key highlights from these summarized walkthrough notes (see tables tables B.2, B.3, B.5, B.6) have been discussed in section 7.3.3.

This appendix also presents version II of CEADA (process models). Version II includes figures B.6 and B.7 and tables B.7 and B.8. Tables B.7 and B.8 were the inputs to the experimental evaluation iteration of CEADA (as discussed in section 7.5).

This appendix also presents the one-page CEADA questionnaire that was used to evaluate the design and performance of CEADA. The CEADA evaluation questionnaire was issued to participants or stakeholders who participated in the group sessions in which CEADA was executed (see figure B.8). The CEADA evaluation questionnaire has been discussed in section 7.4.3.

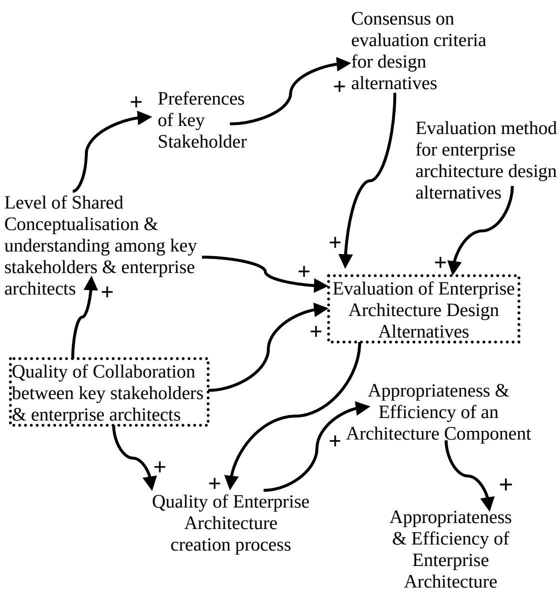

Figure B.1: *Version I of Theory on CDM in Architecture Creation*

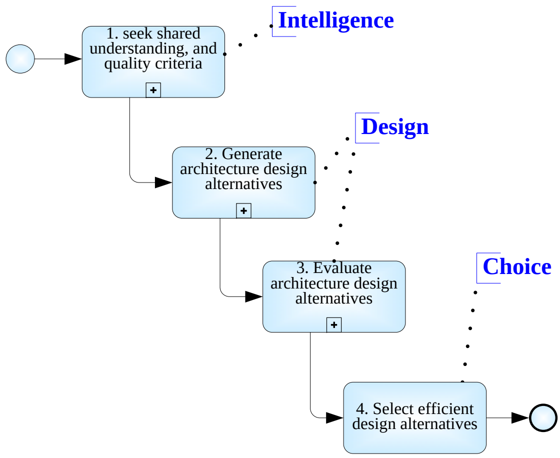

Figure B.2: *Version I of the Synergy of Collaboration Dependent Tasks (Input to Analytical Evaluation Iteration I)*

Table B.1: *Version I of CEADA (Input to Analytical Evaluation Iteration I)*

#	Activity Description	Deliverable	Pattern of Collaboration	ThinkLet
0	Prepare for architecture development sessions	Architecture Development information & sensitization	-	-
SESSION ONE – Shared Conceptualization & Common Evaluation Criteria				
1A	Introduction/Briefing	Guiding information	-	-
1B	Share concerns	Concerns	Generate	LeafHopper
1C	Categorize concerns	Categories of concerns	Reduce & Clarify	FastFocus
1D	Discuss concerns while seeking shared conceptualization & understanding of enterprise aspects	Shared understanding of aspects & a common view of the enterprise	Build Consensus	CrowBar
1E	Identify criteria & methods for evaluating design alternatives	Evaluation criteria & methods	Generate	Free Brainstorm
1F	Categorize criteria & methods	Categories of criteria & methods	Reduce & Clarify	FastFocus
1G	Evaluate criteria & methods	Evaluated criteria & methods	Evaluate	StrawPoll
1H	Agree on evaluation criteria & method	Common evaluation criteria & evaluation method	Build Consensus	MoodRing
SESSION TWO – Generation of Enterprise Architecture Design Alternatives				
2A	Identify design alternatives	Design alternatives	Generate	Comparative Brainstorm
2B	Elaborate alternatives	Elaborated alternatives	Generate	TheLobbyist
2C	Validate alternatives	Validated alternatives	Evaluate	StrawPoll
SESSION THREE – Evaluation and Selection of Design Alternatives				
3A	Evaluate alternatives	Evaluated alternatives	Evaluate	MultiCriteria
4A	Select appropriate & efficient alternative(s)	Appropriate & efficient design	Build Consensus	MoodRing

Table B.2: *Feedback from Analytical Evaluation Iteration I*

#	CEADA Activities	Walkthrough session 1	Walkthrough session 2	Walkthrough session 3
0	Prepare for architecture development sessions	– should not be a trivial activity – type of stakeholders involved affect the value of collaboration & evaluation of alternatives – The type of stakeholders to involve depends on scope of the organization's problem – should include initial definition of organisation problem, & selection of stakeholders to involve in collaboration sessions – initial definition of problem scope initiates determining initial purpose of architecture effort, & preparation of stakeholders' concerns – all collaboration sessions should involve key decision makers of organisation units	– Architect team reveals calendar of events – Architect team briefs stakeholders on what they should expect from the architects, & what architects expect from stakeholders – Architects gain the trust of stakeholders – distribute agenda of a particular collaboration session prior to the session – all collaboration sessions should include key decision makers of organisation units	– determine the type of stakeholders to involve in every collaboration session
1A	Introduction/ Briefing		– communicate purpose of the session & kind of information being sought for – get feedback on the agenda of a session	
1B	Share concerns	– is successful if concerns were prepared by stakeholders prior to the session	– make explicit the type of concerns that stakeholders should share	– relevant
1C	Categorize concerns	– relevant	– relevant	– clarify how to categorize concerns
1D	Discuss concerns, seek shared conceptualization & understanding of enterprise aspects	– should seek for common understanding of organization's problem scope, & initial purpose of the architecture effort, among other aspects	– relevant	– Should also validate stakeholders' concerns against principles – valid concerns are vital for defining criteria & method for evaluating alternatives
1E	Identify evaluation criteria & methods for alternatives	– is driven by the business goals to solve the organization's problem	– relevant	– relevant
1F	Categorize criteria & methods	– should instead involve validating criteria to be SMART	– relevant	– relevant

Table B.3: *Feedback from Analytical Evaluation Iteration I – continued*

#	CEADA Activities	Walkthrough session 1	Walkthrough session 2	Walkthrough session 3
1G	Evaluate criteria and methods	– relevant	– relevant	– relevant
1H	Agree on evaluation criteria and method			
2A	Identify design alternatives	– is driven by criteria balance – Should include stakeholders like business analysts, innovation department	– Architects may identify alternatives prior to session – Is hard to achieve in the case of principles. Architects compiles them – invite stakeholders to brainstorm on business requirements	– For the case of principles, architect compiles the list
2B	Elaborate alternatives	– relevant	– Indicate against each alternative, consequences (positives & negatives) of choosing it. – In the case of business requirements, stakeholders should categorize them	– stakeholders help in the elaboration of principles
2C	Validate alternatives	– effective & efficient if evaluation criteria are SMART – seeking for feasibility of alternatives	– seeking for feasibility of alternatives – stakeholders need to validate principles	– stakeholders need to validate principles
3A	Evaluate alternatives	– Ranking method is used in the case of defining architecture principles	– seeking quality of alternatives – In case of principles, stakeholders prioritize them – In case of architecture scope & constraints, negotiation dominates – In case of business requirements, stakeholders prioritize them	– for principles, stakeholders prioritize principles – In practice, architect evaluates alternatives by performing cross tabulation of principles against alternatives – architects need to consider relevance of opinion of each stakeholder by assigning weights to stakeholders
4A	Select appropriate & efficient alternative(s)	– may need to investigate candidate solution alternatives for more detail, before a final selection is done	– seek consensus on selected alternative(s)	– members of architecture board makes the final decision in the case of TOGAF

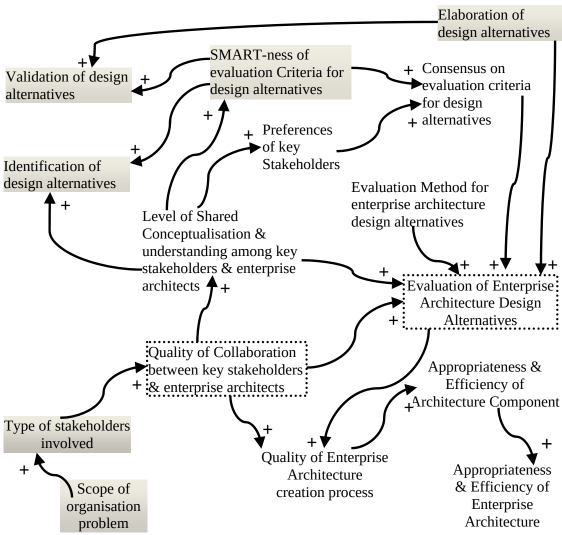

Figure B.3: *Version I.I of Theory on CDM in Architecture Creation (Input to Analytical Evaluation Iteration II)*

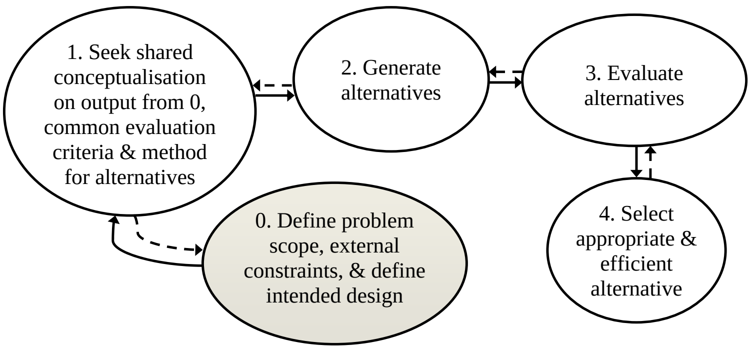

Figure B.4: *Version I.I of the Synergy of Collaboration Dependent Tasks (Input to Analytical Evaluation Iteration II)*

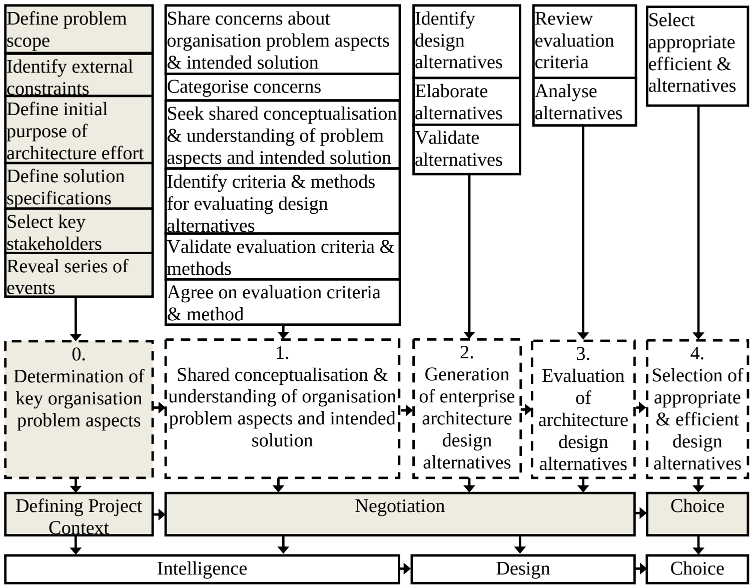

Figure B.5: *Decomposition of Tasks in the Synergy of Collaboration Dependent Tasks*

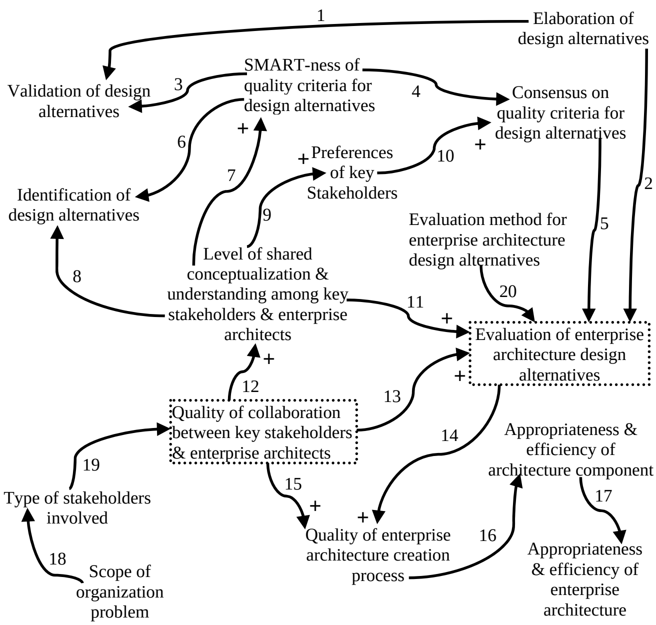

Figure B.6: *Version II of Theory on CDM in Architecture Creation*

Table B.4: *Version I.I of CEADA (Input to Analytical Evaluation Iteration II)*

#	Activity Description	Deliverable	Stakeholders involved	Pattern of Collaboration, ThinkLet
0.1	Define initial organisation problem scope	Initial problem scope	Senior management	-
0.2	Identify external constraints	Nonnegotiable constraints		
0.3	Define initial purpose of the architecture effort	purpose of the architecture effort		
0.4	Select key stakeholders to participate in subsequent collaboration sessions	Key stakeholders to collaborate with architects		
0.5	Reveal calendar of events for architecture effort & expectations of architect team & key stakeholders	Calendar of events & expectations	All selected stakeholders	
SESSION ONE – Seeking Shared Conceptualisation & Defining Common Evaluation Criteria				
1.1	Introduce purpose of session, kind of information required, organisation problem scope, & initial purpose of architecture effort	Guiding information	Decision makers of different organisation units	-
1.2	Stakeholder share concerns about initial purpose of the architecture effort & other aspects on organisation problem scope	Concerns		Generate, LeafHopper
1.3	Categorise concerns by type & organisation domains	Categories of concerns		Reduce & Clarify, FastFocus
1.4	Discuss concerns while seeking shared conceptualisation & understanding of problem aspects and initial purpose of architecture effort	Shared conceptualisation & understanding of problem aspects & architecture purpose		Build Consensus, CrowBar
1.5	Validate stakeholders' concerns	Valid concerns		Evaluate, StrawPoll
1.6	Agree on amendments to problem and solution aspects	Amendments to problem scope, and architecture purpose		Build Consensus, MoodRing
1.7	Identify criteria & methods for evaluating design alternatives	Evaluation criteria & methods		Generate, FreeBrainstorm
1.8	Validate criteria & methods	Valid criteria		Evaluate, StrawPoll
1.9	Agree on evaluation criteria & method for design alternatives	Common evaluation criteria & evaluation method		Build Consensus, MoodRing
SESSION TWO – Generation of Enterprise Architecture Design Alternatives				
2.1	Introduction/Briefing	Guiding information	Business analysts, process innovations unit, IT architects, etc	-
2.2	Identify design alternatives	Design alternatives		Generate, ComparativeBrainstorm
2.3	Elaborate design alternatives	Elaborated design alternatives		Generate, TheLobbyist
2.4	Validate design alternatives	Validated design alternatives		Evaluate, StrawPoll
SESSION THREE – Evaluation and Selection of Design Alternatives				
3.1	Introduction/Briefing	Guiding information	Decision makers of organisation units	-
3.2	Evaluate valid design alternatives	Evaluated design alternatives		Evaluate, MultiCriteria
4	Select appropriate & efficient design alternative	architecture design component		Build Consensus, MoodRing

Table B.5: *Feedback from Analytical Evaluation Iteration II*

#	CEADA Activities	Walkthrough session 4	Walkthrough session 5	Walkthrough session 6
0.1	Define organisation problem scope	– Identifying problem scope and external constraints are vital activities as they are key inputs to visioning and strategy development in a business transformation initiative – Factors like business requirements, business strategy and objectives are vital inputs when defining the problem scope. At this level, detailed information on these factors may not be available but there should be pointers to them, in order to define a clear problem scope – fixed external legal constraints guide the formulation of solution aspects	– Interviews are not a suitable way to achieve these tasks; instead group support system can be used – Pre-existing data files and models (developed using other applications) can be used along with the group support system to enable informed and successful discussions of these aspects – Pre-existing data files and models that were developed (using other applications) before/during step 0 can be used when briefing and executing activities in other sessions	– these activities are important because they yield the first set of design principles – they relate to sponsor meetings in the ASE concept – In practice, ASE is used to address collaboration aspects when developing IAF artifacts
0.2	Identify external design constraints			
0.3	Define purpose of the architecture effort	– defining purpose of the architecture effort is based on a clear problem scope	– relevant	
0.4	Define high level design specifications	– should be global or high level specifications of the solution, and should not be confused with low level implementation (design) alternatives – explicitly define the type of design alternatives that CEADA is addressing – architect takes part in defining low level principles		
0.5	Select key stakeholders to participate in subsequent collaboration efforts	– relevant		
0.6	Reveal calendar of events for architecture effort & expectations of architect team & key stakeholders			– relevant
1.1	Define purpose of session, kind of information required, organisation problem scope, & initial purpose of architecture effort	– relevant	– relevant	– relevant – this can be a plenary activity (e.g. plenary presentation that begins the Scan phase of ASE)

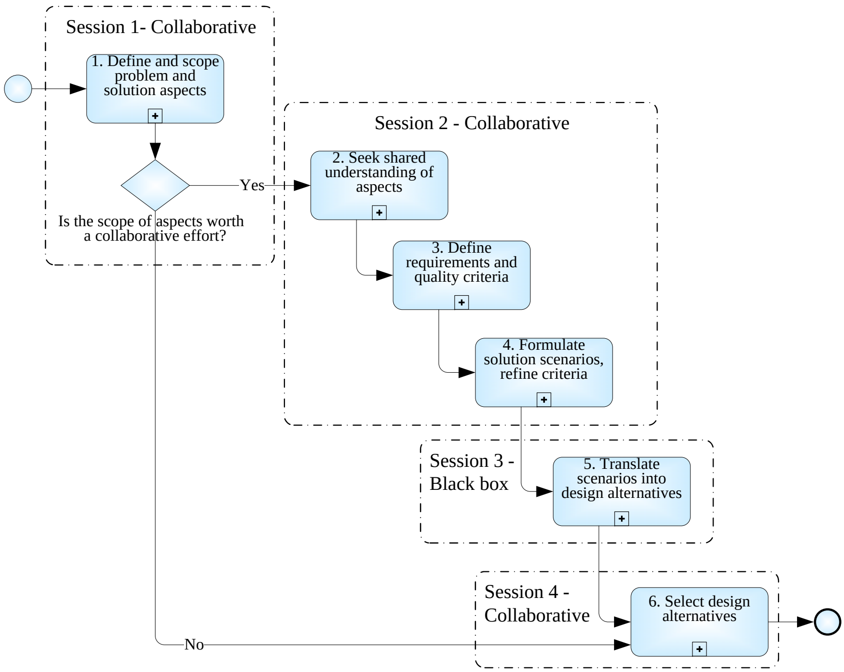

Figure B.7: *Version II of the Synergy of Collaboration Dependent Tasks*

Table B.6: *Feedback from Analytical Evaluation Iteration II – continued*

#	CEADA Activities	Walkthrough session 4	Walkthrough session 5	Walkthrough session 6
1.2	Stakeholders share concerns about problem and solution aspects obtained from session 0	– relevant	– Classify concerns into: concerns associated with problem scope; and concerns associated with solution specifications and negotiable constraints	– this activity can be executed in parallel sessions (in Scan phase of ASE) using where “take-a-panel” technique – participants can be divided according to their organisation domains
1.3	Categorize concerns by type and organisation domains	– relevant	– relevant	– this activity can be executed in parallel sessions using where “share-a-panel” technique of ASE – each participant in each group explains their concerns to group members to understand – a strict time constraint should be assigned to each participant
1.4	Discuss concerns while seeking shared conceptualisation & understanding of problem and solution aspects		– relevant – models developed in preparatory session can also be used	– these must be plenary activities – discussion of concerns can be done after presentations of categorized concerns from the parallel sessions of take-a-panel and share-a-panel
1.5	Validate stakeholders’ concerns			
1.6	Agree on amendments to problem and solution aspects			
1.7	Identify criteria & methods for evaluating design alternatives	– Output from session 0 can be used to define criteria for evaluating design alternatives – Selection of methods for evaluating design alternatives is not the role of stakeholders. – define the type of evaluation criteria (i.e. business criteria, architectural criteria, governance criteria, & operational criteria)		– these can be executed as parallel sessions using “take-a-panel”, and participants divided based on their organisation domains
1.8	Validate evaluation criteria and methods			
1.9	Agree on evaluation criteria & method for design alternatives			– plenary activity

#	CEADA Activities	Walkthrough session 4	Walkthrough session 5	Walkthrough session 6
2.1	Define purpose and output of session	– relevant – There is need to explicitly define the type of design alternatives that CEADA is addressing, since the architecture process involves several levels where formulation of alternatives (and their evaluation) occur	– relevant – models developed in previous sessions can be used	– plenary activity
2.2	Identify design alternatives			– These relate to focus phase in ASE in which scenarios are sought, stretched, evaluated, validated, and integrated into a first draft of the solution that architects thereafter use to create a high level architecture description
2.3	Elaborate design alternatives			
2.4	Validate design alternatives			
3.1	Define purpose and output of session			
3.2	Review evaluation criteria			
3.3	Analyse valid design alternatives			
4	Select appropriate and efficient design alternative			

Table B.7: *Version II of CEADA (Input to Experiment Evaluation Iteration)*

#	Activity Description	Deliverable(s)	Key Actors	Pattern(s) of collaboration	ThinkLet(s)	Additional approaches
Session 1: Define and scope organization's problem and solution aspects (collaborative session)						
1.1	Communicate purpose of the session and kind of information sought for	Guiding information	Senior management and enterprise architects	-	Manual	-
1.2	Define basic information on business strategy, business objectives, and business requirements	Awareness of business strategy, objectives, and requirements		Generate, Reduce, Clarify	DealersChoice, FastFocus	Group model building scripts to create system dynamics models for strategic decision making in this session and subsequent sessions
1.3	Define organization's problem scope	Organization's problem scope				
	1.3.1 Identify aspects on the problem & its scope			Generate, Organize	OnePage, Concentration	
	1.3.2 Agree on aspects of the problem & its scope			Build consensus	MoodRing	
1.4	Identify external solution constraints (from e.g. regulatory authorities)	External constraints		Generate, Clarify	OnePage, FastFocus	
1.5	Define purpose of the architecture effort	Purpose of the architecture effort				
	1.5.1 Generate ideas on purpose of architecture effort			Generate, Organize	OnePage, Concentration	
	1.5.2 Agree on purpose of architecture effort			Build consensus	MoodRing	
1.6	Define high level solution specifications	General solution specifications				
	1.6.1 Generate ideas on solution specifications			Generate	FreeBrainstorm	
	1.6.1 Filer generated solution specifications			Reduce, Clarify	FastFocus	
	1.6.2 Agree on solution specifications			Evaluate	StrawPoll, CrowBar	
1.7	Seek shared understanding on the scope of the problem and its solution, and seek consensus on whether the scope of these aspects is worth a collaboration effort of organization key stakeholders	Understanding scope of problem and its solution, and appreciation of need for collaborative effort		Build Consensus	MoodRing	
1.8	Select key stakeholders to participate in subsequent collaboration efforts with enterprise architects (and define their roles)	Other key stakeholders to collaborate with enterprise architects		Generate	OnePage. It can also be done manually	-
1.9	Reveal calendar of events, communicate the expectations of architect team, and find out stakeholders' expectations in the subsequent collaboration efforts during the architecture effort	Calendar of events and expectations of architects and stakeholders	enterprise architects and all selected stakeholders	Manual (i.e. no ThinkLet support required)		

<u>Evaluation Questionnaire for the Session(s) of the CEADA Process</u>

For the statements in the table below, respond using one of the following options:

1 (Strongly Disagree); 2 (Disagree); 3(Neutral); 4 (Agree); 5(Strongly Agree)

#	Process or Session Evaluation Statement	Response	Additional comment
1	The session helped to increase my understanding of the challenges and requirements of the department/ organization		
2	The session enabled me to freely express my views about the current and desired operations within the department/organization		
3	The session enabled me to understand the concerns of other colleagues about the current and future (or desired) operations within the department/ organization		
4	I am satisfied with the outcomes/output of the session		
5	I am satisfied with the activities done in the session		
6	I understand why (some of) my concerns or views would not be applicable in certain incidences or why others found them invalid		
7	I am NOT unhappy with the way my ideas were criticized in the session		
8	I was able to understand the results of the session		
9	I understood the objectives of the session		

10. Please mention what you expected to get from this session, but DID NOT GET.
11. Do you feel you did not get an opportunity to participant in the activities that involved discussions or negotiations?
12. In your opinion, were all activities in the session assigned enough time? Please specify your answer where necessary
13. In your opinion how could this session be improved?
14. In your opinion, which tools and activities should have been added to (or removed from) those used in this session in order to help stakeholders in this organization to quickly reach a shared understanding and agreement on the problems, requirements, processes, and other issues discussed in the session?

Figure B.8: *Questionnaire that was used to Evaluate CEADA Sessions*

Table B.8: *Version II of CEADA – continued (Input to Experiment Evaluation Iteration)*

#	Activity Description	Deliverable(s)	Actors	Pattern of collaboration	ThinkLet	Additional approaches
	Session 2: Seek shared understanding of problem and solution aspects, define requirements & quality criteria, formulate solution scenarios					
2.1	Communicate purpose of session, kind of information required, and problem and solution aspects defined in session 1	Guiding information	Decision makers of all organization units, domain experts, and enterprise architects	-	Manual	Plenary activity (ASE)
2.2	Stakeholders share their concerns about the problem and solution aspects defined in session1	Stakeholders' concerns on problem and solution		Generate	LeafHopper	Take-a-Panel (ASE)
2.3	Categorize concerns by type and organization domains	Categories of stakeholders' concerns		Reduce, Clarify	Popcorn sort	Share-a-Panel (ASE)
2.4	Analyze and discuss concerns while seeking a shared conceptualization and understanding of problem and solution aspects defined in session1	Refined concerns & a shared understanding of key aspects		Organize	BucketWalk, BucketBriefing	Plenary activity (ASE) - use models created in session 1
2.5	Validate stakeholders' concerns	Valid concerns		Evaluate	StrawPoll	
2.6	Agree on amendments to problem and solution aspects	Refined problem and solution aspects		Build Consensus	StrawPoll, Red-Light-Green-Light	update models created in session 1
2.7	Brainstorm on requirements for the architecture	Requirements for the architecture		Generate	Free-Brainstorm	Take-a-Panel (ASE)
2.8	Validate requirements for the architecture	Valid requirements		Reduce, Clarify, Organize	Popcorn sort	
2.9	Agree on requirements for the architecture	Consensus on architecture requirements		Evaluate, Build Consensus	StrawPoll, BucketWalk	Plenary activity (ASE)
2.10	Brainstorm on quality criteria (i.e. business criteria, governance criteria, & operational criteria) for evaluating design alternatives	Business, governance, & operational evaluation criteria		Generate	Free-Brainstorm	Take-a-Panel (ASE)
2.11	Validate (business, governance, & operational) quality criteria	Valid quality criteria		Reduce, Clarify, Organize	Popcorn sort	
2.12	Agree on (business, governance, & operational) quality criteria	Common evaluation criteria for alternatives		Evaluate, Build Consensus	StrawPoll, BucketWalk	Plenary activity (ASE)
2.13	Brainstorm on types of solution scenarios to be formulated	Required types of solution scenarios		Generate	Free-Brainstorm	
2.14	Identify components of a solution scenario	Components of solution scenarios		Generate	Comparative Brainstorm	Take-a-Panel (ASE)
2.15	Formulate solution scenarios	Solution scenarios		Generate, Organise	Could-Be-Should-Be, BranchBuilder	
2.16	Refine or tighten (business, governance, & operational) quality criteria	Detailed (business, governance, & operational) quality criteria		Clarify, Build Consensus	BucketWalk, Red-Light-Green-Light	Plenary activity (ASE)
	Session 3: Translate solution scenarios into architecture design alternatives (black box session)					
3.1	Define architectural quality criteria for evaluating design alternatives	Architectural evaluation criteria	Enterprise architects and a few interactions with business analysts and domain experts	Black Box Activities		
3.2	Merge quality criteria categories i.e. business criteria, governance criteria, operational criteria, and architectural criteria	Merged quality criteria for evaluating and selecting final alternatives				
3.3	Analyze and translate solution scenarios into architecture design alternatives	Possible design alternatives				
3.4	Elaborate generated design alternatives	Positive & negative implications of design alternatives				
3.5	Validate architecture design alternatives	Valid (feasible) design alternatives				
3.6	Select method for evaluating design alternatives	Evaluation method of design alternatives				
3.7	Analyze design alternatives using merged quality criteria	Analysed design alternatives				
	Session 4: Select appropriate, efficient, and feasible design alternatives (collaborative session)					
4.1	Communicate purpose of session, kind of information required, and the problem and solution aspects from session 2	Guiding information	Decision makers of organization units, domain experts, and enterprise architects	-	Manual	Plenary activity (ASE) - use output from sessions 1, 2, and 3
4.2	Explain positive and negative implications of analyzed design alternatives to stakeholders	Positive and negative implications of design alternatives		-	Manual	
4.3	Seek shared understanding (among stakeholders) on the implications of the analyzed design alternatives	Shared understanding on relevant information for making the final decision		Evaluate	StrawPoll, CrowBar	
4.4	Select appropriate, efficient, and feasible design alternatives (using predefined quality criteria)	Appropriate, efficient, & feasible design alternatives		Evaluate, Build Consensus	MultiCriteria, Red-Light-Green-Light	

Appendix C ThinkLet Notation Model of CEADA

This appendix represents a detailed format of the design of CEADA using the ThinkLet Notation Model. Summarized formats of CEADA's design have been represented in section 6.4 using the tabular format and Facilitation Model Format (see figure 6.15 in section 6.4).

In this appendix, CEADA's ThinkLet Notation Model is presented in tables C.1 – C.19. These tables present the execution details of thinkLets that constitute CEADA. Tables C.1 – C.10 present details that clarify aspects discussed in the collaborative intelligence module of CEADA's design (in section 6.4.1). Tables C.12 – C.18 present details that clarify aspects discussed in the collaborative design module of CEADA's design (in section 6.4.2). Table C.19 presents details that clarify aspects discussed in the collaborative choice module of CEADA's design (in section 6.4.3).

ThinkLet Notation for the Collaborative Intelligence Module of CEADA	
Step #	**Step Name and its Parameters**
A.1.0	Communicate purpose of the session Tool: Holistic data capture pyramid template Facilitator notes: **(1)** Inform stakeholders that this session follows preliminary dialogs between the strategic (and tactical) level stakeholders and enterprise architects on matters concerning the creation of an enterprise architecture for the organization on what an enterprise architecture is, and on how the organization can benefit from its enterprise architecture. **(2)** The purpose of this session is to explore the organization's current/as-is/baseline situation and to collaboratively create and discuss conceptual models that represent the existing situation, in order to acquire a shared understanding thereof. **(3)** Display the **holistic data capture pyramid template** and explain its purpose or structural layout points to the deliverables of the architecture creation effort. Mention that the pyramid template provides a holistic view of all aspects that describe an organization's problems and desired solutions during enterprise architecture creation. **(4)** Mention that the output of this session will be used by the enterprise architects to formulate baseline domain architecture models (which are part and parcel of the architecture vision or enterprise architecture of the organization).
	Warm-up or Orientation activity set: As part of the briefing, a set of three/four very simple and interesting activities (that use the patterns of reasoning and thinkLets that are to be used in this session) can be executed to help stakeholders get acquainted with the tools that are to be used during the session. On how to use EMS technology tools: The EMS technology configurations used in this thinkLet notation are based on Meetingworks[TM], but the equivalent configurations in other EMSs can be used. Thus, suggest a simple activity set that involves brainstorming (so as to show how to use the "generate" tool), converging (so as to show how to use the "organize" tool), and evaluation by voting or rating or other evaluation method (so as to show how to use the "evaluate" tool). On how to use the non-EMS technology supported tool-set of [paper, pen, stickers, markers, flipcharts, and model prints (on A0/A1/A3/A4)]: Suggest a simple activity in which the manual tool-set is used as follows: **(1)** Flip charts are used when readable (A4/ A3) model prints, have insufficient room to allow further additions on a given diagram template, or when the diagram template must be populated by a subgroup or a group stakeholders simultaneously. So, what is done is to sketch out the structural layout of a given diagram template onto a flip chart, using the markers (multiple colors of markers can be used in order to properly demarcate the structure of the diagram template onto the flipchart). **(2)** Thereafter, stakeholders of the subgroup or group note down their contributions on papers or stickers (still multiple colours of stickers can be used depending on the variety of aspects that are being generated, where particular colours of stickers can be allocated to generating answers to a particular topic). **(3)** After the brainstorming, the stickers can be plotted onto the flip chart in the appropriate location on the template. This manual set of tools can be used in incidences where EMS technology is not available to support simultaneous brainstorming (and yet stakeholders prefer some kind of anonymity for them to participate) and to support the convergence (filtering, clarifying, and organizing) of brainstormed aspects in a subgroup. **(4)** Inform stakeholders that the way of using both the EMS tools and the manual tool-set may vary depending on the demand of a given activity in the session.
A.1.1.	Define organization processes and problematic aspects. This involves defining baseline processes and their attributes and the breadth and depth of the organization problems. This activity is decomposed into A.1.1.1 – A.1.1.2 below. If an organization has its processes well documented, then activity A.1.1.1 is not executed in a group session.
A.1.1.1	Define processes, projects, and services/products of the organization. This further decomposes into A.1.1.1.1 – A.1.1.1.3.
	A.1.1.1.1. List existing processes, projects, and services/products of the organization **LEAFHOPPER** Input: Any relevant information acquired through dialogs with strategic level stakeholders prior to the session. Tools: "Generate" tool configured as: *"Step Specific Information: Number of input items allowed - An unlimited number of items per topic (or if participants are many, then the number of items can be*

Figure C.1: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 1)*

	restricted to <=5); Viewing other participants' input is allowed - [Yes]; Topic selection will be controlled by the participants – [YES] (this is because the LeafHopper thinkLet is used to save time by allowing participants to respond to only the questions they would like to, otherwise topic selection can be controlled by facilitator if another thinkLet like DealersChoice is used)". Other tools are: Paper, pen, stickers, markers, flipcharts, and data capture functions. Topic list: **(1)** What are the processes executed in the organization? **(2)** What are the services or products provided by the organization? **(3)** What are the (information) inflows and outflows associated with each operational process or department? **(4)** Who are the external partners of this organization, and which departments do they collaborate with? **(5)** What are the completed and ongoing projects in the organization? Facilitator notes: Inform stakeholders that all data capture functions (i.e. required answering formats) have their first entry part or code as the name of department from which the stakeholder or participant works/represents. This is done so that the entries can be properly filtered in the next activity. Then display and explain data capture functions for each question, i.e.: **(1)** {Department name} –{Processes it executes to offer its services or products}; **(2)** {Department name} – {services or products it offers}; **(3a)** {Department or process name} – {type of information inflow} – {information sender}; **(3b)** {Department name} – {type of information outflow} – {information recipient}; **(4)** {Department name} – {External partner(s)}; **(5)** {project name} – {project status} – {departments participating in the project} – {where to find documentation about the mentioned project}. Alternatively, without EMS technology support, distribute copies of readable prints of the **diagram template for process attributes** (discussed in chapter 6) such that stakeholders populate the template with required information. This can best be achieved using the FreeBrainstorm thinkLet, where the FreeBrainstorm sheets or pages are the copies of the diagram template for process attributes. Output: Gathered information on baseline processes, services or products, inflows and outflows, and existing and ongoing projects and programs in the organization.
	A.1.1.1.2. Clarify and organize the organization's baseline processes and their attributes **FASTHARVEST** Input: Output of A.1.1.1.1 and readable prints of the diagram template for process attributes and the set of symbols for drawing a Rich Picture. Tools: "Organize" tool configured as: "*Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: Display the generated list of processes and invoke a specialization-driven division, so as to divide the group into subgroups (for a quick and proper execution of this activity as demanded by the FastHarvest thinkLet). Distribute copies of the **diagram template for process attributes** to all subgroups. Guide each subgroup to do the following: **(1)** Clean and clarify items in the processes associated with a given department. **(2)** Use the cleaned aspects or lists (that pertain to a given department) to fill in the required prompts in the provided diagram template. **(3)** Display key symbols you have chosen for drawing a Rich Picture. Guide each subgroup to use the symbols to draw a basic **Rich Picture of the baseline situation** of its department, showing the actors, their roles or how they interact, and their concerns. **(4)** Converge subgroups and encourage representatives of each subgroup to discuss their department-specific diagrams for process attributes and/or department-specific Rich Pictures. Definitely for readability and flexibility, these departmental level conceptual models can be represented on flipcharts but in the format of the diagram template that was provided. **(5)** To help the group to acquire a shared understanding of baseline processes, show how the department-specific diagrams for process attributes can be viewed on an organization-wide diagram template for process attributes. Also, position (or sketch a merging of) the department-specific Rich Pictures to form an abstract organization-wide Rich Picture. To help the group to view their output in the context of information required for enterprise architecture creation, make reference to the nodes on the holistic data capture pyramid template where these conceptual models are of importance. **(6)** Appendix III shows examples of a fully populated diagram template for process attributes, an abstract organization-wide Rich Picture, and a somewhat detailed unit-level Rich Picture. Output: Populated diagram templates for baseline processes and their attributes, and Rich Picture of the baseline situation.
A.1.1.2	Define major problematic aspects in the organization. This further decomposes into activities A.1.1.2.1

Figure C.2: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 2)*

	– A.1.1.2.5 below
	A.1.1.2.1. List major problematic aspects in the organization **FREEBRAINSTORM** Input: Any relevant information acquired through dialogs with strategic level stakeholders prior to the session, copies of readable prints of the diagram template for problem analysis. Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: What are the challenges or problems faced in this organization? Facilitator notes: Display and explain the data capture function: {Department name} – {problem(s) faced by the department} Output: Brainstormed list of problems faced in the organization
	A.1.1.2.2. Reduce, clarify, organize, and analyze organization challenges or problems **FASTHARVEST** Input: Output of A.1.1.2.1 and copies of readable prints of the diagram template for problem analysis. Tools: "Organize" tool configured as: "*Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: Display the generated list of challenges/problems and invoke a specialization-driven-division, so as to divide the group into subgroups (for a quick and proper execution of this activity as demanded by the FastHarvest thinkLet). Distribute copies of the **diagram template for problem analysis** to all subgroups. Guide each subgroup to do the following: **(1)** Clean and clarify items in the challenges list under (or associated with) their department. **(2)** Encourage stakeholders (still in their subgroups) to use the cleaned list(s) of problems to perform a cause-effect analysis of problems in a given department, by filling the required prompts in the diagram template for problem analysis. Note that the department-specific conceptual models from activity A.1.1.1 can be used as a source of information in this activity. **(3)** Converge subgroups and encourage representatives of each to discuss their department-specific diagrams for problem analysis and what the subgroup feels is the root problem cause(s) in a given department. **(4)** Show/sketch how the department-specific diagram templates for problem analysis can be viewed on an organization-wide diagram template for problem analysis. **(5)** If the organization has many departments, the organization-wide diagram for problem analysis will be very overcrowded and complex to guide further analysis, thus the need for the architect(s) to formulate/sketch a **causal loop diagram** to represent problems that have nested causes. **(6)** Appendix III shows examples of a fully populated diagram template for problem analysis at unit-level and a diagram template for problem analysis at organization-wide level. Output: Detailed analysis of the organization problems
	A.1.1.2.3. Identify un-captured or misrepresented problem aspects **LEAFHOPPER** Input: Output from A.1.1.2.2, i.e. populated diagram template(s) for problem analysis, causal loop diagram (if it was necessary to formulate it). Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: What concerns do you have regarding the way problems in the baseline situation have been represented? **OR** Which effects and causes of problems (or organizational weaknesses and threats) have been misrepresented or have not been represented? Facilitator notes: Display and explain the data capture functions: {Department name/ label of a given diagram template} – {comment or cause or effect or weakness or threat}. Note that in this activity there is one question/topic that relates to several populated diagrams for problem analysis (and in some situations also a causal loop diagram) that pertain to the different departments/units in the enterprise. Thus, LeafHopper is used to allow stakeholders check the various departmental problem analysis templates, and then comment on only the ones of interest. However, if one diagram template for problem analysis was used to represent all problems faced by departments or units in the organization, then FreeBrainstorm thinkLet is used. Output: Brainstormed list of un-captured or misrepresented problem ideas.
	A.1.1.2.4. Clarify and organize raised concerns or amendments to the organization's problem analysis formulations

Figure C.3: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 3)*

	CONCENTRATION Input: Output from A.1.1.2.3 and prints of the populated diagram templates for problem analysis (and causal loop diagram if it was formulated) Tools: "Organize" tool configured as: "*Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Display the brainstormed or suggested amendments to problem aspects. **(2)** Encourage stakeholders to remove any redundancies and ambiguities in the suggested amendments to problem aspects. **(3)** Encourage stakeholders to identify the locations in diagram templates where suggested amendments can be placed. Output: Updated diagram templates of the problem situation.
	A.1.1.2.5. Evaluate and seek consensus on outcomes of the organization's problem analysis **STRAWPOLL, CROWBAR** Input: Output from A.1.1.2.4 (i.e. updated conceptual models of the problem situation). Tools: "Evaluate" tool configured as: "*Step specific information: Input Topic List Items* – [Yes, I agree with the way problems and their causes have been represented in the diagram templates; No, I do not agree with the way problems and their causes have been represented in the diagram templates]; *Evaluation Method* – [Vote (Yes/No)]; *Display Variability* – [Yes]". Other tools are: Paper, pen, stickers, marker, and flipchart. Facilitator notes: **(1)** Inform stakeholders that in this activity we explore the level of agreement among group members regarding the representations of the problem situation in the organization. That this is to be done by indicating whether one agrees with the representations in the models or does not agree. **(2)** Prompt stakeholders to vote, wait for their votes, and display voting results. If there is low consensus (indicated by a high level of variance) on how problem aspects have been represented in the diagram templates, inform stakeholders about how divergent their views are on the problem analysis, and that the polling is going to be repeated with the intention of revealing reasons why some stakeholders do not agree with the problem analysis results. **(3)** Re-poll or prompt stakeholders to re-vote and encourage stakeholders who do not agree to include comments as to why they do not agree. **(4)** Display voting results, interpret them for the group, and discuss any comments that have been entered by stakeholders. **(5)** After discussions, prompt stakeholders to re-vote and display results, and incite discussion until a realistic level of agreement on problem aspects is attained. **(6)** Without EMS technology, encourage stakeholders who disagree with any aspects in the model to either openly express their views or anonymously use the comment papers to express their dissatisfaction with particular aspects. On receiving their comments, read them to the group and incite a discussion about those comments. Output*:* Stakeholders' shared understanding of, and consensus on, aspects describing the problem situation
A.1.2	Define scope of the organization problem. This decomposes into A.1.2.1 – A.1.2.3 below
	A.1.2.1. Identify aspects that describe scope of the organization problem **LEAFHOPPER** Input: Output of A.1.1 (readable prints of populated diagram templates for baseline processes and their attributes, populated diagram template(s) for problem analysis, causal loop diagram if it was necessary to formulate it) and Rich Picture of the baseline situation. Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** Which processes are affected by the problems the organization is facing? **(2)** Which processes are likely to be affected by the problems incase no solution is devised? Facilitator notes: **(1)** Display the populated diagram templates for processes and their attributes, populated diagram templates for problem analysis, the causal loop diagram, and Rich Picture for baseline situation. Guide stakeholders to use these models to point out processes that are affected (or likely to be affected) by the organization problem. **(2)** Explain data capture function to be used: {Department} – {name of (likely to be) affected organizational process} Output: Suggestions on processes that constitute the organization's problem scope
	A.1.2.2. Clarify and organize the generated aspects on the problem scope **CONCENTRATION**

Figure C.4: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 4)*

	<u>Input</u>: Output of A.1.2.1 <u>Tools</u>: "Organize" tool configured as "*Step will run in Outliner Mode".* <u>Other tools</u>: Paper, pen, stickers, markers, and flipcharts. <u>Facilitator notes</u>: **(1)** Encourage stakeholders to identify redundancies in the list of processes that are currently affected by the problem, and the list of processes that are likely to be affected by the problem. **(2)** Encourage stakeholders to further classify processes in these two lists, with respect to departments in which they are executed. This helps to determine the departments/units that are currently affected by the problem aspects and the units/departments that are likely to be affected by the problem incase no solution is devised. <u>Outputs</u>: Classified aspects defining the problem scope
	A.1.2.3. Evaluate and agree on aspects that define the organization's problem scope **STRAWPOLL, CROWBAR** <u>Input</u>: Output of A.1.2.2 and the populated diagram templates for the baseline or problem situation. <u>Tools</u>: "Evaluate" tool configured as *"Step specific information: Input topic file* - [filename-of-cleaned-lists-of-processes-on-problem-scope.mw]; *Evaluation Method - [Select (Mark all that apply)]; Display Variability* - [Yes]". <u>Other tools are</u>: Paper, pen, stickers, marker, and flipchart. <u>Facilitator notes</u>: **(1)** Inform stakeholders that in this activity we explore the level of agreement among group members on the scope of the organization problem, and this is to be done by marking/ticking all processes on the list that should be considered part of the problem scope. **(2)** Prompt stakeholders to vote, wait for their votes, and display voting results. **(3)** In the voting results, see the processes that are marked by the highest number of people, and processes that are marked by the lowest number of people. Incite a discussion as to why the processes marked by few people were not considered to be part of the problem scope by the majority. This helps the minority who marked those processes to either express themselves regarding their marks, or to know why the majority of stakeholders didn't mark the processes. **(4)** After the discussion, suggest to the group that the polling is going to be repeated with the intention of revealing any un-expressed reasons why some processes should or should not be considered part of the problem scope. **(5)** Re-poll or prompt stakeholders to re-vote and encourage stakeholders to include comments to justify their mark for a given process (especially processes that earlier received low votes). **(6)** Display voting results, interpret them for the group, discuss any comments that have been entered by stakeholders, and incite a discussion until a realistic level of agreement on problem aspects is attained. **(7)** Without EMS technology (and when ideas are plotted in models), the evaluation method and facilitator notes in A.1.1.2.5 are used. In this case, encourage stakeholders who disagree with the consideration of some processes as part of the problem scope to either openly express their views or anonymously use the comment papers to express their dissatisfaction. On receiving their comments, read them to the group and incite a discussion about those comments. <u>Output</u>: Explicit definition of the problem scope and stakeholders' agreement on the problem scope.
A.1.3	Determine possible business solution alternatives. This decomposes into A.1.3.1 – A.1.3.2 below
	A.1.3.1. List any possible business solutions or business solution alternatives (i.e. ways in which the root organization problems can be addressed) **FREEBRAINSTORM** <u>Input</u>: A shared understanding (among stakeholders) of output from A.1.1 – A.1.2. <u>Tools</u>: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. <u>Other tools are</u>: Paper, pen, stickers, marker, and flipchart. <u>Topic</u>: What are the possible business solutions that the organization can undertake in order to overcome its core problems? <u>Facilitator notes</u>: **(1)** Inform stakeholders that this activity involves identifying possible ways to solve the organization problems. Note that if this activity is executed after activity A.1.4.2, then the question/topic is rephrased as: "what are the possible solutions or ways to achieve the business strategy and goals". **(2)** Display and explain the data capture function: {What should be done} – {how it can be done} – {Why should it be done}. <u>Output</u>: Possible business solutions to the organization problem(s).
	A.1.3.2. Reduce, clarify, and organize the generated business solution into (distinct) business solution alternative(s)

Figure C.5: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 5)*

	CONCENTRATION, REVIEWREFLECT Input: Output from A.1.3.1 and readable prints of the diagram template for requirements classification. Tools: "Organize" tool configured as *"Step will run in Outliner Mode".* Other tools are: Paper, pen, stickers, marker, and flipchart. Facilitator notes: **(1)** Guide stakeholders to remove redundancies and ambiguities in the list of suggested business solution alternatives and to merge related suggestions of business solutions, so as to get a meaningful abstraction of say two or three business solution alternatives. **(2)** Populate the **diagram templates for requirements classification** (discussed in chapter 6) with aspects that have been suggested to solve the organization problems, specifying the "what should be done" aspects, the "how it should be done" aspects, and the "why it should be done" aspects. Output: Possible business solution alternatives, each having its own (partially) populated diagram template for requirements classification.
A.1.4	Determine internal constraints associated with solution alternative(s). This involves specifying, reviewing, and verifying aspects from existing business principles that relate to the problem and the possible solution alternatives; and from the organization's business strategy and goals. This activity is decomposed into activities A.1.4.1 – A.1.4.2 below
A.1.4.1	Reaffirm key principles associated with problems and/or solution alternative(s). Decomposes into A.1.4.1.1 – A.1.4.1.2
	A.1.4.1.1. List key principles associated with the problems and/or business solution alternative(s) and the constraints they impose on each business solution alternative. **LEAFHOPPER** Input: A shared understanding (among stakeholders) of the baseline situation, output from A.1.3, readable prints of the diagram template for constraints classification, and the holistic data capture pyramid template. Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, marker, and flipchart. Topic list: **(1)** Which organization principles (if they exist) are associated with the problems the organization is facing? **(2)** Which organization principles (if they exist) are associated with the possible business solution alternative(s)? **(3)** What are the accepted practices in this organization? **(4)** Which principles from the existing management/governance frameworks in this organization are associated with the possible business solution alternatives? **(5)** What constraints do the organization's principles (values, practices, frameworks, projects, programs) impose on each business solution alternative? Facilitator notes: Use the holistic data capture pyramid template to show stakeholders the relevance of aspects (that are to be defined in this activity) in the enterprise architecture development effort. Display and explain data capture function: For questions (1) to (4) use {name of principle or practice or framework} – {source of information about it}; question (2) use {business solution alternative label/name} – {name of principle or framework} - {the constraint it imposes on a given business solution alternative}. Alternatively, if some information on these can be obtained before the session, use it to prepare a seed file listing relevant business principles, practices, and management frameworks. This seed file can then be used in the sessions to prompt stakeholders to give their views on principles that have been left out (and yet they are relevant to consider in the problem and solution aspects) and the constraints that each of these principles imposes on each business solution alternative. Output: Business principles and values that must be considered in the enterprise architecture and a list of suggested constraints (resulting from business principles and values) on the possible business solution alternatives.
	A.1.4.1.2. Clarify, organize, and validate on principles associated with the problems and/or business solution alternatives, and constraints from business principles and values **CONCENTRATION, REVIEWREFLECT** Input: Output from A.1.4.1.1 and readable prints of the diagram template for constraints classification. Tools: "Organize" tool configured as "*Step will run in Outliner Mode".* Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Encourage stakeholders to remove redundancies and ambiguities from the contributed ideas, and to merge related ideas. **(2)** Populate the **diagram template for constraints**

Figure C.6: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 6)*

	classification (discussed in chapter 6) with internal constraints that have been derived from the generated business principles or values. Also, each distinct business solution alternative has its own diagram template that shows the internal constraints associated with it. Alternatively, if there are few members present, the concentration thinkLet can be used. Output: Validated principles associated with the problem and/or business solution alternatives and validated constraints from business principles and values.
A.1.4.2	Specify existing information on business strategy, goals, and requirements. Decomposes into A.1.4.2.1 – A.1.4.2.3
	A.1.4.2.1. Note down existing information on business strategy and business goals, and their implications or constraints **LEAFHOPPER** Input: Shared understanding of output from A.1.1 – A.1.3, (partially) populated diagram template for constraints classification, and the holistic data capture pyramid template. Tools: "Generate" tool configured like in step A.1.1.1.1 except topic list, and here the *facilitator controls topic selection*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** Which business strategy and goals does the organization have with respect to overcoming its problems? **(2)** What constraints do the existing business strategy and goals impose on the business solution alternatives? Facilitator notes: Use the holistic data capture pyramid template to show stakeholders the relevance of aspects that are to be defined in this activity in the enterprise architecture development effort. Display and explain data capture function: {strategy or goals} – {information on strategy or goals}; {strategy or goals} – {the constraint it imposes on a given business solution alternative} – {business solution alternative referred to}. Like in A.1.4.1.1, if the business strategy and goals are already documented and known before the session, prepare a seed file listing them and then use it in the session to prompt stakeholders to give their views on the constraints imposed by the strategy and goals on each business solution alternative. Output: Existing information on business strategy and goals, and constraints implied by these.
	A.1.4.2.2. Clarify, organize, and validate the defined aspects on the business strategy and goals, and their implications **CONCENTRATION, REVIEWREFLECT** Input: Output from A.1.4.2.1 and the (partially) populated diagram templates for constraints classification. Tools: "Organize" tool configured as "*Step will run in Outliner Mode".* Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Encourage stakeholders to remove redundancies and ambiguities from the contributed ideas, and to merge related ideas. **(2)** Further populate the **diagram template for constraints classification** with internal constraints that have been derived from the generated business strategy and goals. Also, each business solution alternative has its own diagram template that shows internal constraints associated with it. Output: Existing information on business strategy and goals, and their implications on the business solution alternatives.
	A.1.4.2.3. Evaluate and agree on all internal constraints that have been derived from business principles and values, business strategy and business goals **STRAWPOLL, CROWBAR** Input: Output from A.1.4.1 and A.1.4.2.2, and the (partially) populated diagram templates for constraints classification. Tools: "Evaluate" tool configured as: "*Step specific information: Input topic file* – [filename-of-merged-list-of-internal-constraints.mw]; *Evaluation Method: [Rate from 1 to N (numbers may be reused)]; Display Variability: [Yes]*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Inform stakeholders that in this activity we explore the level of agreement among group members on the priority of the listed internal constraints, and this is to be done by rating all constraints on a scale of 1 to N. **(2)** Prompt stakeholders to enter their rates for internal constraints, wait for their votes, and display voting results. **(3)** In the voting results, see the constraints that are rated high priority and those that are rated low priority, and also consider the variability among

Figure C.7: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 7)*

	stakeholders. If variability among stakeholders is high, incite a discussion as to why some constraints could be viewed as low priority, and yet others view it as high priority. **(4)** After the discussion, suggest to the group that the polling is going to be repeated with the intention of revealing any un-expressed reasons why some constraints are considered to be of high/low priority by some stakeholders and yet some stakeholders consider them to be otherwise. **(5)** Re-poll or prompt stakeholders to re-vote and encourage stakeholders to include comments to justify their rate for a given constraint. **(6)** Display voting results, interpret them for the group, discuss any comments that have been entered by stakeholders, and incite a discussion until a realistic level of agreement on constraints' priorities is reached. **(7)** Without EMS technology (and when ideas are plotted in models), encourage stakeholders who consider some constraints to be of low priority to either openly express their views, or anonymously use the comment papers to express their views. On receiving their comments, read them to the group and incite a discussion about those comments. Output: Internal constraints on each business solution alternative.
A.1.5	Define external constraints associated with the business solution alternative(s). This decomposes into A.1.5.1 – A.1.5.2.
	A.1.5.1. List external constraints associated with the business solution alternatives **DEALERSCHOICE** Input: A shared understanding of output from A.1.1 – A.1.4, (partially) populated diagram templates for constraints classification, and the holistic data capture pyramid template. Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list, and here the *facilitator controls topic selection*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** What are the policies from regulatory authorities that are associated with the possible business solution alternative(s)? **(2)** What are the policies from the organization's partnerships (i.e. consortiums, donors or sponsors, unions etc) that are associated with the possible business solution alternatives? **(3)** What constraints to do these policies from regulatory bodies and external partners of the organization impose on the possible solution alternatives? Facilitator notes: **(1)** Inform stakeholders that external constraints here refer to constraints (from e.g. regulatory authorities, external partners, and corporate unions) on output from A.1.3. Ensure to get contributions from stakeholders who are the organization's experts in domains that are part of the problem scope or in domains associated with the business solution alternatives (e.g. relevant legal issues or domain-specific external restrictions). **(2)** Display and explain the data capture functions: {name of organ or institution} – {external principle} – {implied/imposed external constraint}; {name of organ or institution} – {description of imposed external constraint}. Output: Gathered information on external policies and the constraints they impose on each business solution alternative.
	A.1.5.2. Clarify and organize the identified external constraints **CONCENTRATION, REVIEWREFLECT** Input: Output from A.1.5.1, readable prints of the (partially) populated diagram templates for constraints classification, and the holistic data capture pyramid template. Tools: "Organize" tool configured as *"Step will run in Outliner Mode".* Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Encourage stakeholders to remove redundancies and ambiguities, and to integrate related aspects. (2) Populate the **diagram template for constraints classification** with external constraints that have been derived from the external regulations and policies. Also, each business solution alternative must have its own diagram template that shows external constraints associated with it. Record the labels of the constraints that appear as the key nodes on the "external constraints" arrow of the diagram template for constraints classification. Output: Information on external constraints on each business solution alternative.
A.1.6.	Choose the most appropriate business solution alternative **STRAWPOLL, CROWBAR** Input: Output from A.1.3 (possible solution alternatives), A.1.4 (internal constraints), A.1.5 (external constraints). These are all represented on (readable prints of) populated diagram templates for requirements classification (whereby each business solution alternative has at least one diagram template), and populated diagram templates for constraints classification for each business solution

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	alternative. Tools: "MultiCriteria" tool configured as: "*Step specific information: List of Alternatives* - [list-of-possible-business-solution-alternatives.mw]; *Input Criteria List Items* - [Suitability of a solution alternative with respect to: **(a)** satisfying the defined internal constraints; **(b)** satisfying the defined external regulations or constraints]". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Prompt stakeholders to evaluate the possible (business) solution alternatives with respect to criteria in categories (a) and (b) above. **(2)** Encourage stakeholders to comment on their scores of the business solution alternatives. **(3)** Repeat this activity until the variability among scores that stakeholders assign to the leading alternative is low. Output: The chosen business solution alternative.
A.1.7.	Agree on purpose of the enterprise architecture in implementing the chosen business solution alternative. **STRAWPOLL, CROWBAR** Input: A shared understanding of output from A.1.6 (the chosen business solution alternative) and readable prints of the template for specifying the purpose of the enterprise architecture. Tools: "Evaluate" tool configured as: "*Step specific information: Input topic file - [names-of-the-four-quadrants-of-the-template-used.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability - [Yes]*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Inform stakeholders that they need to agree on a way in which the resultant enterprise architecture will be used to realize the desired solution, as this determines the level of detail of the architecture. Also explain the template for specifying the purpose of the enterprise architecture to stakeholders, so that they get a clearer understanding of the significance of their participation in the subsequent tasks of the enterprise architecture creation effort. **(2)** Inform stakeholders to highlight how they want to use the enterprise architecture results for, by marking in at least one of the names of the four quadrants of the **template for specifying the purpose of the architecture**. **(3)** Encourage stakeholders to also comment on quadrant(s) on the template where they feel the architecture results are most useful. **(4)** Repeat this activity until the variability among stakeholders on this topic is low. Output: Clear definition and understanding of the purpose of the enterprise architecture during and after the transformation.
A.1.8	Determine high level solution specifications and scope of the enterprise architecture. With the chosen business solution alternative in activity A.1.6, this activity involves brainstorming, filtering, and agreeing on the desired features and the scope of the solution alternative. Note that if output from A.1.3 resulted in several business solutions suggestions that were classified to form distinct business solution alternatives, then the constituent sub-solutions in the chosen business solution alternative from A.1.6 are perceived as high level solution specifications of the desired situation. If this is so, then this activity can be skipped, since what would have been defined here was generated at A.1.3. Otherwise, if the output from A.1.6 is too abstract, then this activity can be executed. This activity is decomposed into activities A.1.8.1 – A.1.8.2 below.
A.1.8.1	Determine high level solution specifications of the chosen business solution alternative. This decomposes into A.1.8.1.1 – A.1.8.1.3 below
	A.1.8.1.1. List high level solution specifications of the chosen business solution alternative **LEAFHOPPER** Input: Output from A.1.6 (i.e. the chosen business solution alternative) and readable prints of its diagram template for constraints classification and its diagram template for requirements classification. Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** What are the key issues that you feel must be done in order to achieve the chosen business solution alternative? **(2)** Suggest any organization-wide constraints or principles that need to be put in place in order to properly achieve the chosen business solution alternative. **(3)** Suggest any unit level constraints or principles that need to be put in place in order to properly achieve the chosen business solution alternative. **(4)** From the completed and ongoing projects in the organization, which information resources are available and can be considered for use when creating the architecture of the chosen business solution alternative? Facilitator notes: Inform stakeholders that sources of ideas for solution specifications are: the (partially)

Figure C.9: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 9)*

	populated diagram template for constraints classification regarding the chosen business solution alternative and the (partially) populated diagram template for requirements classification regarding the chosen business solution alternative. Display and explain data capture functions: {what must be done} – {your suggestion of what must be done}; {organization-wide constraints} – {description of the constraint}; {unit level constraints} – {description of the constraint} Output: Brainstormed ideas on high level specifications (which can also be perceived as high level requirements that are suggested by strategic/tactical management regarding the chosen business solution alternative) that the enterprise architecture must address.
	A.1.8.1.2. Clarify and assess the generated high level solution specifications **FASTHARVEST** Input: Output from A.1.8.1.1, readable prints of the diagram template for constraints classification (pertaining to the chosen business solution alternative), and readable prints of the diagram template for requirements classification (pertaining to the chosen business solution alternative). Tools: "Organize" tool configured as "*Step will run in Outliner Mode*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Invoke a specialization-driven division and encourage stakeholders to: clean the list of high level solution specifications, the list of organization-wide constraints, unit-level constraints, and existing information resources that can be reused in the architecture creation effort. **(2)** Populate the diagram template for requirements classification with the cleaned list of high level solution specifications. **(3)** Populate the diagram template for constraints classification with the cleaned list of organization-wide constraints and unit level constraints. Output: Populated diagram template for constraints classification, (partially) populated diagram template for requirements classification, and list of existing information resources that can to be re-used during enterprise architecture creation.
	A.1.8.1.3. Agree on high level solution specifications **STRAWPOLL, CROWBAR** Input: Output of A.1.8.1.2 Tools: "Evaluate" tool configured as: "*Step specific information: Input topic file - [list-of-organized-aspects-on-high-level-specifications.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability: [Yes]."* Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: See facilitator notes under A.1.2.3, except that here stakeholders are informed to comment on why some high level solutions are not marked by the majority and are instead marked by the minority. Output: Validated and agreed on high level solution specifications.
A.1.8.2	Determine scope of the enterprise architecture effort. This decomposes into A.1.8.2.1 – A.1.8.2.3
	A.1.8.2.1. List aspects that describe the scope of the enterprise architecture effort **LEAFHOPPER** Input: Output from A1.1, A.1.2, A.1.7, and A.1.8.1 Tools: "Generate" tool configured as specified in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** Which of the existing and/or desired organization functions (or services, products, or units) should the enterprise architecture creation effort focus on? **(2)** Which of the existing and/or desired business functions (or services, products, or units) should not be considered when creating the enterprise architecture for the desired situation? **(3)** Which architecture domains (i.e. business, data, applications, and technology) should be covered during architecture creation and to what level of detail (e.g. vision level of detail)? Facilitator notes: Inform stakeholders that information from this activity helps the architects to determine the required or desired level of detail that the enterprise architecture creation effort should cover. Display and explain data capture functions: {What to consider in the architecture creation effort} – {(existing situation, target situation?)} — {description of departments or business functions or services to consider}; {What NOT to consider in the architecture creation effort} - {description of departments or business functions or services not to consider}; {Domains to consider} – {list of domains to consider} Output: Suggestions of aspects related to scope of the architecture creation effort.

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	A.1.8.2.2. Clarify and assess the defined aspects on the scope dimensions of the architecture **CONCENTRATION** Input: Output from A.1.8.2.1. Tools: "Organize" tool configured as "*Step will run in Outliner Mode*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: Encourage stakeholders to clean (remove redundancies and ambiguities) in the lists of departments or business functions or services to consider, departments or business functions or services not to consider, and list of domains to consider. Output: Organized aspects on the scope of the architecture creation effort.
	A.1.8.2.3 Agree on scope of the enterprise architecture creation effort **STRAWPOLL, CROWBAR** Input: Output from A.1.8.2.2 Tools: "Evaluate" tool configured as: "*Step specific information: Input topic file - [list-of-organized-aspects-on-architecture-scope.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability: [Yes].*" Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: See facilitator notes under A.1.2.3, except that here stakeholders are informed to comment on why the minority feel that some departments/units/business functions/services should be considered, and yet the majority feel those units should not be considered. Output: Agreed on scope of the architecture creation effort
A.1.9.	Determine key stakeholders and their roles. This decomposes into A.1.9.1 – A.1.9.3.
	A.1.9.1. Determine all problem owners and solution owners and their roles in the enterprise architecture creation effort **LEAFHOPPER** Input: A shared understanding of output from A.1.1, A.1.2, and A.1.4 – A.1.8. Tools: "Generate" tool configured like in step A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: **(1)** List all problem owners (i.e. stakeholders who are affected by the problem situation), and mention their role/responsibility in the architecture effort. **(2)** List all possible problem owners (i.e. stakeholders who are likely to be affected by the problem situation), and mention their role/responsibility in the architecture effort. **(3)** List all solution owners (i.e. stakeholders who will benefit from the desired solution), and mention their role/responsibility in the architecture effort. **(4)** List all possible solution owners (i.e. stakeholders who are likely to benefit from the desired solution), and mention their role/responsibility in the architecture effort. **(5)** List all stakeholders who will be the internal actors during the implementation of the desired solution, and mention their role/responsibility in the architecture effort. **(6)** List all stakeholders who will be the external actors during the implementation of the desired solution, and mention their role/responsibility to the enterprise. **(7)** Which stakeholders will constitute the architecture board (i.e. the board responsible for endorsing various aspects in the architecture creation effort)? Facilitator notes: Display and explain the data capture function: {problem/solution owner} - {role in the enterprise or in the architecture creation effort}; {department or unit representative on the architecture board} - {decision maker(s) of the unit} Output: lists of suggested key stakeholders and their roles in the enterprise architecture creation effort.
	A.1.9.2. Clarify and organize list of key decision makers (i.e. problem owners, solution owners, and decision makers) **CONCENTRATION** Input: Output from A.1.9.1. Tools: "Organize" tool configured as: "*Step will run in Outliner Mode*" Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: Inform stakeholders to remove redundancies and to integrate duplicate entries. Use the cleaned list of stakeholders to populate the "Analysis One" node in **diagram template for Analysis One Two Three** (discussed in chapter 6). Output: Organized representations of key stakeholders and description of their roles in the architecture creation effort.
	A.1.9.3. Agree on all key stakeholders and decision makers in the architecture process and their roles **STRAWPOLL, CROWBAR** Input: Output from A.1.9.2. Tools: "Evaluate" tool configured as: "*Step specific information: Input Topic List Items – [Yes, I agree with the selected stakeholders; No, I do not agree with the selected stakeholders]; Evaluation Method – [Vote (Yes/No)]; Display Variability – [Yes]*". Facilitator notes: See facilitator notes under A.1.1.2.5, except that here stakeholders are informed to comment on why some of them do not agree on the consideration of some stakeholders or their roles in the architecture creation effort. Output: Agreed on key stakeholders in the architecture creation effort and their roles.
A.2.0.	Recess time: architects execute A.2.1 – A.2.3 in sync with architecture board and key stakeholders.

Figure C.11: *ThinkLet Notation of CEADA – Collaborative Intelligence Module (Page 11)*

ThinkLet Notation for the Collaborative Design Module of CEADA	
Step #	**Step Name and its Parameters**
A.3.0	Communicate purpose of the session. Input: Summary of problematic aspects in the baseline situation that were defined in collaborative intelligence module. Facilitator notes: Explain the (partially) populated diagram templates on problem aspects that were defined in the collaborative intelligence module. This enables stakeholders who were not part of that session to get an overview of the problem aspects that the enterprise architecture creation effort intends to address. Consider executing the warm-up or orientation activity set (see A.1.0) for the sake of stakeholders who were not involved in collaborative intelligence module.
A.3.1	Define concerns about (and elaborate) the organization problems that were defined in the collaborative intelligence module. **LEAFHOPPER** Input: Copies of readable prints of the following (partially) populated baseline-situation conceptual models with labels A – E from the collaborative intelligence module, i.e.: Model **A** represents the Rich Picture diagram of the baseline situation, Model **B** represents diagram templates for process attributes, Model **C** represents diagram templates for problem analysis, Model **D** represents causal loop diagram (if it was formulated), Model **E** represents diagram template for Analysis One Two Three. Each of these model prints has a small "assignment box" (on one of its corners) which shows the topic(s) of discussion or questions that need to be answered in that particular model. For a large organization, conceptual model A can be represented by A1, A2, A3 and the same goes for conceptual models B – E. Appendix D provides examples of these models. Tools: "Generate" tool configured as specified in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic list: The assignment box for each conceptual model has a general question of: "what concerns do you have regarding aspects represented in this model (in other words, what has been misrepresented or not represented in this model)?" **OR** a specific question. For example, on the problem analysis diagram template (i.e. model labeled C), the question in the assignment box can be: "what has not been captured in the problem aspects?" On the Analysis One Two Three template (i.e. model labeled C), the specific question can be: "which stakeholders are affected by the problem situation or desired situation but have not been included? or which cultural values have not been included?" Facilitator notes: **(1)** Distribute copies of conceptual models A – E. Display and explain data capture functions for this activity, i.e.: {model label} – {concern/issue associated with aspects in the model}. *E.g. {model E} – {description of missing or misrepresented information}*. **(2)** Encourage stakeholders to share their concerns about the organization's problematic aspects that are represented in models A – E. In this activity other stakeholders (who didn't participate in the collaborative intelligence module) get to share their views and concerns, while those who participated get to reconsider and elaborate the problem aspects. **(3)** The alternative thinkLet here is a FreeBrainstorm but using it will imply dealing with only one type of conceptual model (or diagram template) at a given time, until all the five types of models (i.e. A – E) are completed (but this would be very time consuming). Output: Lists of concerns about, or additions to, the problem aspects that were defined in collaborative intelligence session.
A.3.2	Clarify and organize concerns about (and additional issues to) the problem aspects **FASTHARVEST** Input: Brainstormed comments from A.3.1 and readable prints of (partially) populated diagram templates (i.e. models listed as A – E in A.3.1) that were used in collaborative intelligence module. Tools: "Organize" tool configured as: *"Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Display the generated list of concerns or refinement suggestions and invoke a specialization-driven-division, so as to divide the group into subgroups (for a quick and proper execution of this activity as demanded by the FastHarvest thinkLet). **(2)** Subgroups in this activity

Figure C.12: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 1)*

	prepare a list of cleaned and well phrased concerns or refinement suggestions with respect to aspects in a given unit/department that are represented in conceptual models A – E. **(3)** Converge subgroups and encourage presentations and discussions of suggestions or refinements from each subgroup regarding models A – E. Output: Updated models on the problem or baseline aspects represented in models A – E in A.3.1.
A.3.3	Validate and agree on the concerns about (and additional issues to) problem aspects **STRAWPOLL, CROWBAR** Input: Output of A.3.2 (i.e. updated models A – E). Tools: "Evaluate" tool configured as: "*Step specific information: Input Topic List Items* – [Yes, I agree with the way problems and their causes have been represented in the diagram templates; No, I do not agree with the way problems and their causes have been represented in the diagram templates]; *Evaluation Method* – [Vote (Yes/No)]; *Display Variability* – [Yes]". Other tools are: Paper, pen, stickers, marker, and flipchart. Facilitator notes: See facilitator notes of A.1.1.2.4. Output: Validated aspects in diagram templates of problem aspects (i.e. conceptual models A – E)
A.4.0	Communicate solution/desired aspects in the target situation that were defined in collaborative intelligence module. Input: Summary of solution/desired aspects in the target situation that were defined in collaborative intelligence module. Facilitator notes: Explain the (partially) populated diagram templates on solution aspects that resulted from the collaborative intelligence module. This enables stakeholders who were not part of that session to get an overview of the solution aspects in the target situation and what the enterprise architecture creation effort intends to address.
A.4.1	Define business requirements that the enterprise architecture must fulfill **FREEBRAINSTORM** Input: Copies of readable prints of the following (partially) populated target-situation conceptual models (with labels F – G) from the collaborative intelligence module, i.e.: Model **F** is the requirements classification diagram template, and Model **G** is the constrains classification diagram template. Also, the refined baseline-situation models (as output from A.3.3). Tools: "Generate" tool configured as specified in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: Also, conceptual models F and G have an "assignment box" (on one of its edges) which shows the topic(s) of discussion or questions that need to be answered in that particular model. The assignment box for model labeled F (i.e. the requirements classification template) has the following two topics. The desired situation or business solution alternative that was chosen in the collaborative intelligence module is indicated at the starting node of this model, therefore: **(1)** In your view, post or note down in the model **WHAT** you feel should be done at *organization-wide level* (in order to achieve the desired situation) and **WHY** you feel it should be done. **AND/OR (2)** In your view, post or note down in the model **WHAT** you feel should be done at *departmental/unit levels* (in order to achieve the desired situation) and **WHY** you feel it should be done. **OR (3)** If you have no new suggestions now, then please comment on the suggestions that are already plotted in the requirements classification diagram template (i.e. model labeled F). Facilitator notes: **(1)** Inform stakeholders that a business requirement can be perceived to be made up of three parts, i.e.: "WHAT should be done", "HOW it should be done", and "WHY it should be done" (this is discussed in chapter 6). In this activity we first define the parts of "what should be done" and "why it should be done" because it is better that these two parts are defined in a pair so that we know which problems are being addressed by what. Then we will later define the "how it should be done" part of the requirement in order to make the requirement definitions complete. **(2)** Display and explain the data capture function: {type of requirement: organization-wide, unit-specific [mention unit name]} - {WHAT should be done} - {WHY it should be done}. *For example, {enterprise level requirement} – {improve our working conditions and benefits} – {in order to reduce the staff resignation rate}.* **(3)** Explain that the "WHY it should be done" part of the requirement should relate to the refined and elaborated problematic aspects defined in models A – E (i.e. output from A.3.3), and the high level

Figure C.13: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 2)*

	solution specifications that already appear in the (partially) populated requirements classification template that was formulated in collaborative intelligence module (i.e. output of A.1.8). Output: Brainstormed aspects on the "WHAT should be done" and "WHY it should be done" parts of the requirements.
A.4.2	Clarify and categorize business requirements by type **FASTHARVEST** Input: Output of A.4.1, and readable prints of (partially) populated Model F (i.e. template for requirements classification). Tools: "Organize" tool configured as: *"Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Invoke a specialization-driven division (or task-driven or interest-driven division), and provide each subgroup with copies of the diagram template for requirements classification. Inform stakeholders that each subgroup will first work on classifying aspects/requirements for a specific department/unit, and then work on classifying the implications of those aspects at organization level. **(2)** Encourage each subgroup to work on all brainstormed aspects on "WHAT should be done" and "WHY it should be done" that pertain to a given department/unit. Encourage each subgroup to remove redundancies and ambiguities in all duplicate requirements, and to integrate some requirements by determining which aspects/requirements are sub aspects (or sub requirements) of others, and highlight/eliminate invalid aspects/requirements. **(3)** Plot the cleaned aspects/requirements in the "WHAT should be done" and "WHY it should be done" prompts on to the diagram template for requirements classification for a given department. **(4)** Plot the cleaned aspects/requirements in the "WHAT should be done" and "WHY it should be done" prompts on to the diagram template for requirements classification for the organization. **(5)** Converge subgroups and encourage presentations and discussions of output or classified requirements from subgroups. **(6)** Encourage stakeholders to examine requirements within each category (or department) and also across categories (or departments), so as to remove any redundancies and ambiguities. Output: Populated diagram templates for requirements classification for departments/units and for the organization.
A.4.3	Validate and agree on the requirements for the enterprise architecture **STRAWPOLL, CROWBAR** Input: Output of A.4.2. Tools: "Evaluate" tool configured as: *"Topic list: Input topic file - [list-of-cleaned-requirements.mw]; Evaluation Method - [Rate from 1 to N (numbers may be reused)]; Display Variability: [Yes]"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** In this activity stakeholders validate and agree on business requirements by putting into consideration the internal and external constraints (in model labeled G or output from activities A.1.4, A.1.5, A.1.6), and the high level solution specifications in model F). See facilitator notes under A.1.4.2.3, except here stakeholders comment on the rates they assign to the requirements. **(2)** Alternatively the evaluation method and facilitator notes used in A.1.2.3 can be used. Output: Rates indicating priorities of requirements for the architecture.
A.4.4	Define quality criteria (or quality assurance principles) with respect to achieving the business requirements **FREEBRAINSTORM** Input: Model G (i.e. the diagram template for constraints classification which was populated with data on internal constraints at A.1.4 and date on external constraints at A.1.5) and model F (i.e. the diagram template for requirements classification which was populated with partial data on business requirements at A.4.3). Tools: "Generate" tool configured like in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: In the effort to achieve the defined business requirements, suggest ways in which this organization's way of operation (and service delivery) in the desired situation can be differentiated from the way of working (and service delivery) of other organizations that offer similar services and products (and have the same business requirements and goals)?

Figure C.14: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 3)*

	Facilitator notes: Inform stakeholders that the quality criteria defined in this activity will help architects to generate, evaluate, and validate alternative ways in which the organization's enterprise architecture can be designed to fulfill the business requirements. Output: Suggestions or ideas on quality assurance principles with respect to achieving business requirements.
A.4.5	Clarify and categorize quality criteria by type **CONCENTRATION, REVIEWREFLECT** Input: Output of A.4.4 Tools: "Organize" tool configured as: *"Step will run in Outliner Mode"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Encourage stakeholders to remove redundancies and ambiguities in the suggested ideas on quality assurance with respect to achieving the business requirements. **(2)** Categorize ideas suggested into governance quality criteria, business quality criteria, and operational quality criteria. Output: Cleaned list of quality criteria or quality assurance principles
A.4.6	Evaluate, discuss, validate and agree on quality criteria **STRAWPOLL, CROWBAR** Input: Output of A.4.5 Tools: "Evaluate" tool configured as: *"Topic list: Input topic file - [list-of-quality-assurance-criteria.mw]; Evaluation Method - [Rate from 1 to N (numbers may be reused)]; Display Variability: [Yes]"*. Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: In this activity stakeholders validate and agree on the (governance, business, and operational) quality criteria with respect to the organization's internal constraints and external constraints. See facilitator notes under A.1.4.2.3, except here stakeholders comment on the rates they assign to the quality assurance principles/criteria. Output: Valid quality criteria or principles with respect to achieving business requirements.
A.5.1.	Define names of transformation process(es) required to achieve the business requirements **FREEBRAINSTORM** Input: Output from A.4.4 (i.e. partially populated diagram templates for requirements classification) and output from A.4.6. Tools: "Generate" tool configured as specified in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: Name new or existing business (or operational) processes that need to be implemented (or that need to be revised/redesigned) at enterprise level or at departmental level, in order to achieve the business requirements? Facilitator notes: **(1)** Inform stakeholders that the aim of this activity is to define the third part of the business requirements classified in A.4.4, and that this is going to be done by determining the "HOW it should be done" part of the business requirement. Also, communicate that a given business requirement can have one phrase or combination of phrases defining the "HOW it should be done" aspect. **(2)** Display and explain the data capture function: {title of requirement} – {"HOW it should be done" (i.e. the name of the required transformation process)} – {status of the proposed process (i.e. new or existing)}. In this data capture function, the "title of requirement" refers to a given category name of "WHAT should be done", whereas the "required transformation process" refers to a name of a enterprise/departmental level business/operational process that needs to be put in place (or to be revised) in order to achieve a given business requirement. Output: A brainstormed list of business processes or functions that need to be redefined or implemented in order to achieve the business requirements.
A.5.2.	Clarify and organize names of required transformation process(es) **FASTHARVEST** Input: Output from A.5.1 and A.4.4 (i.e. partially populated diagram template for requirements classification) Tools: "Organize" tool configured as: "*Step will run in Outliner Mode*". Other tools are: Paper, pen, stickers, markers, and flipcharts.

Figure C.15: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 4)*

	Facilitator notes: **(1)** Invoke a specialization-driven division (or task-driven or interest-driven division), and provide each department or subgroup with copies of the diagram template for requirements classification. **(2)** Inform stakeholders that in this activity there are three guiding themes for organizing the suggested processes are: First, classifying suggested processes into those that are at enterprise level and those that are new or proposed processes, and those that are existing processes. Second, classifying suggested processes into those that are at enterprise level and those that are at department level. Third, how the suggested transformation processes can interact or support each other in order to achieve the agreed on business requirements and goals? **(3)** Inform subgroups to work towards these themes, each subgroup will first work on classifying processes for a specific department/unit, and then work on classifying the implications of those processes at enterprise level. Each subgroup needs to first remove redundancies and ambiguities by identifying any duplicate entries of transformation/business processes in aspects that pertain to its department/unit, and then determine which processes are sub processes of other processes. **(4)** Plot the cleaned list of processes in the "HOW it should be done" prompts on to the diagram template for requirements classification for a given department. **(5)** Plot the cleaned list of processes in the "HOW it should be done" prompts on to the diagram template for requirements classification for the enterprise. **(6)** Converge subgroups and encourage presentations and discussions of subgroup results (i.e. classified processes for a given department and for the enterprise). **(7)** Encourage stakeholders to examine processes within each category (or department) and also across categories (or departments), so as to further remove duplicate or redundant departmental processes and/or enterprise-level processes. Also, stakeholders need to identify process names that are similar to those already existing in the baseline situation. If such are identified, then it is vital to determine whether it is sufficient to refine the existing process or function to address a given requirement. **(8)** Encourage stakeholders to express their dissatisfaction or disagreements with the resultant classifications of new processes and "existing-but-to-be-refined" processes (at enterprise level and departmental level). Output: Fully populated diagram templates for requirements classification showing the transformation processes that have to be defined in order to achieve the desired or target situation.
A.5.3.	Elaborate business requirements using CATWOE analysis **FREEBRAINSTORM** Input: Output of A.5.2 (fully populated diagram template for requirements classification), and readable prints of model labeled H, i.e. diagram template for requirements elaboration (also known as scenarios formulation template). Tools: "Generate" tool configured as specified in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: Perform a CATWOE analysis of each enterprise-wide business requirement by: providing answers to the following questions or topics: **(1)** Who are/will be the **C**ustomers or beneficiaries? **(2)** Who are/will be the **A**ctors responsible for realizing the transformation process(es) associated with that requirement? **(3)** What are/will be the inputs required to realize the **T**ransformation process(es) associated with that requirement, and what are/will be the expected outputs from the transformation process(es)? **(4)** What are the **W**orld views that make that requirement meaningful or rational? **(5)** Who are/will be the **O**wners or sponsors responsible for either sponsoring the realization of that requirement, or stopping it? **(6)** What are/will be the **E**nvironmental or external issues or constraints that may hinder the realization of that requirement? Facilitator notes: The better way to execute this activity is by using copies of **the diagram template for requirements elaboration** (i.e. model H) as FreeBrainstorm sheets. This is because aspects captured in this activity can be better presented and "cleaned" if they are captured in the diagram template. Otherwise, if EMS technology is used, display and explain data capture functions: (1) {name of enterprise-wide business requirement} – {name of a given CATWOE aspect (e.g. Customers)} - {description of the required aspect (e.g. list of beneficiaries incase that business requirement is achieved)} Output: Brainstormed aspects of CATWOE analysis of the business requirements
A.5.4.	Clarify and organize CATWOE aspects associated with the business requirements **FASTHARVEST**

Figure C.16: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 5)*

	Input: Output of A.5.3, fully populated diagram template for requirements classification (output of A.5.2), and readable prints of diagram templates for requirements elaboration (i.e. model labeled H). Tools: “Organize” tool configured as: “*Step will run in Outliner Mode*”. Other tools are: Paper, pen, stickers, markers, flipcharts Facilitator notes: **(1)** Invoke a specialization-driven division (or task-driven or interest-driven division), and provide each department or subgroup with copies of **the diagram template for requirements elaboration** (discussed in chapter 6). **(2)** Guide stakeholders to use the diagram template for requirements elaboration to clean (i.e. clarify, organize, and verify) the CATWOE aspects associated with fulfilling enterprise-level business requirements that were assigned to their subgroup to work on. **(3)** The cleaned CATWOE aspects are then plotted on the five (5) edges of the pentagon frame that exists in the diagram template for requirements elaboration (chapter 6 and appendix III show this pentagon frame in the template). Each enterprise-level business requirement or transformation process is elaborated on a new copy of the diagram template for requirements elaboration. Thus, if there are, e.g. 8 enterprise level business requirements or transformation processes, then those would mean having 8 separate sheets of the diagram template for requirements elaboration (such that each sheet is used for each enterprise-level requirement). **(4)** Converge subgroups and encourage presentations and discussions of output from each subgroup (i.e. results of CATWOE analysis of enterprise-level business requirements). **(5)** Encourage stakeholders to identify requirements that have the same CATWOE aspects, and to determine if they are not duplicate or redundant, or if they need to be integrated. Output: Partially populated diagram templates for requirements elaboration, showing CATWOE aspects associated with all the business requirements.
A.5.5.	Sketch solution scenarios of the solution/desired or target situation **FREEBRAINSTORM** Input: Output from A.4.4 (i.e. the populated diagram template for requirements classification) and output from A.5.4 (i.e. the partially populated diagram template for requirements elaboration or scenarios formulation). Tools: “Generate” tool configured as specified in A.1.1.1.1 except topic list. Other tools are: Paper, pen, stickers, markers, and flipcharts. Topic: What are the possible sub processes or activities that must be executed in order to accomplish the enterprise-level business or operational processes associated with each enterprise-level business requirement? (In other words, suggest ways of HOW each transformation process that is associated with a given business requirement can be achieved). Facilitator notes: **(1)** Invoke a specialization-driven division (or task-driven or interest-driven division), and provide each department or subgroup with copies of the partially populated diagram template for scenarios formulation. **(2)** Encourage stakeholders in each subgroup to use the diagram template for scenarios formulation to sketch or define tasks or activities that have to be executed in order to achieve a given desired business (or operational) process that pertains to a given business requirement. **(3)** With FreeBrainstorm in this activity, it is possible to have quick exchange of various sheets of the scenarios formulation template among stakeholders, if they are in subgroups. This helps to draw sketches and then other stakeholders add on those sketches to improve and fully populate the diagram template. To quicken the next steps, it is vital that the readable prints of the scenarios formulation template (which can be perceived as FreeBrainstorm scenarios sheets) are labeled (H_1, H_2, …. H_N). Labeling these sheets quickens up activity A.5.6. **(4)** Inform stakeholders that in this activity, each diagram template for scenarios formulation can be taken to represent a given business requirement or enterprise-level process. It is also possible that sub processes of a given enterprise-level process are represented using two or more diagram templates for scenarios formulation. **(5)** Communicate that in the template for scenarios formulation, sub processes (activities or tasks) that have to be executed to fulfill a given enterprise-level business process are represented using small circles labeled as process P_K (where K = 1, 2, …., N) in the template (this template is discussed in chapter 6 and an example is provided in appendix III). **(6)** Further, clarify that the flow or dependences or interactions among these sub processes are represented using lines with arrow heads showing the direction of the flow. Also, clarify that these arrow-headed lines help to assemble the processes with

Figure C.17: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 6)*

	respect to how they interact to achieve a given enterprise-level process. **(7)** Note that for transformation processes that are similar to those that already exist in the baseline environment, the output of activity A.1.1.1 (i.e. populated diagram template for process attributes) can be used as a starting point to define or refine processes or activities (or define additional tasks). Output: Various sketches of models for enterprise-level transformation processes that are associated with the defined business requirements. These sketches are suggestions of HOW the business requirements can be achieved.
A.5.6.	Analyze and refine each formulated solution scenario of the desired situation **FASTHARVEST** Input: Output from A.5.5, and readable prints of the populated diagram template for requirements classification, and diagram templates for requirements elaboration or scenarios formulation. Tools: "Organize" tool configured as: "*Step will run in Outliner Mode*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: Ensure that stakeholders are still in a specialization-driven division. Encourage subgroups to use their sketched diagram templates on the FreeBrainstorm scenarios sheets (that were labeled H_1 …. H_N (if they were not labeled it is vital that they are labeled at this point, so that they can be easily or clearly referred to when doing the following): **(1)** Encourage each subgroup representative to work along with his/her subgroup members to converge aspects in their sketches of solution scenarios (on the FreeBrainstorm scenarios sheets labeled H_1 …. H_N) onto a flip chart using marker(s). **(2)** In doing so, the contents of the labeled FreeBrainstorm scenarios sheets are used to formulate a new solution scenario (of a given transformation process or enterprise-level process corresponding to a given business requirement) that has no redundant or duplicate sub processes or aspects like those represented in the various FreeBrainstorm sheets (that are marked H_1, H_2, …. H_N) that resulted from activity A.5.5. **(3)** Also, there is need for stakeholders to examine the new formulated solution scenario model(s) with respect to the business requirement it is associated with and the CATWOE aspects of that requirement. In other words, stakeholders determine if CATWOE aspects associated with a given requirement are actually represented in the new formulated solution scenario model(s) that pertain to a given transformation process. **(4)** Encourage discussions of any flaws or weaknesses in the new formulated solution scenario model(s) by subgroups. Output: Refined sketches of conceptual models of solution scenarios, showing sub processes or activities that constitute the required transformation processes.
A.5.7.	Validate solution scenarios of the desired situation **CONCENTRATION** Input: Output from A.5.6 and readable prints of the populated diagram template for requirements classification. Tools: "Organize" tool configured as: "*Step will run in Outliner Mode*". Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: **(1)** Invoke a plenary session where output from each subgroups (i.e. models of solution scenario(s) pertaining to the required transformation processes) is presented and discussed. **(2)** During the presentations of output from subgroups, encourage stakeholders to note down unnecessary delays caused by somewhat similar sub processes across departments or units (i.e. those that appear in more than one department or unit), and any flaws that they see in the output or models or representations from subgroups. **(3)** After all subgroup models have been presented, encourage members to share with the group any issues that they have noted down with respect to the models of the formulated solution scenarios from the subgroups. **(4)** Encourage a discussion of identified flaws (or redundancies) in the populated scenarios formulation templates. Output: Refinement suggestions on aspects presented in the scenarios formulation diagram templates from each subgroup.
A.5.8.	Agree on solution scenarios for the desired situation **STRAWPOLL, CROWBAR** Input: Output from A.5.7. Tools: "Evaluate" tool configured as: *"Step specific information: Input Topic List Items* – [Yes, I agree with the aspects in the solution scenarios; No, I do not agree with some aspects in the solution scenarios]*; Evaluation Method – [Vote (Yes/No)]; Display Variability – [Yes]".* Other tools are: Paper, pen, stickers, markers, and flipcharts. Facilitator notes: See facilitator notes under A.1.1.2.5. Output: Validated formulations or sketches of solution scenarios that the enterprise architecture is to address.

Figure C.18: *ThinkLet Notation of CEADA – Collaborative Design Module (Page 7)*

ThinkLet Notation for the Collaborative Choice Module of CEADA	
Step #	**Step Name and its Parameters**
A.7.0	Communicate purpose of the session. The holistic data capture pyramid template. <u>Facilitator notes</u>: Give a recap of the holistic data capture pyramid template, and the relevance of this session with respect to aspects represented in the pyramid.
A.7.1	Discuss positive and negative implications of the possible architecture views for each solution scenario that resulted from the collaborative design module. <u>Input</u>: Architecture view models that have been designed the based on output from the collaborative intelligence and collaborative design modules. <u>Facilitator notes</u>: Invoke a specialization-driven or task-driven-division to form subgroups that represent particular departments/units. To (each) subgroup, discuss positive and negative implications of possible (design alternatives of) architecture views for each solution scenario that relates to a given transformation process (that is executed through interactions within or across units or departments). <u>Output</u>: A shared understanding within subgroups of how the architecture views address their concerns and requirements.
A.7.2	Discuss positive and negative implications of each enterprise architecture design alternative (i.e. a combination of the various architecture views that represent the solution scenarios). <u>Input</u>: Enterprise architecture design alternatives that have been designed the based on output from the collaborative intelligence and collaborative design modules. <u>Facilitator notes</u>: Converge all subgroups of stakeholders to form one group in which members from various units or departments are invited. Discuss positive and negative implications of each possible enterprise architecture design alternative, which is a combination of various architecture views for each solution scenario that relates to a given transformation process (or set of concerns and requirements). <u>Output</u>: A shared understanding among stakeholders on how unit level and enterprise level concerns and requirements are addressed in each enterprise architecture design alternative.
A.7.3 and A.7.4	Evaluate and discuss enterprise architecture design alternatives **STRAWPOLL, CROWBAR** <u>Input</u>: An understanding of the positive and negative implications of enterprise architecture design alternatives and readable prints of architecture view models and models of enterprise architecture design alternatives. <u>Tools</u>: "MultiCriteria" tool configured as: "*Step specific information: List of Alternatives* - [list-of-possible-enterprise-architecture-design-alternatives.mw]; *Input Criteria List Items* - [Suitability of a design alternative with respect to: **(a)** satisfying a set of predefined quality criteria; **(b)** satisfying a set of concerns and requirements]". <u>Other tools are</u>: Paper, pen, stickers, markers, and flipcharts. <u>Facilitator notes</u>: **(1)** Prompt stakeholders to evaluate the possible enterprise architecture design alternatives with respect to criteria in categories (a) and (b) above. **(2)** Encourage stakeholders to comment on their scores of the enterprise architecture design alternatives. **(3)** Repeat this activity until the variability among scores that stakeholders assign to the leading alternative is low. <u>Output</u>: The chosen enterprise architecture design alternative.

Figure C.19: *ThinkLet Notation of CEADA – Collaborative Choice Module*

Appendix D Sample Models from CEADA Sessions

This appendix presents selected examples of models that were formulated during the evaluation of CEADA in enterprises that participated in field studies I and II. These examples have been discussed in sections 7.8 and 7.9. As highlighted in section 7.10, field study I resulted in 14 models, while field study II resulted in 143 models. This appendix presents a very small sample of these models.

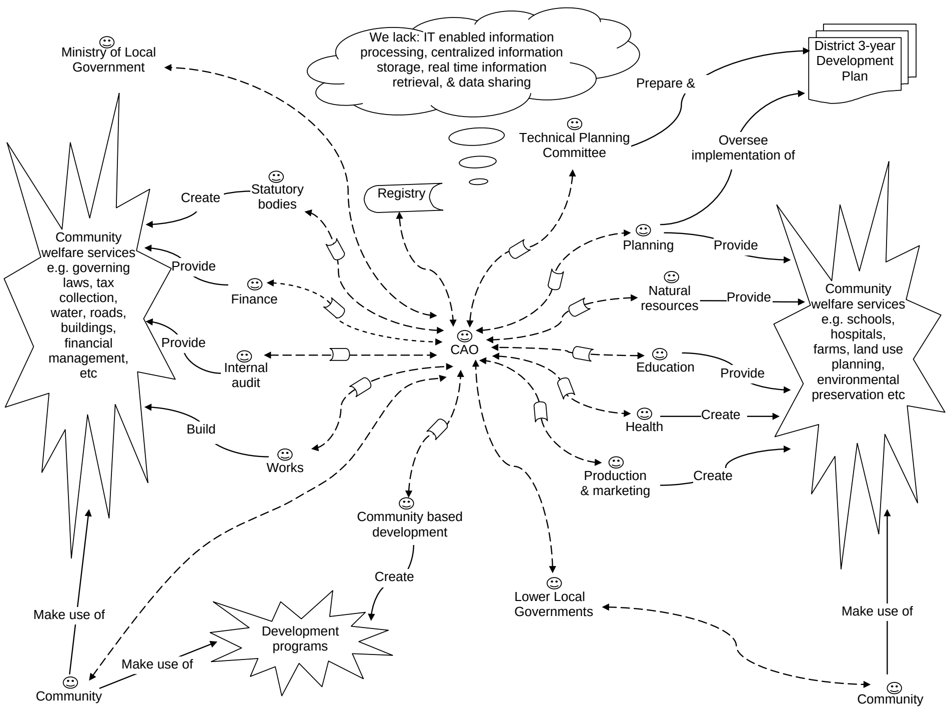

Figure D.1: *Rich Picture For WDLG as-is Situation*

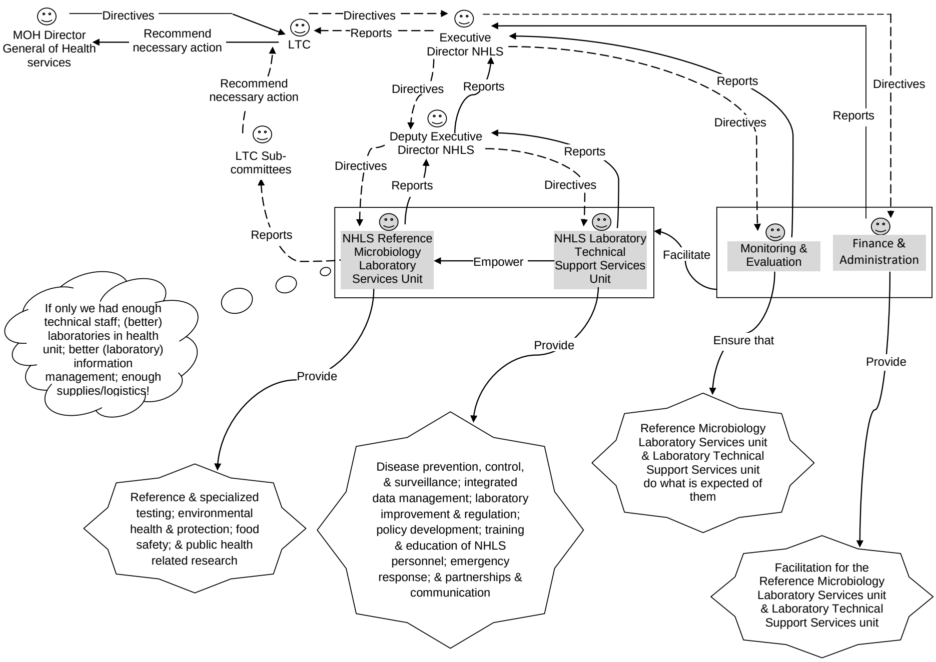

Figure D.2: *Rich Picture of NHLS (Showing only the Main Units of NHLS (a.k.a CPHL))*

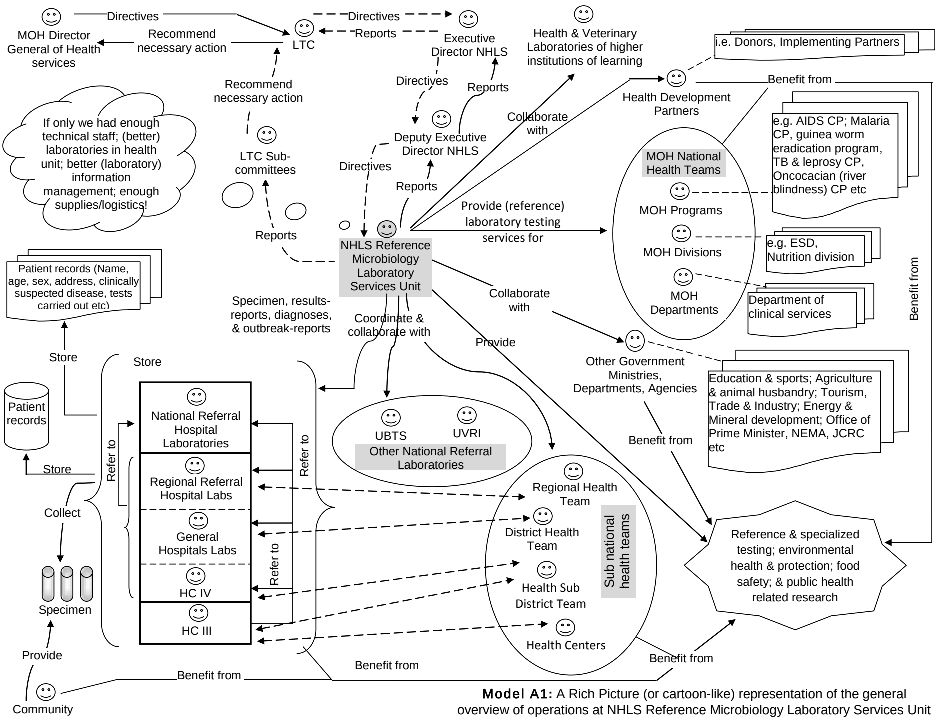

Figure D.3: *Rich Picture of the Microbiology Reference Services Unit of NHLS (*this is an example of a Rich Picture that is congested with a lot of information*)*

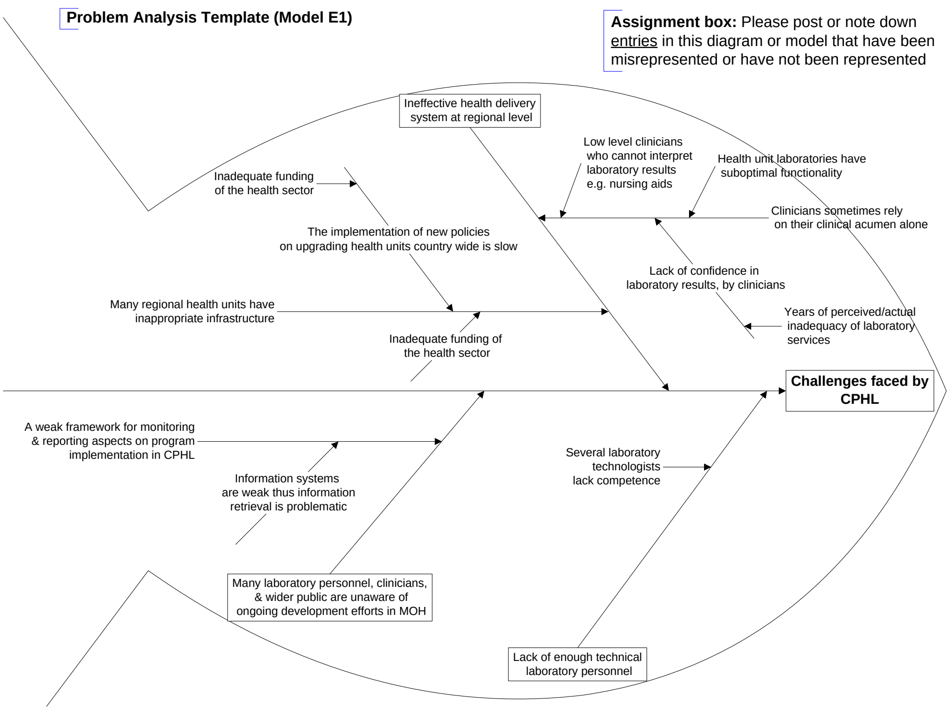

Figure D.4: *An example of an assignment box in one of the corners of a model print (used at, e.g., activity A.3.1 in collaborative intelligence module)*

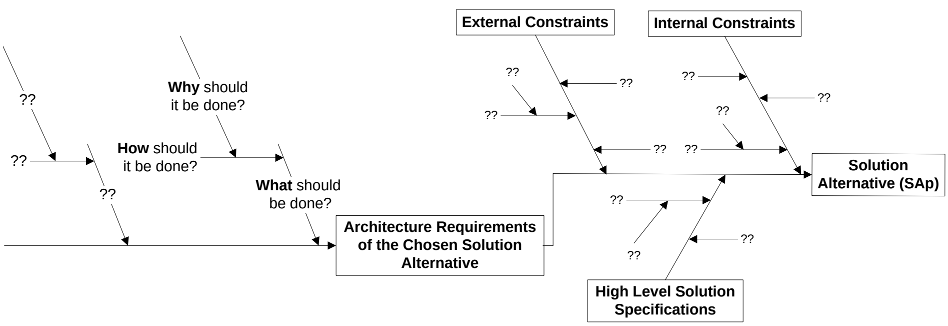

Figure D.5: *Diagram Template for Constraints and Requirements Classification – Information on* When *and* How *to use this template is provided in CEADA's ThinkLet Notation Model*

Model 0B1 - Ishikawa showing the attributes of the Reference Microbiology Laboratory Services Unit, i.e.: the core functions of the unit, inputs/inflows; output/outflows; benefiting parties; internal stakeholders (players within NHLS); external stakeholders (players outside NHLS)

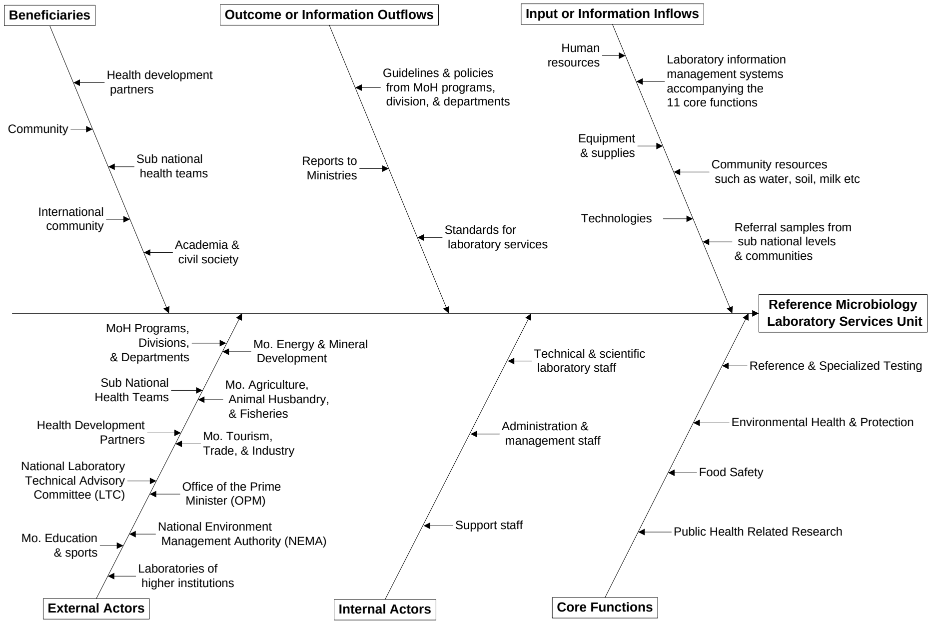

Figure D.6: *Customized Process Attributes Model of one of the units of NHLS (a.k.a CPHL)*

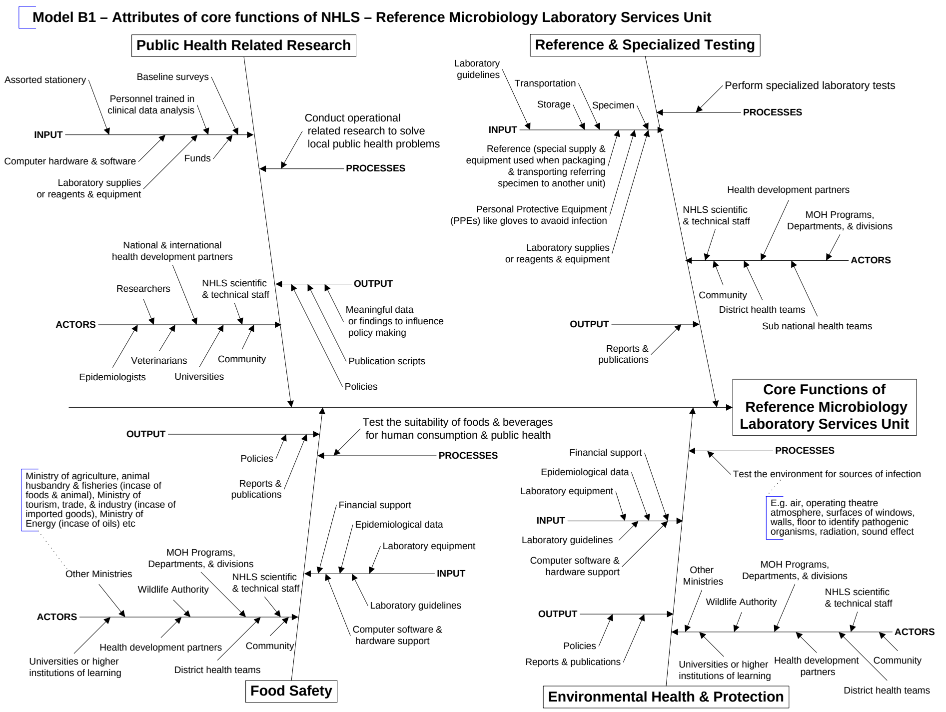

Figure D.7: *Customized Process Attributes Model of one of the units of NHLS (a.k.a CPHL)*

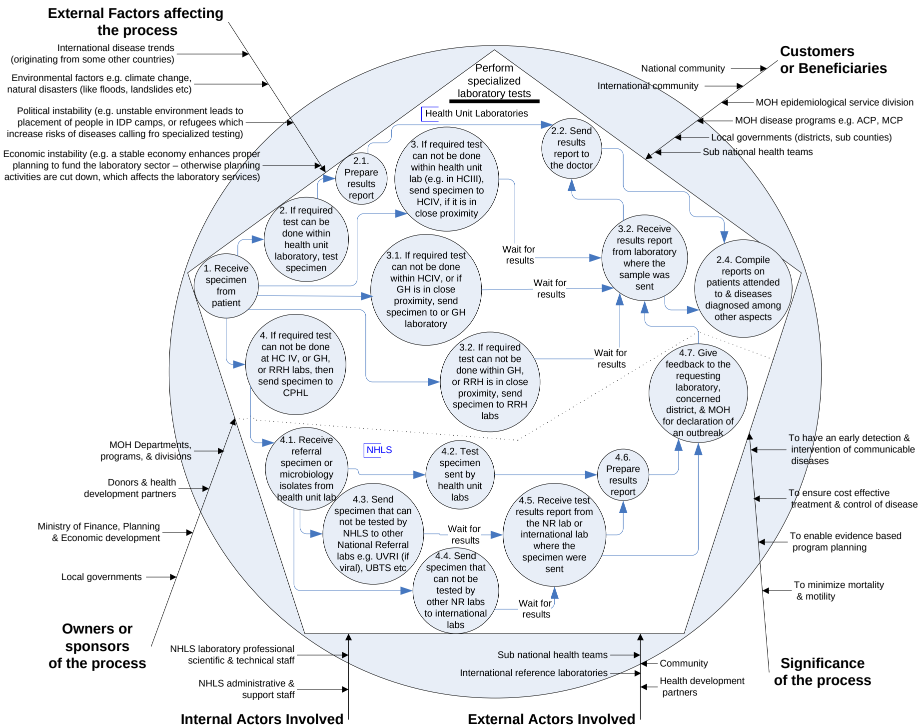

Figure D.8: *Scenarios Formulation Template Showing Details of an Event or Operational Process of "Perform Specialized Laboratory Tests" in CPHL*

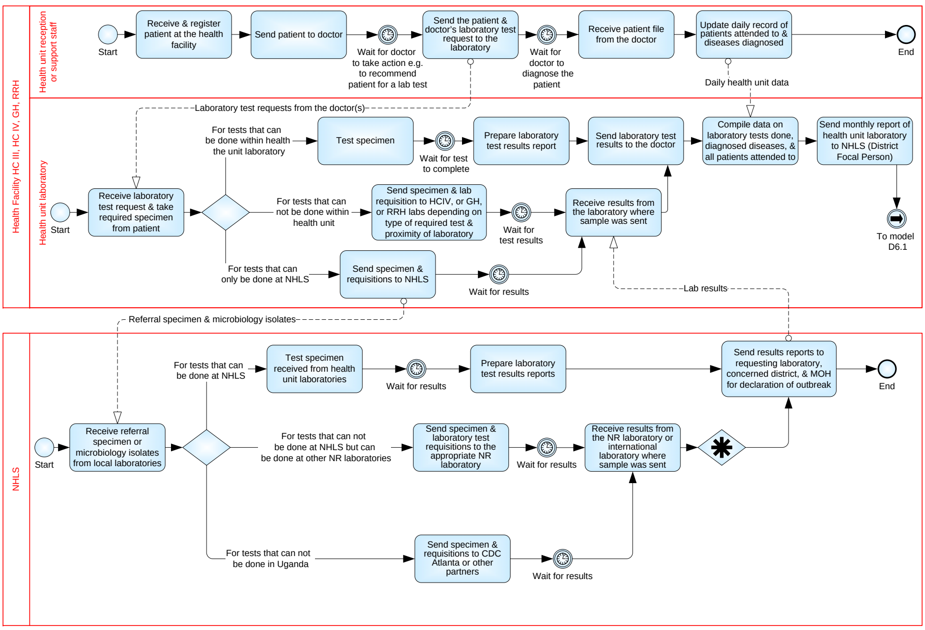

Figure D.9: *Business Architecture View of the Operational Process of "Perform Specialized Laboratory Tests" in CPHL*

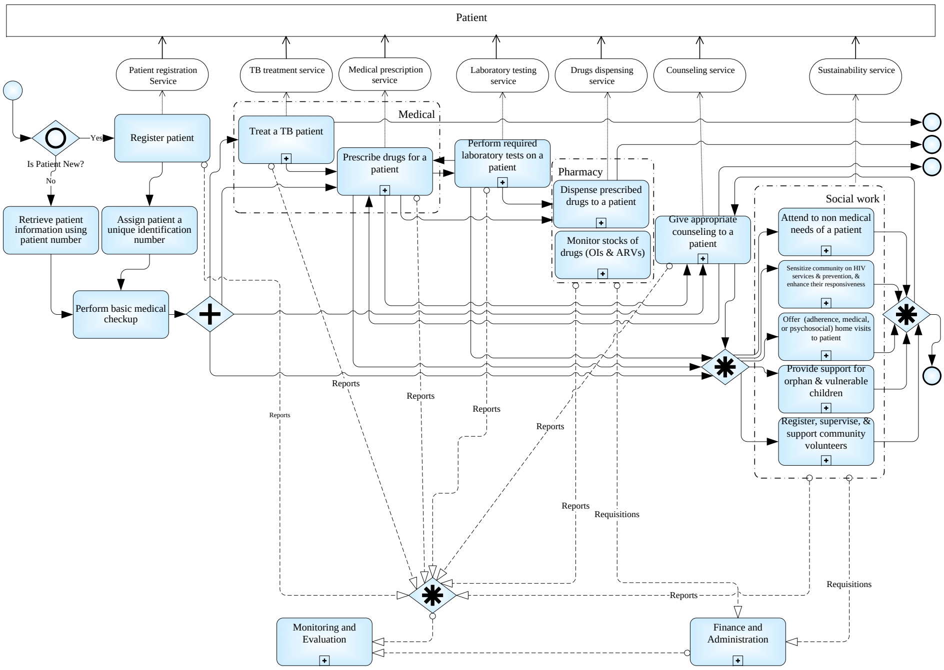

Figure D.10: *Architecture Vision – Processes in NHC*

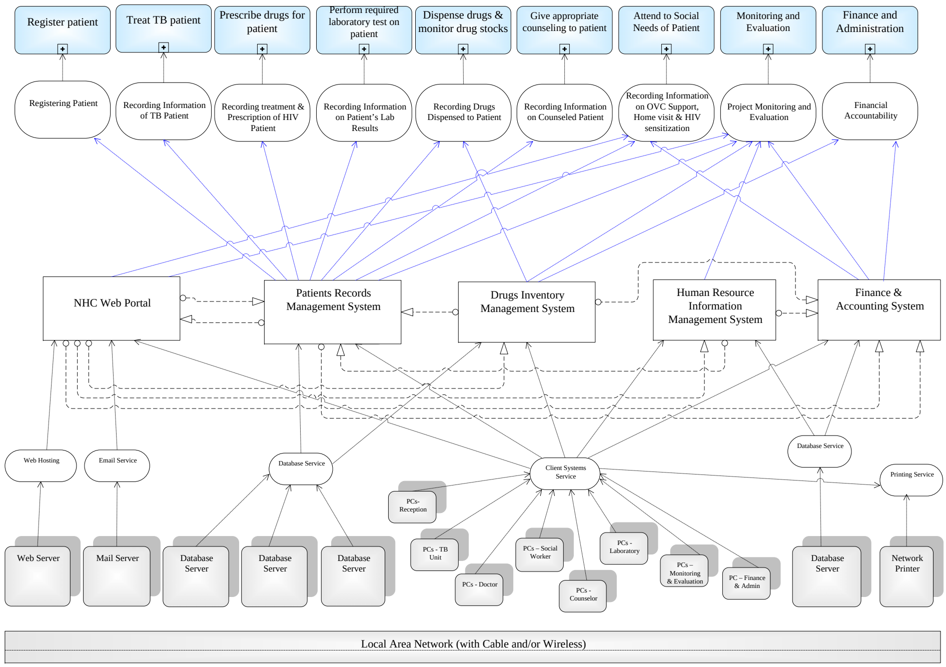

Figure D.11: *Architecture Vision – Processes, Application Systems, and Technology in NHC*

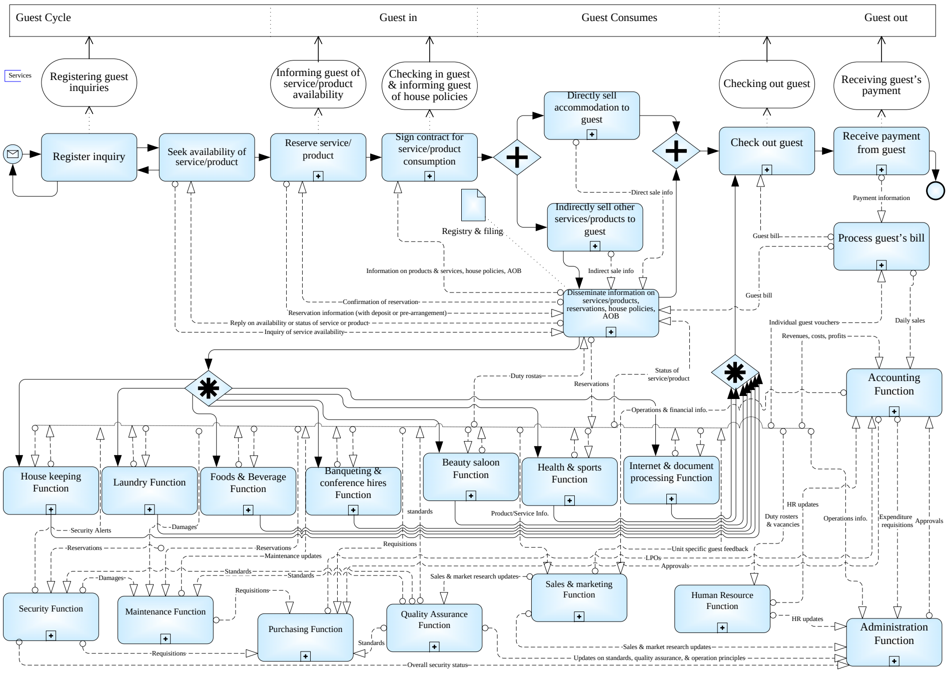

Figure D.12: *Architecture Vision – Processes in MUKGH*

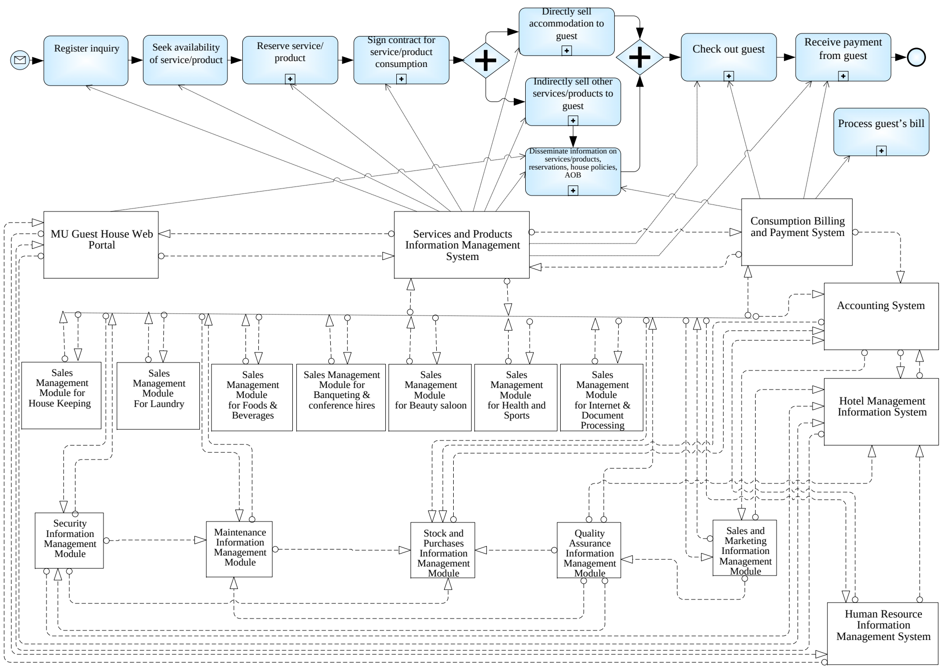

Figure D.13: *Architecture Vision – Processes and Application Systems in MUKGH*

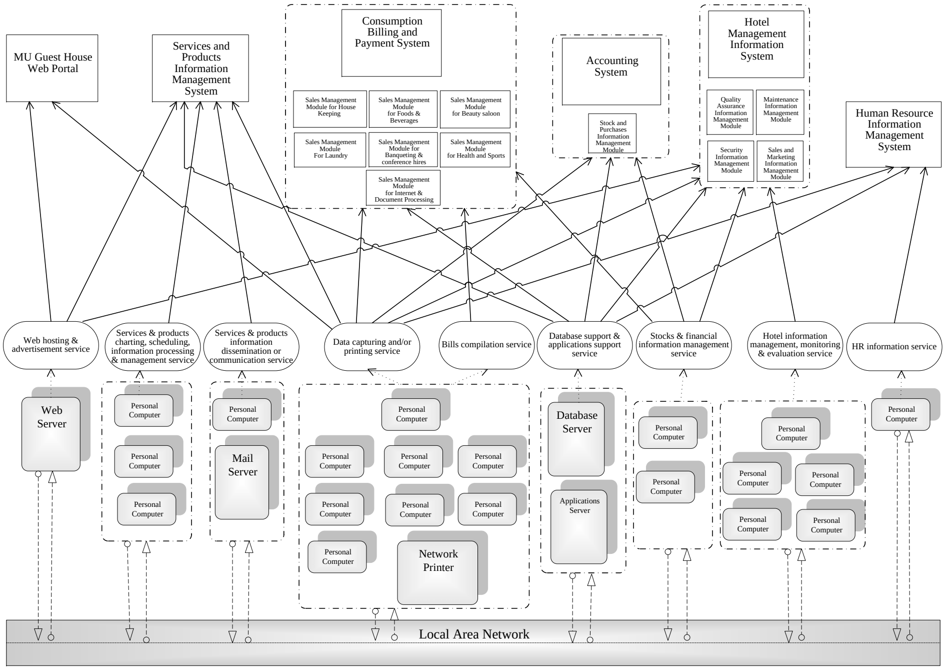

Figure D.14: *Architecture Vision – Application Systems and Technology in MUKGH*

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Summary

Creating or designing an enterprise architecture involves two types of tasks, i.e. architect-specific tasks (those that are executed by enterprise architects) and collaboration dependent tasks (those whose proper execution requires enterprise architects to collaborate with organizational stakeholders). Since enterprise architecture frameworks and methods richly inform the execution of architect-specific tasks, this research was motivated to provide insights into the execution of collaboration dependent tasks. The basic idea in executing collaboration dependent tasks during enterprise architecture creation is to ensure that stakeholders make collaborative decisions on problems (or concerns) and requirements that the enterprise architecture must address. In doing so, stakeholders and architects acquire a shared understanding of the problems in the baseline situation and the requirements associated with the target situation of the enterprise. We assume that this results in increased awareness (among stakeholders) of the enterprise architecture creation process, creates a sense of ownership of the architecture creation results, and leads to collaborative organizational change or transformation.

Enterprise architecture creation is a recurring initiative to an enterprise architect. However, literature hardly provides an explicit and flexible procedure with detailed operational guidelines of how enterprise architects can manage and facilitate the execution of collaboration dependent tasks during enterprise architecture creation. This implies that an enterprise architect has to rely on the presence of a professional or skilled facilitator in order to effectively collaborate with stakeholders during architecture creation. Avoiding this required this research to seek an answer to the question: *how can a process for executing collaboration dependent tasks during enterprise architecture creation be structured?* We therefore adopted the Design Science research methodology [49] to design and evaluate an artifact (a collaboration process per se) that offers a structured and flexible way for enterprise architects to facilitate the execution of collaboration dependent tasks during enterprise architecture creation. In the course of achieving this, the following four sub questions had to be answered.

What are the challenges that enterprise architects face when executing collaboration dependent tasks during enterprise architecture creation? We answered this by conducting an exploratory survey among enterprise architects. From the survey findings, we formulated two taxonomies. First is a taxonomy of problems faced when executing collaboration dependent tasks. It includes (a) ineffective communication, (b) lack of a shared understanding and shared vision or strategy, (c) social complexity, (d) lack of long term planning, (e) lack of a clear decision making process or unit in the organization and architecture governance, (f) lack of supporting tools and techniques for executing collab-

oration dependent tasks, and (e) others. Second is a taxonomy of recommendations (given by enterprise architects) for addressing the problems they face. It includes (i) explicitly defining the purpose of enterprise architecture creation, (ii) collaborating with the right people, (iii) communicating clearly and regularly, (iv) ensuring an establishment of a clear decision making process and governance framework, and (v) others.

What are the essential phenomena in the execution of collaboration dependent tasks, and the interrelationships among those phenomena? We answered this by formulating a theory on Collaborative Decision Making (CDM) in enterprise architecture creation that explains interrelationships among essential phenomena associated with executing collaboration dependent tasks. The theory is made up of eleven notions. The core notion of the theory asserts that the main parameters in executing collaboration dependent tasks are effective communication, negotiations, and a shared understanding of baseline and target aspects among enterprise architects and stakeholders. The phenomena represented in the theory and their interrelations are entirely based on existing literature. The theory was formulated by adopting the guidelines of theory-driven design of collaboration systems [12] and the cause-effect analysis concept [45].

Which tasks during enterprise architecture creation are collaboration dependent? Basing on notions of the theory on CDM in enterprise architecture creation, we formulated the synergy of collaboration dependent tasks in enterprise architecture creation. In the synergy, we structured collaboration dependent tasks into three sessions, i.e. collaborative intelligence, collaborative design, and collaborative choice. The formulated synergy of collaboration dependent tasks is mainly based on the generic decision making process [118], the multilevel thinking technique [22]), and enterprise architecture creation literature. In addition, the theory notions were used to provide insights into addressing challenges and recommendations from the exploratory survey that we conducted among enterprise architects. These insights were also incorporated into the synergy of collaboration dependent tasks. Since Checkland [22] warns that unorganized communications or expressions is one of the core causes of unsuccessful human conversations, we devised this synergy to serve as a springboard for structuring conversations on architecture creation or structuring the execution of collaboration dependent tasks.

How can Collaboration Engineering and SSM be adopted to provide an explicit and flexible procedure that addresses the challenges associated with the essential phenomena in executing collaboration dependent tasks? In answering this we first discussed a taxonomy of CDM approaches that are relevant in enterprise architecture creation. Thereafter, we chose to adopt Collaboration Engineering [14, 62, 130] to design a collaboration process that supports **C**ollaborative **E**valuation of (**E**nterprise) **A**rchitecture **D**esign **A**lt-ernatives (i.e. CEADA). CEADA process comprises a set of eight *thinkLets* that are repeatedly used to offer detailed facilitation guidelines for executing collaboration dependent tasks. These thinkLets include LeafHopper, FreeBrainstorm, DealersChoice, FastHarvest, Concentration, ReviewReflect, StrawPoll, and CrowBar. After evaluating CEADA in real life settings, it was found necessary to supplementary adopt Soft Systems Methodology (SSM). SSM [22] was mainly adopted to supplement thinkLets that constitute CEADA with support for visualization, categorization, and organization of aspects during execution of collaboration dependent tasks. This was done by formulating templates in form of diagrams, that are based on SSM techniques (such as Rich Picture, Analysis One Two Three, Root Definitions, CATWOE analysis, and Activity Models) and other techniques such as the Ishikawa diagram concept [56].

The design of CEADA has been evaluated using the analytical evaluation method, experiment evaluation method, and Action Research method in at least eight enterprises. Findings from each evaluation method led to refinements in the earlier versions of CEADA. The theory on CDM in enterprise architecture creation helps to explain some incidences associated with the performance of CEADA in the experiment and in the real enterprises in which CEADA was evaluated. Based on evaluation findings on CEADA's performance in eight real enterprises, we can claim that CEADA is a repeatable and predictable process for supporting the execution of collaboration dependent tasks. CEADA is repeatable because when it is used in different enterprises (to support the execution of collaboration dependent tasks during enterprise architecture creation), the patterns of reasoning it creates (among stakeholders) in those enterprises are somewhat alike. This is indicated by the mean scores of CEADA under particular evaluation goals. In addition, although the use of CEADA in each enterprise requires customization (which can be done basing on various situational parameters that are also discussed in this thesis), it is predictable in supporting the execution of collaboration dependent tasks.

This research generally attempted to strengthen enterprise architecting guidelines with support for collaboration dependent tasks, so as to achieve CDM in enterprise architecture creation. This support has been packaged in CEADA. Therefore in this thesis, we also discuss how CEADA supplements existing enterprise architecture approaches with support for executing collaboration dependent tasks. We specifically show the use of CEADA in the Architecture Development Method (ADM) of the The Open Group Architecture Framework (TOGAF). In this demonstration, CEADA is visualized as a potential collaboration support plug-in for enterprise architecture frameworks.

Samenvatting (Summary in Dutch)

Bij het ontwerpen van de architectuur van een organisatie zijn twee soorten taken belangrijk, namelijk taken die specifiek zijn voor de architect en taken die afhankelijk zijn van de samenwerking met anderen. Dit onderzoek richt zich op de taken die afhankelijk zijn van samenwerking. In die samenwerking moeten verschillende belangengroepen samen met de architecten beslissingen kunnen nemen. Daarbij is het essentieel dat alle betrokkenen een gemeenschappelijk begrip hebben van de problemen.

Het ontwerpen van een architectuur is niet een eenmalige taak. Het is daarom belangrijk dat er gewerkt kan worden volgens expliciete en flexibele procedures. Dergelijke procedures zijn echter nauwelijks beschikbaar. Dat leidt tot de volgende vraag: *hoe kunnen de taken die betrekking hebben op samenwerking gedurende het ontwerpen van de architectuur van een organisatie worden gestructureerd?* We maken daarbij gebruik van Design Science [49] op basis van de volgende vier subvragen:

1. Wat zijn de uitdagingen waar architecten mee te maken hebben tijdens het ontwerpen van de architectuur van een organisatie?

2. Wat zijn de onderdelen van taken waarin samenwerking een grote rol speelt, en wat zijn de relaties tussen deze onderdelen?

3. Welke taken tijdens het ontwerpen van de architectuur van een organisatie zijn afhankelijk van samenwerking?

4. Hoe kunnen Collaboration Engineering en Soft Systems Methodology worden gebruikt in een expliciete en flexibele procedure voor de uitvoering van taken waarin samenwerking een grote rol speelt?

In dit onderzoek hebben we Collaboration Engineering [14, 62, 130] gebruikt om een proces te ontwerpen ter ondersteuning van **C**ollaborative **E**valuation of (**E**nterprise) **A**rchitecture **D**esign **A**lternatives, dat is CEADA. Het ontwerp van CEADA is geevalueerd met een analytische mothode, een experimentele methode en met de Action Research methode in acht organisaties.

Curriculum Vitae

7^{th} December 1980: Agnes Nakakawa was born at Kampala (in Uganda).

1987 – 1993: She undertook primary education at Nakasero Primary School.

1994 – 1997: She undertook ordinary level secondary education at Old Kampala Senior Secondary School.

1998 – 1999: She undertook advanced level secondary education at Makerere College School.

2000 – 2003: She pursued and acquired a Bachelor of Statistics degree at Makerere University (ISAE). Her research involved developing an application system for analyzing and predicting sales data of organizations using time series analysis techniques.

2003 – 2004: She was an ICT instructor at Byte International Group and the then Department of Women and Gender studies at Makerere University (in 2004).

2004 – 2006: She pursued and acquired a Master of Science in Computer Science degree at Makerere University (CIT). Her research involved developing a spatial decision support tool for selecting landfill sites for municipal solid waste management in Kampala and Wakiso districts.

2004 – 2009: She was a teaching assistant in the Department of Information Systems at the then Faculty of Computing and IT (Makerere University).

2008 – 2012: She has been undertaking a PhD research project at Radboud University Nijmegen (The Netherlands).

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2008

2008-01 Katalin Boer-Sorbán (EUR) Agent-Based Simulation of Financial Markets: A modular, continuous-time approach

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2009

2009-01 Rasa Jurgelenaite (RUN) Symmetric Causal Independence Models

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2009-44 Roberto Santana Tapia (UT) Assessing Business-IT Alignment in Networked Organizations

2009-45 Jilles Vreeken (UU) Making Pattern Mining Useful

2009-46 Loredana Afanasiev (UvA) Querying XML: Benchmarks and Recursion

2010

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2010-02 Ingo Wassink (UT) Work flows in Life Science

2010-03 Joost Geurts (CWI) A Document Engineering Model and Processing Framework for Multimedia documents

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2010-48 Withdrawn

2010-49 Jahn-Takeshi Saito (UM) Solving difficult game positions

2010-50 Bouke Huurnink (UVA) Search in Audiovisual Broadcast Archives

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2011

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2011-46 Beibei Hu (TUD) Towards Contextualized Information Delivery: A Rule-based Architecture for the Domain of Mobile Police Work

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2012

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