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SUPPLEMENTING ENTERPRISE ARCHITECTURE APPROACHES WITH SUPPORT FOR EXECUTING COLLABORATIVE TASKS – A CASE OF TOGAF ADM

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Effective execution of collaborative tasks during enterprise architecture creation helps to increase stakeholders' involvement and awareness in the architecture effort. However, enterprise architecture approaches lack detailed support for collaborative tasks. In an effort to address this, an exploratory survey was conducted among enterprise architects to investigate issues associated with executing collaborative tasks during enterprise architecture creation. Accordingly, this paper discusses mainly three aspects. First, it discusses how issues that were reported in the survey can be addressed by adopting the Design Science research methodology to guide the development of a process or method that supports the execution of collaborative tasks in architecture creation. The developed process is principally rooted in collaboration engineering and Soft Systems Methodology (SSM). Second, the paper discusses how the developed method can be used to supplement enterprise architecture approaches that are used in practice (e.g. TOGAF) with support for executing collaborative tasks. Third, the paper discusses key findings from evaluating the developed process in two real organizations.

Keywords: Enterprise Architecture, Collaboration Engineering, Soft Systems Methodology, TOGAF ADM.

1. Introduction

Enterprise architecture approaches generally include enterprise architecture frameworks, architecture modeling languages, and methods or techniques that support enterprise architecting. Enterprise architecture approaches provide means for (a) ordering and guarding completeness of architecture results, (b) understanding interrelationships of architecture results, and (c) enabling traceability of architecture decisions and their impact.[1] Examples of enterprise architecture approaches include The Open Group Architecture Framework (TOGAF), Zachman, ArchiMate, Integrated Architecture Framework (IAF), Federal Enterprise Architecture Framework

(FEAF), Extensible Architecture Framework (xAF), Treasury Enterprise Architecture Framework (TEAF), etc. While the majority of architecture approaches specify deliverables of architecting and are relatively silent about the procedure for creating them, TOGAF's Architecture Development Method (ADM) offers detailed guidelines for architecture development.[2] Some of these guidelines need to be executed by enterprise architects, while successful execution of other guidelines requires enterprise architects to collaborate with stakeholders. Herein the former are referred to as *expert-driven tasks*, while the latter are referred to as *collaborative guidelines or tasks* (see top part of figure 1).

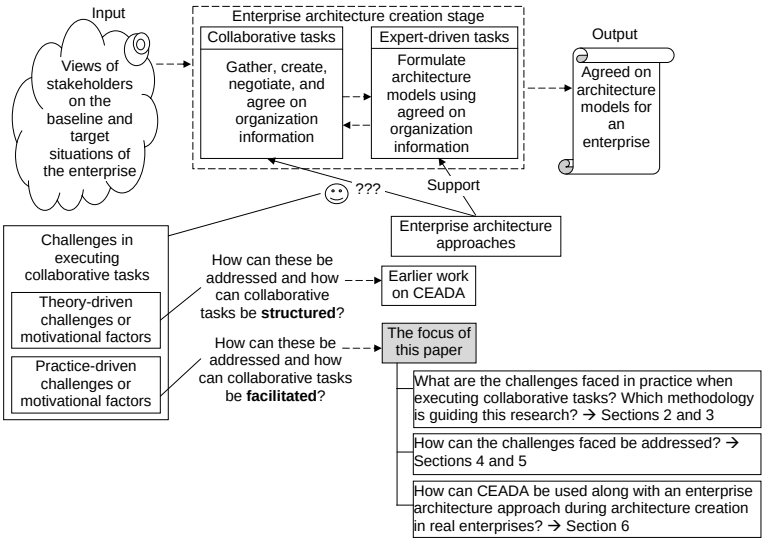

Fig. 1. Paper Structure and Focus

Effective execution of collaborative tasks during architecture creation helps to increase stakeholders' involvement and awareness in the architecture effort. Increasing stakeholders' involvement helps to increase their control in the architecture process, and this gradually reduces their resistance of the architecture process.[4] Despite the significance of effectively executing collaborative tasks in architecture creation, enterprise architecture approaches mainly provide support for executing expert-driven tasks and offer inadequate support for collaborative tasks (as shown in the top middle part of figure 1). Enterprise architecture approaches lack detailed answers to the question: how is the procedure of executing collaborative tasks during enterprise architecture creation *structured* and *facilitated*?

In our earlier research[3,41] we followed the Design Science research methodology to formulate a theory-based perspective of addressing the issue of how the architecture creation procedure can be structured (as indicated in the middle part of figure 1). We adopted concepts in literature on enterprise architecture creation with respect to collaboration engineering concepts,[43,15] Soft Systems Methodology (SSM)

techniques,[30] and other theories and methods that support (collaborative) problem solving and decision making (e.g. Refs.[42,38]). These earlier efforts yielded *theory-based* designs or versions of a method that supports Collaborative Evaluation of (Enterprise) Architecture Design Alternatives (CEADA).

After an earlier evaluation of the theory-driven design of CEADA,[3] it was found vital to augment CEADA with solutions to the *practical* problems that enterprise architects encounter when executing collaborative tasks. This implied the need to elicit information from enterprise architects (using for example an exploratory survey), on problematic issues that they encounter when they involve stakeholders in architecture creation. Accordingly, this paper generally extends our earlier work by ensuring that CEADA provides solutions to problems or issues encountered in practice during architecture creation (as shown in the left part of figure 1). Moreover, the theory-driven design of CEADA lacked a detailed discussion of how collaborative sessions on architecture creation can be *facilitated* (e.g. how existing tools and techniques can be used in those sessions). Certainly the lack of details on how to use collaboration-support tools and techniques is not a concern to a professional or skilled facilitator[5], but it is a concern for enterprise architects who are not professional or skilled facilitators. Therefore, in an effort towards making the procedure of executing or facilitating collaborative tasks in architecture creation explicit and transparent, this paper focuses on the following three aspects.

- It presents some of the findings from an exploratory survey that we conducted among enterprise architects to investigate issues associated with executing collaborative tasks during enterprise architecture creation. It also discusses how some of the issues that were reported in the survey can be addressed.
- It discusses how CEADA can be used to supplement enterprise architecture approaches (e.g. TOGAF) with support for executing collaborative tasks.
- It discusses key findings from evaluating CEADA in two real organizations.

As shown in the bottom part of figure 1, the remaining part of this paper is structured as follows. Section 2 discusses the research gap and how the Design Science research methodology was adopted to guide this research. Section 3 discusses the design of the exploratory survey that was conducted to elicit challenges faced in practice when executing collaborative tasks during architecture creation. It also discusses selected findings from the survey. Section 4 discusses the requirements implied by the survey findings, and the design choices that need to be taken in order to address the requirements. Section 5 presents a detailed discussion of CEADA's design, and shows how the design choices were orchestrated so as to address requirements that were implied by survey findings. Section 6 discusses how CEADA can be embedded in TOGAF's ADM (so as to supplement its guidelines with collaboration support), and discusses how action research method was used to evaluate the use of CEADA in two real organizations. Section 7 concludes the paper.

2. Research problem and research methodology

This section comprises two key parts. Section 2.1 discusses the research gap and section 2.2 discusses the guiding methodology.

2.1. *Research problem*

Enterprise architecture creation can be perceived as an activity comprising several sub activities that contribute to the completion of the main activity. According to Refs.[24,26], activity theory articulates that (a) artifacts (e.g. tools, models) *mediate* between the subjects or important actors in an activity and the objective of an activity, (b) there are rules that influence or govern the execution of an activity, and (c) the execution of an activity involves a community of actors and requires division of labour. These notions of the activity theory have been adopted in this research so as to clearly define the problem associated with executing collaborative tasks during enterprise architecture creation (see table 1).

Table 1. Perceiving enterprise architecture creation as an activity

#	Aspect to identify (based on Mwanza and Engestrom 2003)	Interpretation of the activity theory aspect in this research
1	Name or type of activity of interest	Enterprise architecture creation
2	Objective of the activity	To create an enterprise architecture for a given organization. According to Op't Land *et al. (*2008), enterprise architecture can be created for any of the following purposes, i.e.: 1. Decision making regarding an intended business transformation, 2. Formulating business strategy impact, 3. Specifying (business) requirements, and 4. Informing and contracting service providers.
3	Subjects involved in carrying out the activity	Enterprise architects and organizational stakeholders
4	Tools used by the subjects to perform the activity	Enterprise architecture approaches, architecture modeling languages, and other tools that may be relevant depending on the situation in a given organization
5	Rules and regulations or cultural norms governing the performance of the activity	These include the following: 1. An organization's policies, principles, culture, strategic business drivers, business goals, and business requirements, 2. External laws of business from regulatory bodies to which the organization is accountable, and 3. Guidelines defined by enterprise architecture approaches.
6	Division of labour (i.e. clear articulation of who is responsible for what when carrying out the activity and organizing the roles)	In enterprise architecture creation, there are mainly two types of roles, i.e.: 1. Expert-driven roles – those accomplished by enterprise architects, 2. Collaborative roles – those accomplished through effective collaboration between enterprise architects and organizational stakeholders
7	The community or environment in which the activity is carried out	The environment comprises of enterprise architects and organizational stakeholders. Stakeholders can be categorized into those at the organization's strategic level, managerial level, and operational level (Turban and Jay, 1998)
8	The desired outcome from carrying out the activity	A feasible enterprise architecture that addresses stakeholders' concerns. According to Op't Land *et al. (*2008), architecture products are: tangible and intangible including: principles, view models, intermediate results used to develop the architecture view models, the evaluation of alternative solutions, shared understanding, shared agreement, and commitment among stakeholders

Column 2 of table 1 shows key aspects of the activity theory. These aspects have been interpreted in the context of enterprise architecture creation (see column 3 of table 1). The shaded row in table 1 indicates that the problem this research intends to address is associated with the *division of labour* during the execution of collaborative tasks or fulfillment of collaborative roles in enterprise architecture creation. This problem is relevant because of the following two factors.

First, enterprise architecture creation demands that an enterprise architect identifies all stakeholders' concerns and develops architecture views that reflect how all concerns will be addressed in the architecture and the intended tradeoffs.[2] Second, 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.[10] In addition, an acceptable and understandable enterprise architecture is obtained through (1) modeling interdependencies within architecture layers, (2) proper visualization of enterprise aspects using models, and (3) creating a shared vision, communicating with stakeholders, and analyzing possible impacts.[13] Enterprise architecture approaches such as ArchiMate sufficiently support the modeling and visualization tasks[10], but explicit support for creating a shared understanding is lacking in many architecture approaches.[13] Yet a shared understanding of enterprise aspects among stakeholders enhances collaboration between architects and stakeholders.[14] Efforts describing the procedure of how architects can collaborate with stakeholders and how they can create a shared understanding during architecture creation are scarce. Examples of existing efforts include the following.

Spewak[8] developed the Enterprise Architecture Planning approach, which describes how to obtain deliverables of the Zachman framework, i.e. an organization's business objectives, scope, and a high level business, data, applications, and technology architecture models. Spewak recommends that architects can conduct interviews with stakeholders in order to gather information for developing a detailed as-is business model of the organization. In addition to conducting interviews, literature (e.g. Refs.[13,57]) shows that architects can also conduct workshops or group sessions involving key stakeholders to gather and validate information on an organization's baseline and target situations.

Moreover, The Open Group recommends the use of Business Scenarios, i.e. a method for defining (business) requirements before or during enterprise architecture development.[2,12] The Business Scenarios method comprises three phases, i.e. 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, and their responsibilities.[2,12] In the gathering phase, several techniques can be used (e.g. basic research, qualitative and quantitative analysis, surveys, request for information, workshops) to elicit the required information from stakeholders.[2,12] However, details are not given on how to use the prescribed techniques, for example how to facilitate the workshops. Yet workshops are very vital in gathering information on business requirements.[2,12] For example, they can be conducted to elaborate (or seek consensus on conflicting aspects in) information that has been gathered using interviews with stakeholders or information that has been gathered using other methods.

However, in this research we do not advocate for the use of only workshops or only interviews to gather information required for architecture creation. Instead we advocate for a detailed procedure that shows how to synergically or complementarily use interviews, workshops, and other techniques to support the execution of

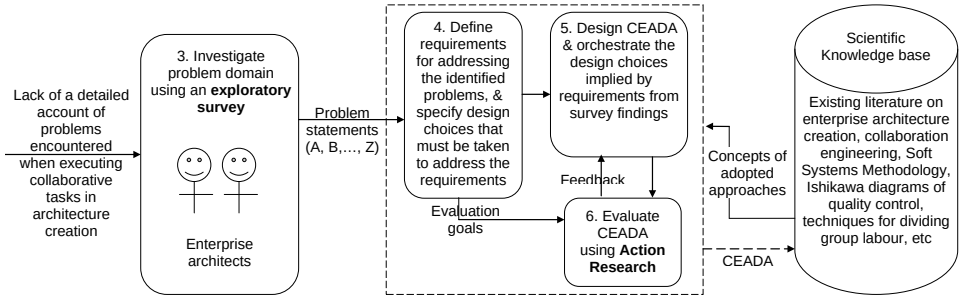

Fig. 2. Adoption of Design Science methodology

collaborative tasks during architecture creation. Such a procedure can be an answer to the question (posed in section 1) of how collaborative tasks in architecture creation can be structured and facilitated in order to achieve repeatable results.

2.2. *Adoption of Design Science methodology*

Design Science guides the design and evaluation of artifacts that address relevant organization problems.[28] Design Science was adopted because this research generally aims at developing an artifact that provides explicit support for collaborative tasks in enterprise architecture creation. The relevance of this is discussed in section 2.1. Our earlier work on this initiative (see section 1) did not fully address this problem because there was lack of a detailed account of problematic issues that enterprise architects face when they involve organizational stakeholders in architecture creation (as shown in the middle part of figure 1 and the left part of figure 2). Accordingly, there was need to use the exploratory survey method to gather details of such problems (as indicated in the box marked 3 in the left part of figure 2). This is because exploration is a suitable method in situations where phenomena of interest have "*received little or no systematic empirical scrutiny*", or have "*been largely examined using prediction and control rather than flexibility and open-mindedness*".[47]

The numbers in the boxes that constitute figure 2 represent sections in this paper where particular aspects in figure 2 are discussed. Thus, section 3 discusses details of the exploratory survey. From the survey findings, requirements that the resultant artifact must address were identified. Thus, in section 4 we define requirements implied by issues reported in the survey (as shown in the middle part of figure 2), and design choices implied by the requirements. In section 5 we extend the theory-based design of CEADA (that appeared in our earlier work[3]) by incorporating design choices and/or techniques that provide solutions to the requirements implied by survey findings. In defining requirements and making design choices of CEADA, we adopt a number of existing approaches in the scientific knowledge base (see cylinder and arrows in the right part of figure 2). In section 6 we then discuss how action research method was used to evaluate the use of CEADA (along with TOGAF ADM) when creating architectures for two real organizations (as shown in

the bottom middle part of figure 2). 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.[46] In general, the key research methods used herein include the exploratory survey and action research, as discussed in sections 3 and 6 respectively.

3. Challenges in executing collaborative tasks

It is often difficult for enterprise architects and stakeholders to effectively collaborate during enterprise architecture creation.[14] This becomes a concern during the division of labour to fulfil collaborative roles that occur in architecture creation (see row 6 in table 1). Resolving this issue may require one to have an in-depth understanding of challenges enterprise architects face when they collaborate with stakeholders to accomplish collaborative roles. However, literature on enterprise architecture is silent on details of the problematic nature of collaboration between stakeholders and enterprise architects during architecture creation (as indicated in the left part of figure 2). Therefore, there was need to conduct an exploratory survey to investigate the challenges encountered during execution of collaborative tasks. Section 3.1 presents the design of the exploratory survey, while section 3.2 presents a selection of survey results that are in line with the discussion in this paper.

3.1. *Design of the exploratory survey*

This section discusses the aim of the survey, respondents, survey questionnaires, sampling method used, sample size, how 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 collaborative tasks during enterprise architecture creation. Questions for the survey were formulated on three topics, namely (a) factors that hinder effective collaboration among stakeholders and enterprise architects during enterprise architecture creation, (b) methods that architects use to manage the execution of collaborative tasks with stakeholders, and the strengths and weaknesses of those methods, and (c) recommendations on how to overcome the challenges encountered during execution of collaborative tasks, and on factors for successful enterprise architecture creation. These topics are formulated with respect to two key phenomena or constructs in this research, i.e. (1) collaboration between stakeholders and enterprise architects, and (2) methods used in practice to support collaboration between stakeholders and enterprise architects. This is because, given the discussion in section 2.1 and the interpretation in table 1, the problem addressed in this paper is associated with the tools and procedure that the subjects use to fulfil collaborative roles in the architecture creation activity. Thus, the survey mainly focused on eliciting architects' insights into challenges associated with these two phenomena, and recommendations to address such challenges.

Respondents and questionnaires used. The 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 (a sample of the open-ended questionnaire is shown in figure 24 in the appendix). The questionnaire with open-ended questions was then pretested among ten (10) enterprise architects. This was done by emailing the open-ended questionnaire to fourteen (14) enterprise architects, ten of which responded. Thereafter, responses from the ten enterprise architects were reviewed, summarized, and similar opinions in the responses were aggregated in order to form possible multiple choice options for a given question. Thus, the first version of the self administered questionnaire was refined (by converting the majority of the open-ended questions that it contained into closed questions) based on responses or insights that were gathered from the ten architects who participated in the questionnaire pretesting. This was motivated by the fact that in an exploratory survey respondents can be asked closed questions that are based on qualitative data that was collected beforehand, and in doing so one can augment qualitative data or results with descriptive statistics such as percentages.[47] The refined version of the self administered questionnaire is provided in the appendix (see figures 25 and 26) and was the one used in the exploratory survey. In converting the open-ended questions that appeared in the first version of the questionnaire (see figure 24) into closed questions, we left an option for respondents to provide open-ended responses on each question by using the "*others (specify) ...*" option on each closed question (see figures 25 and 26). For the survey to be conducted, there was need to first determine an appropriate sampling method.

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).[27,23,21] 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 Refs.[27,23,21] Purposeful sampling is used when there is need to study and understand something about, or features of, a specific (small) group of people.[23] Purposeful sampling technique may be appropriate in exploratory surveys, but in surveys that aim at making statistical inferences about the population probability sampling techniques are used.[22] Therefore, in this research purposive sampling was most appropriate because the major aim of the survey was not to make predictions on the population of architects, but to gather details of problems architects encounter when executing collaborative tasks in architecture creation.

How the survey was administered. The survey was conducted online (via http://www.thesistools.com/). The questionnaire (presented in figures 25 and 26 in the appendix) was uploaded on http://www.thesistools.com/, and the link to the questionnaire was sent to the respondents via the mailing lists of enterprise

architects. This was done because the subscribers to these mailing lists are enterprise architects, who in this case were the target respondents. Thus, we did not have to inquire whether one was an architect or not for him or her to participate in the survey. For every architect who received the questionnaire link, the survey questionnaire was active online for a period of three months.

Response count. At the end of the three months, a maximum of 70 enterprise architects had participated in the online survey.

Limitations of the survey. Since it was difficult to estimate the actual population of enterprise architects, we can not determine detailed aspects of the survey such as the non-response rate in this survey, or the accuracy of a sample size of 70 enterprise architects that participated in the survey. Also, the survey questionnaire did not investigate details of demographic or heterogenous factors in the population of architects (e.g. their age, gender, years of experience, number of architecture projects they have been involved in, their successful and failed projects, etc). Moreover, since we used purposive sampling (a non probability sampling method), results from the survey are treated as pointers to the breadth and/or depth of the problematic issues that the research needs to address. 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 findings from the exploratory survey as a basis for testing hypothesis or drawing predictions on the population of architects or on matters associated with research. Section 3.2 discusses survey results that were considered relevant in this paper.

3.2. *Selected survey results*

This section describes how survey responses were analyzed and presents findings under the three topics highlighted in section 3.1, i.e. challenges architects face when executing collaborative tasks, methods they use, and recommendations on how challenges can be solved.

3.2.1. *Analysis of survey results*

The analysis of survey responses mainly resulted in (a) percentages of respondents who experience particular problems or who recommend particular measures to be taken, and (b) categorization of problems and recommendations that were elicited from respondents. An overview of how the analysis was done is provided below.

Percentages of respondents who experience particular issues. Responses in the 70 questionnaires were captured using the Statistical Package for Social Scientists (SPSS). This was possible because numeric codes were first assigned to the response options of the multiple choice questions in the survey questionnaire (in figures 25 and 26), and the codes that corresponded to particular responses on each question were entered into SPSS. Options for the multiple choice questions were coded using $1, 2, ..., n$, where n is the number of options that the question has (see figures 25 and 26 in the appendix). Text responses to the open ended question

(see question 4 in figure 25 in the appendix) were reviewed, summarized, and similar opinions were aggregated to form lists of strengths and weaknesses of methods currently used in practice (e.g. see text presented in the left and right boxes of figure 3). The captured data was checked again to ensure that no errors were made. Thereafter, data was analyzed using the descriptive statistics menu item in SPSS. Percentages of responses on particular options or aspects on a given question were generated using SPSS. Sections 3.2.2 – 3.2.4 present the selected survey results.

Categorization of responses. Converting open ended questions that were used in the first version of the questionnaire (as discussed in section 3.1) to closed questions that were used in the survey helped us to analyze responses from the 70 respondents in a less time consuming way. It also helped us to form multiple choice options that could be categorized into at least 7 problem statements and at least 5 recommendation statements during the analysis of responses. The categorization of aspects into these problem statements and recommendation statements was based on the similarity of aspects mentioned in the response options under a given question. Section 3.2.2 presents the 7 categories of problem statements and section 3.2.4 presents the 5 categories of recommendation statements.

3.2.2. *Challenges reported by architects*

Exploring problems faced in executing collaborative tasks was necessary for motivating and informing the formulation of detailed support for these tasks. Thus, questions 4, 5, 9, and 11 in the questionnaire (see figures 25 and 26 in the appendix) aimed at eliciting challenges that hinder effective collaboration between stakeholders and architects during tasks that involve (i) gathering information about the client organization, (ii) generating and evaluating enterprise architecture design alternatives with stakeholders, and (iii) delivering architecture products. Following the discussion in section 3.2.1, responses on these questions were categorized into problem statements A – G that are presented below.

A – Ineffective communication

(A1) Communication is problematic because architects explain the value of architecture in a language that is abstract to stakeholders, while the stakeholders use words that do not have the same meaning for everyone (reported by 50% of the respondents).

(A2) There is limited awareness of architecture (and its relevance, goals, and content) among stakeholders, causing them to perceive architecture to be about only technology (reported by 53% of the respondents).

(A3) The old fashioned distinction between business and IT (reported by 30% of the respondents). Traditionally IT used to *automate information processing within enterprises* yet IT has now *become part of almost everything and many processes have become IT-reliant of not fully automated.*[58]

(A4) There is lack of documentation of knowledge in the organization (reported by

31% of the respondents).

B – Lack of a shared understanding and shared vision

(B1) 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, and its enterprise architecture (reported by 70% of the respondents).
(B2) 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 (reported by 36% of the respondents).
(B3) It is complex to bridge the gap between the abstract long term consequences and the more concrete examples that stakeholders can understand (reported by 31% of the respondents).

C – Social complexity. Social complexity refers to an incidence where there are various stakeholders with different perspectives regarding various issues that are to be addressed in a given project.[49] Survey issues classified under social complexity include:

(C1) Key stakeholders have low priority or insufficient time for participating in collaborative tasks, and yet project time schedules are tight (reported by 77% of the respondents).
(C2) Organization politics and hidden agendas result in fuzzy decision making and blockage of long term visions to achieve short term and selfish needs (reported by 56% of the respondents).
(C3) There are conflicting stakeholders' interests, differences in perception, and stakeholders climbing the ladder of inference – overreacting or quickly drawing conclusions based on personal beliefs and insecurities (reported by 40% of the respondents).
(C4) Architecture conclusions conflict with personal ambitions (reported by 37% of the respondents).
(C5) Biased scores or judgments due to personal preferences or the "not invented here" syndrome among stakeholders (reported by 34% of the respondents).
(C6) 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 (reported by 24% of the respondents).
(C7) The "100% syndrome" of some architects impairs collaboration with stakeholders (reported by 16% of the respondents). The "100% syndrome" here refers to incidences where architects recommend technical solutions to problems faced within an organization without deliberating on the actual uniqueness of cultural and social issues raised by stakeholders in a client organization.
(C8) Some stakeholders have an attitude of "the outsider is the expert, but the outsider does not understand our situation".

D – Lack of long term planning

(D1) 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 (reported by 42% of the respondents).
(D2) There is lack of commitment from people who were not earlier involved in the architecture process (reported by 24% of the respondents), or concerns arise from other stakeholders who were not seen as key stakeholders before (reported by 21% of the respondents).

E – Lack of a clear decision making process and architecture governance

(E1) Stakeholders are not accountable for their decisions (reported by 47% of the respondents).
(E2) Some organizations lack a clear decision making unit, leading to a loud applause to matters discussed, but after there is no action taken towards supporting their realization (reported by 44% of the respondents).
(E3) Since architecture is often perceived to be about only technology, some organizations lack a governance process that can ensure architecture compliancy (reported by 44% of the respondents).
(E4) It can be difficult to translate enterprise architecture products to program architectures (reported by 17% of the respondents).
(E5) Architecture products do not deliver what was promised or required (reported by 11% of the respondents).
(E6) The created architecture may be too complex for the decision making unit or organization maturity level.

F – Inadequate support for executing collaborative tasks

(F1) Lack of supporting tools and techniques for executing collaborative tasks (reported by 17% of the respondents). This issue also takes into account the weaknesses of the methods currently used in practice by architects to manage the execution of collaborative tasks. An overview of these methods is provided in section 3.2.3.

G – Other problems

(G1) It is difficult to quantify the advantages and disadvantages of design alternatives so as to enable informed evaluation or tradeoff analysis.
(G2) Some stakeholders are unqualified to execute the tasks assigned to them.
(G3) 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 provides answers to such issues.[2]

Problem statements A – G above can be further categorized into two, i.e. (a)

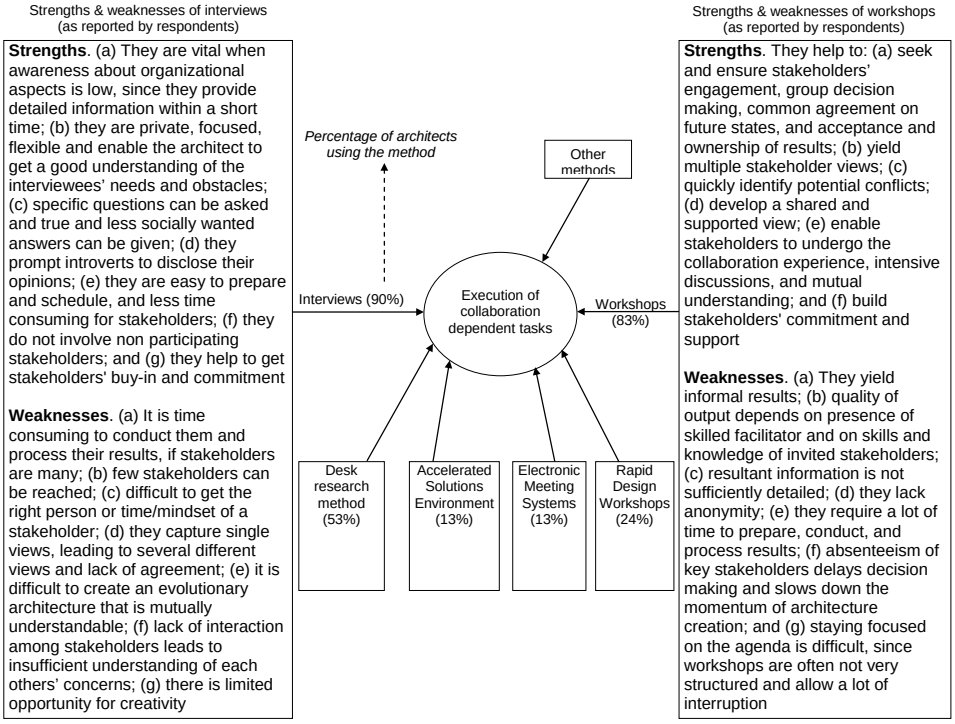

Fig. 3. Survey Findings on Methods Used When Executing Collaborative Tasks

those associated with the procedure of executing collaborative tasks, and (b) those associated with the tools and techniques used to support that procedure. Problem statements A – E are procedure-related problem categories, while problem statements F and G are associated with tools and techniques. Details associated with problem statement F are discussed in section 3.2.3 below.

3.2.3. *Methods architects use when executing collaborative tasks*

Contents of this section represent responses of architects to questions 3 and 4 of the survey questionnaire (in figure 25 in the appendix). Figure 3 shows the methods that architects use during the execution of collaborative tasks in enterprise architecture creation. The advantages and disadvantages of these methods, as reported by architects in the survey, are presented below.

Interviews and Workshops. From the percentages shown in figure 3, the two most widely used methods are interviews and workshops. The strengths and weaknesses of these two methods, as reported by the respondents, are presented in the left and right boxes of figure 3. It was also reported that if workshops are prepared and conducted properly, they are an efficient way of executing collaborative tasks.

Workshops supported by Electronic Meeting Systems (EMSs). In the

survey it was reported that EMSs enable effective and efficient sharing and storing of content in a workshop, but conducting an EMS-supported workshop requires a lot of preparation time.

Desk research. In the survey it was reported that although the desk research method is useful in almost all cases to get a deeper understanding of various aspects in an organization, it is difficult to divide work among architects and it is time consuming to process results gathered using desk research method.

Rapid design workshops and Accelerated Solutions Environment (ASE). These methods are used to create commitment and approval of a business transformation strategy among a large group of critical stakeholders.[16] In the survey it was reported that these two methods support thorough discussions and interactions among stakeholders, and things are done at a good speed. However, two major weaknesses of these methods were also reported in the survey. First, ASE is sometimes too fixed on achieving a specific task. Second, these methods support a limited depth of problem solving and detailing.

3.2.4. *Recommendations given by enterprise architects*

We found it necessary to also gather insights from architects into how the challenges they reported (as presented in section 3.2.2) could be addressed. This was the aim of question 12 in the survey questionnaire (see figure 26 in the appendix). Following the discussion in section 3.2.1, responses on this question were also categorized into recommendation statements H – L that are presented below.

H – Explicitly define purpose of enterprise architecture creation

(H1) Get the business goals clear and know the reasons for creating the architecture, or which organization problems should be solved by creating the architecture (reported by 72% of the respondents).

(H2) Create a vision of the enterprise architecture and ensure that enterprise architecture vision is shared and owned by top management (reported by 48% of the respondents).

(H3) Evaluate projects basing on long term contribution, rather than just time and budget as is normal practice.

I – Collaborate with the right people

(I1) Select the right stakeholders and collaborate with them early in the architecture process (reported by 71% of the respondents).

(I2) Ensure good collaboration with owners or subject matter experts in order to create a strong sense of cooperation and shared objectives (reported by 66% of the respondents).

(I3) Create a situation where all stakeholders participate and experience the development process e.g. schedule short group sessions that fit in the schedules of key stakeholders early in the process (reported by 24% of the respondents).

(I4) Architects, project manager(s), and business executive(s) need to respect each others' roles.

J – Communicate clearly and regularly

(J1) Ensure regular communication with stakeholders (e.g. problem owners or subject matter experts) to keep everyone on track (reported by 66% of the respondents).

(J2) 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 (reported by 51% of the respondents). Architecture creation entirely involves translating strategy into desired business operations.[1,48]

K – Establish a clear decision making process and governance board

(K1) 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 (reported by 48% of the respondents).

(K2) Ensure that the architecture function is clear and linked to other management frameworks in the organization (reported by 31% of the respondents).

(K3) Show short-term and long-term benefits of architecture, and develop an architecture roadmap that fits to the organization's overall maturity, ambitions levels and change management potential.

L – Other

(L1) Start on architecture creation as soon as possible and deliver results to key stakeholders in the shortest possible time.

Having presented the selected survey findings in sections 3.2.2 – 3.2.4, section 4 below discusses how these findings influenced the refinement of CEADA to address the practice-driven problems and recommendations in executing collaborative tasks during architecture creation.

4. Requirements and design choices implied by survey findings

Since findings from the survey highlight challenging aspects in the problem domain, they are treated as problem statements for which requirements must be developed. The requirements define *what* can be done to enable effective execution of collaborative tasks during architecture creation, and design choices or decisions define how the requirements can be addressed. In order to properly discuss the requirements and design choices implied by issues presented in the preceding section, we first briefly introduce two key approaches that were identified as candidate sources of answers to statements A – L in sections 3.2.2 – 3.2.4. These approaches are introduced in section 4.1. Thereafter, section 4.2 discusses requirements (implied by

survey issues) and design choices (implied by the requirements) that are integral to supplementing architecture approaches with support for collaborative tasks.

4.1. *Key possible solution approaches*

Solutions to complex collaborative work practices (e.g. executing collaborative tasks in architecture creation) can be drawn from the field of Group (Decision) Support Systems (GSSs). GSSs can be generally classified into Electronic Meeting Systems (EMSs) and Problem Structuring Methods (PSMs).[35] The common feature in these systems is that they are facilitator-driven, i.e. using them successfully to address a given problem requires the presence of a professional facilitator.[35,43,18] This is one of the underlying motivational factors that inspired collaboration engineering research.[43,15,18] Below we introduce collaboration engineering and one type of a PSM as candidate sources of answers to issues presented in the preceding section.

Collaboration engineering. Affordable facilitation support for collaborative work practices can be achieved through adopting collaboration engineering, i.e. an approach that guides the design of collaborative processes that can be executed by practitioners of recurring mission-critical collaborative tasks; and can be reused to obtain predictable successful results.[17,18,15] This is possible because collaboration engineering is concerned with the development of collaboration processes that help one to transfer relevant facilitation skills and knowledge of using EMSs and group dynamics to practitioners.[18] Sections 4.2 – 4.3 discuss how collaboration engineering concepts informed the determination of requirements and design choices that must be considered in order to address issues that were reported in the survey.

Soft Systems Methodology (SSM). SSM is a rational procedure of inquiring or exploring messy or ill-structured (organizational) situations.[30] It involves mainly four stages, i.e.: (a) investigating and documenting or representing the problem situation, (b) describing the desired situation using a well structured format and conceptual models, (c) comparing and deliberating conceptual models of the desired situation with real world scenarios and agreeing on ways of improving the problem situation, and (d) taking appropriate action to address the problem situation.[30] Sections 4.2 – 4.3 discuss how SSM concepts informed the determination of requirements and design choices that must be considered in order to address issues that were reported in the survey.

4.2. *Addressing problem statements associated with procedure*

This section presents requirements that must be fulfilled in order to address the problem and recommendation statements that are associated with the *procedure* followed when executing collaborative tasks. From sections 3.2.2 and 3.2.4, table 2 gives an overview of problem statements A – G and their corresponding recommendation statements H – L. In sections 4.2.1 – 4.3 we base on survey findings (presented in the preceding section and summarized in table 2) to define requirements that the research artifact must fulfil. These requirements are denoted as *Rp*

(where $p = 1, 2, 3, ..., n$). We also use concepts of the solution approaches introduced in section 4.1 to specify the design choices that we took to address particular requirements.

Table 2. Summary of survey findings on challenges and recommendations

#	Problem statements	#	Recommendation statements
A	Ineffective communication	J	Communicate clearly and regularly
B	Lack of a shared understanding and shared vision or strategy	H	Explicitly define purpose of enterprise architecture creation
C	Social complexity	I	Collaborate with the right people
D	Lack of long term planning		
E	Lack of a clear decision making process or unit in the organization and architecture governance	K	Ensure establishment of a clear decision making process and governance framework
F	Lack of supporting tools and techniques for executing collaboration dependent tasks	L	Other
G	Other problems		

4.2.1. *Requirements to address problem A – ineffective communication*

Three major requirements (R1 – R3) were identified to solve problem A. First, R1 states that the research artifact needs to provide means through which stakeholders and architects can use a common and understandable vocabulary when (a) expressing their concerns and needs, (b) defining the business goals, (c) demonstrating how the business strategy and goals translate into architecture, (d) explaining the reasons for creating the architecture and the short-term and long-term benefits or value of the architecture, and (e) demonstrating the linkages between the architecture content and other (existing) organization frameworks. R1 aims at addressing survey issues labeled A1 – A3, J2, and K2 in sections 3.2.2 and 3.2.4. Second, R2 states that the research artifact needs to provide a (semi)structured and regular communication schedule that will enable architects to communicate the architecture content and status of the architecture project to various stakeholders. R2 aims at addressing issue labeled J1 in section 3.2.4. Third, R3 states that the research artifact needs to provide means through which knowledge in the organization can be documented in an understandable way. R3 aims at addressing issue labeled A4 in section 3.2.2.

Design choices made to address the requirements implied by problem A: Collaboration engineering literature[43,17,15] provides six patterns of reasoning (see table 3) that enable a team to communicate their views on a given topic, refine their views to the extent that the wording used to document or describe the views have the same meaning to every team member. These patterns of reasoning are created using a technique known as a *thinkLet*, which comprises the following three aspects: (a) a precise description of the tool that one can use to create a given pattern of reasoning in a group, (b) how to configure or setup the tool, and (c) the script or procedure to follow when using the tool.[43,17,15] The tools can be computer-based (e.g. EMSs such as Meetingworks^{TM}, GroupSystems^{TM}) or not computer-based (this is elaborated in section 5.1). Table 3 gives a few examples

of thinkLets that can create a given pattern of reasoning. Thus, basing on the information presented in column 2 of table 3, we made the design choice of assigning the *clarify* and *organize* patterns of reasoning (see table 3 for their definitions) to activities that are associated with clearly defining business strategy, business goals, and stakeholders' problems or concerns or needs. We also selected thinkLets that create these patterns of reasoning and we assigned them to these activities (see section 5.5 for details on how the selection of thinkLets was done). This was done to address requirements R1(a), R1(b), and R2.

Table 3. Patterns of Collaboration and ThinkLets (based on guidelines in Refs. 43,17,15)

#	Patterns of reasoning or collaboration	ThinkLets to create a pattern
1	Generate – this pattern helps a team to move from a state of having few concepts to more concepts	OnePage, LeafHopper etc
2	Reduce – this pattern helps a team to move from a state of having several concepts to fewer concepts that the group considers worth concentration	FastFocus, OneUp, ReviewReflect, FastHarvest etc
3	Clarify – this pattern helps a team to move from having less to more shared understanding of concepts	
4	Organize – this pattern helps a team to move from less to more understanding of relationship among concepts of group interest	ThemeSeeker, PopcornSort etc
5	Evaluate – this helps a team to move from having less to more understanding of the value of concepts of group interest, with respect to some quality criteria	StrawPoll, MultiCriteria etc
6	Consensus building – this helps a team to move from having fewer to more group members consenting to a proposed idea	CrowBar, MoodRing etc

In addition, SSM literature[30] provides at least six techniques (see table 4) that can help a group of actors to communicate and represent or visualize aspects in an easily understandable way. Thus, we further made the design choice of adopting these techniques such that architects can use them to document organizational aspects and communicate with stakeholders (in an easily understandable way) aspects associated with (i) how business strategy and goals translate into architecture, (ii) short-term and long-term reasons of creating the architecture, and (iii) linkages between architecture content and other organization frameworks. The multi-level thinking technique (see row 2 in table 4) was particularly adopted to help in formulating a (semi)structured communication schedule that can be followed during architecture creation (see section 5.1). Section 5.5 provides details on how other SSM techniques in table 4 were adopted to address requirements R1(c) – R1(e), R2 and R3.

Furthermore, literature was silent on how one can use SSM techniques in a collaborative setting, so we made the following design choices. First, we selected patterns of collaboration and thinkLets that will support each collaborative task (see sections 5.4 and 5.5). Second, we identified particular SSM techniques that can supplement the thinkLets that were selected to support execution of a given task. Third, we devised a diagram template (based on a given SSM technique) that can be used to represent aspects that stakeholders and architects discuss in group and/or interview sessions (see section 5.5). This was done because we conjectured that stakeholders would find it less time consuming and less hectic to populate diagram templates with required data, than to draw conceptual models from scratch using

Table 4. Definitions of SSM techniques (based on Ref. 30)

#	SSM technique	Description of technique
1	Multi-level thinking	This 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.
2	Rich Picture	Is a holistic representation of aspects that describe the problem situation e.g. processes, actors and their concerns
3	Analysis One Two Three	Is a description of all problem owners (i.e. Analysis One), political aspects (i.e. Analysis Two), and cultural or social aspects (i.e. Analysis Three) affecting the problem situation
4	Root Definitions	These are short explicit phrases that indicate the desired transformation in the format of "what should be done", "how it should be done", and "why it should be done"
5	CATWOE analysis	Involves assessing the following details of each root definition: **C**ustomers that will be affected by the transformation, **A**ctors that will implement the transformation, **T**ransformation process(es) that will be affected, **W**orld views regarding the relevance of the transformation, **O**wner(s) of the transformation, and **E**nvironmental and external issues that will affect the transformation
6	Activity models	These are diagram representations of the desired situation, which are obtained by assembling all desired transformation processes that are defined in each Root Definition and its CATWOE analysis

SSM techniques that they are not be conversant with. Section 5.5 provides details more details on the diagram templates. These diagram templates helped to address R3, which also calls for the need to deploy techniques that can enable stakeholders to collaboratively define the baseline and target situations.

4.2.2. *Requirements to address problem B – lack of a shared understanding and shared vision*

Four major requirements (R4 – R7) were identified to solve problem B. First, R4 states that the research artifact needs to provide a way of enabling architects and stakeholders to explicitly demonstrate abstract aspects regarding the long term consequences of the organization's problem situation and desired situation, and to evaluate the long term contribution of development projects. R4 aims at addressing issues labeled B3 and H3 in sections 3.2.2 and 3.2.4. Second, R5 states that the research needs to provide a detailed collaboration procedure that an architect can follow to create a shared understanding and vision and a sense of ownership (among top management, problem owners, subject matter experts) of the baseline situation, its strategic objectives, its future development, and its enterprise architecture. R5 aims at addressing issues labeled B1, H2, and I1 – I3 in sections 3.2.2 and 3.2.4. In addition, recommendation K2 demands for effective collaboration with stakeholders in order to gather sufficient information on the existing frameworks such that they are linked to the architecture function. Also, challenge G2 calls for the need to devise ways of enhancing learning among stakeholders. It has been reported that effective collaboration helps to enhance learning in groups.[31] Thus, devising a collaboration procedure that enables effective collaboration among stakeholders will help stakeholders to learn problem solving skills and to imagine aspects in the target situation.

Third, R6 states that the research artifact needs to provide ways of building consensus or shared agreement among stakeholders on aspects associated with the

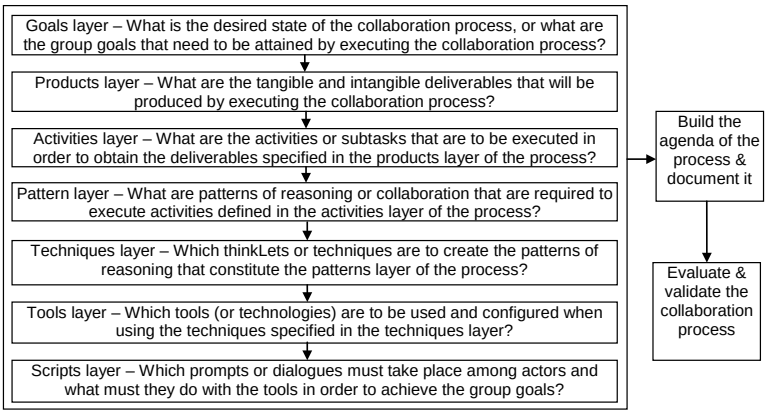

Fig. 4. Collaboration engineering approach (based on guidelines in Refs. 51,43,34,15)

architecture. R6 aims at addressing issues labeled B2 and C3 – C5 in section 3.2.2. Fourth, R7 states that the research artifact needs to provide means to ensure that at the start of architecture creation, the first information gathered is associated with business goals and problems that shall be solved by creating the architecture. R7 aims at addressing issue labeled H1 in section 3.2.4.

Design decisions made to address the requirements implied by problem B: Collaboration engineering literature provides the *organize* and *evaluate* patterns of reasoning and various thinkLets that create these patterns (see table 3). Thus, we made the design choice of assigning the organize and evaluate patterns of reasoning to activities associated with demonstrating and evaluating short-term and long-term consequences of the baseline and desired situations, and we selected appropriate thinkLets to create these patterns of reasoning during the execution of these activities. This was done to address requirement R4. Second, collaboration engineering literature[51,43,34] provides steps, guidelines, and design concerns that must be considered when developing a collaboration process for a given task. Such design aspects are shown in figure 4. Thus, we made the design choice of adopting the collaboration engineering design aspects in order to develop a detailed procedure that architects can follow to create a shared understanding and vision among stakeholders during the execution of collaborative tasks. This was done to address R5. Sections 5.1 – 5.5 discuss how this was done. To address R6, activities associated with building consensus on aspects in the target situation were assigned (a) the *evaluate* and *build consensus* patterns of reasoning (defined in table 3), and (b) appropriate thinkLets to create these patterns of reasoning during the execution of these activities. Sections 5.4 and 5.5 provide details on how this was done.

In addition, SSM literature provides the root definitions, CATWOE analysis, and activity models techniques (see table 4). Thus, in addressing requirement R4, we also made the design choice of supplementing the thinkLets that were selected to create the organize and evaluate patterns of reasoning (among stakeholders and

architects) with techniques such as root definitions, activity models, and CATWOE analysis. This was done to enable a comprehensive deliberation on short-term and long-term consequences of the baseline processes and desired transformation projects. In addition to the multi-level thinking technique of SSM (see table 4), Simon[38] structures all decision making processes into three stages, i.e. intelligence stage (where a problem environment is investigated), design stage (where possible solutions to problematic aspects are explored), and choice stage (where the most appropriate solution or course of action is chosen). Thus, we made the design choice of adopting the multi-level thinking technique and the generic decision making process to enable us to structure collaborative tasks in a way that those associated with gathering business goals and problems are executed first. This was done to address requirement R7. Section 5.1 discusses how this was done.

Furthermore, literature was silent on how to perform CATWOE analysis and formulate activity models in a collaborative context with stakeholders, so we made the design choice of designing a diagram template for formulating solution scenarios (see figure 14 in section 5.5). The diagram template can be populated with data during collaborative sessions with stakeholders. We also provided a script or facilitation notes on how the selected thinkLets could be used along with this diagram template (see figures 15 – 22 in section 5.5). This is because we conjectured that without this template, it would be challenging to provide a holistic representation of all aspects described in the root definitions, their CATWOE analysis, and activity models representing the desired transformation.

4.2.3. *Requirements to address problem C – social complexity*

Three major requirements (R8 – R10) were identified to solve problem C. First, R8 states that there is need to align goals, interests, and priorities of individual stakeholders to those of the group. R8 aims at addressing issues labeled C1 and C3 – C5 in section 3.2.2. Second, R9 states that there is need to (a) devise a collaboration procedure that involves schedules of interview sessions, small group sessions, and plenary group sessions such that every key stakeholder participates in the architecture creation process, and (b) devise ways of supplementing output from (small) group sessions with output from interview sessions. R9 aims at addressing issues labeled C1, C6, and I3 in sections 3.2.2 and 3.2.4. Third, R10 states that there is need to provide ways through which architects can listen to stakeholders, thoroughly understand their concerns and needs, and align their goals with goals of the entire group. Moreover, Raadt et al[14] conducted an exploratory study among stakeholders who reported that they would like architects to be able and willing to "*think along*" with them and "*understand their goals and their problems in order to provide the best solution proposals*". Thus, R10 aims at addressing issues labeled C5, C7, C8, and I1 in sections 3.2.2 and 3.2.4. Addressing some issues associated with problem C may result in resolving some of the communication issues discussed in section 4.2.1. This is because socially complex work environments hinder effective

communication.[49]

Design decisions made to address the requirements implied by problem C: In collaborative work environments, professional facilitators help to skillfully align divergent individual goals with group goals.[15] Although the help of professional or skilled facilitators positively affects group productivity, it is quite expensive to rely on their support when executing recurring collaborative tasks.[18,15] Since to an enterprise architect executing collaborative tasks is a recurring initiative with complexity that varies across client enterprises, it is important to have a clear method or process that enterprise architects can use to successfully execute collaborative tasks without depending on help from professional facilitators. Thus, to address requirement R8, we made the design choice of adopting collaboration engineering approach to develop a collaboration process that can be followed by architects to, e.g., gradually align goals and priorities of individuals to the group goals and priorities (section 5 discusses how this was done).

In addition, collaboration engineering literature[33,5] shows that it is possible to schedule group sessions in a discrete manner, where output from one session is elaborated in another session. For example, a collaboration process for usability testing can be executed in 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.[5] Thus, to address requirement R9, we made the design choice of scheduling interview sessions that elaborate output from workshop sessions, and scheduling workshop sessions that elaborate output from interview sessions. Collaboration engineering literature[17] also provides the *generate*, *reduce*, *clarify*, *organize*, and *evaluate* patterns of reasoning among participants (defined in table 3). Thus, to address requirement R10, we made the design choice of assigning these patterns of reasoning to collaborative tasks that required architects to listen and understand views of stakeholders. We also selected suitable thinkLets for creating these patterns during the execution of these tasks. Sections 5.3 – 5.5 discuss how this was done.

SSM literature[30] provides the Analysis One Two Three technique that helps one to explore the political and social factors associated with the problem and desired situations of an enterprise (see table 4). Thus, in addressing requirement R8, we made the design choice of adopting this technique such that architects can be able to explore social and political issues that may affect consensus levels among stakeholders on baseline and target enterprise aspects. SSM literature also suggests that there is need to seek comprise on activity models that represent aspects about an organization's problem and desired situations.[30] Thus, in addressing requirement R8, we further made the design choice of adopting the activity models. Sections 5.3 – 5.5 discuss how this was done.

Furthermore, SSM literature was silent on how to conduct debates on activity models, so we made the design choice of elaborating thinkLets that had been selected to support the debates by amending or providing facilitator notes or scripts

on how to conduct the debate on the activity models. We also made the design choice of formulating a diagram template that is based on the technique of activity models (see figure 14 in section 5.5). This is because we conjectured that it is easier and quicker for a group to populate a diagram template with data than to collaboratively draw an activity model from scratch. Also, we conjectured that if a diagram template is populated with baseline and/or target data from various stakeholders, it can trigger or incite debates and enhance communication among stakeholders. This assumption is supported by the findings from evaluating CEADA in two real enterprises (see section 6.3).

In addressing R9, in order to properly determine stakeholders who will participate in which interview sessions or group sessions, we made the design choice of adopting techniques of dividing group labour. These techniques include *take-a-panel* and *share-a-panel*[16] and *committees* and *subcommittees*[55]. Take-a-panel means dividing participants into small groups or 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.[16] In this research 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 (such tasks are clearly specified in figures 15 – 22 in section 5.5). The committees and subcommittees technique is based on the *divide and conquer* principle which 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.[55] In CEADA we adopt this technique so as to enable simultaneous and coherent execution of some activities. These group labour division techniques were adopted and used to define four ways of dividing stakeholders during execution of activities that constitute the developed CEADA process. The four ways are presented in table 5 and details of how they are used are given in figures 15 – 22 in section 5.5.

Table 5. Techniques of dividing group labour in CEADA

#	Group division technique in CEADA	Description of technique
1	Governance-driven division	This means that the required type of stakeholders that 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
2	Specialization-driven division	This means that executing a given CEADA activity requires architects to ensure that participating stakeholders are divided into small groups based on their units of specialization or departments
3	Task-driven division	This means that executing a given CEADA activity, requires 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
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 architects give stakeholders the free will of deciding which subgroup (or sub task) he or she would like to join (or work on)
Task-driven and interest-driven divisions are 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		

4.2.4. *Requirements to address problem D – lack of long term planning*

To solve problem D, R11 states that there is need to devise a way through which architects and stakeholders can explore the full breadth and depth of the organization's problem situation. Thus, the lack of long term planning implies the need for a thorough analysis of the problem situation. This is because a comprehensive analysis of the organization's problem or situation helps to identify current, possible, or future problem owners.[30] If the organization problem is explicit, then the purpose of creating the architecture also becomes explicit and all business and IT stakeholders (i.e. problem owners and key decision makers) can be identified and their roles can be defined prior to scheduling the collaborative sessions. R11 aims at addressing issues labeled H1, I1, I2, and K2 in section 3.2.4. In R11 it is assumed that clearly defining roles of all identified stakeholders helps to overcome a deadlock that may occur in a group debate when variability among participants is high during execution of collaborative activities that involve evaluating aspects and choosing among them. In addition, issues I1 and I2 in section 3.2.4 recommend ensuring early and good collaboration with stakeholders, where the "early" implies the necessity of effective collaboration with stakeholders when analyzing the as-is situation. Also, identifying and involving all business and IT staff that should participate in the architecture project helps to explore the long term effects of the business case. This helps to address issues labeled D1, D2, and I1 in sections 3.2.2 and 3.2.4.

Design decisions made to address the requirement implied by problem D: Collaboration engineering literature provides the *clarify*, *organize*, *evaluate*, and *build consensus* patterns of reasoning. Thus, we made the design choice of (a) assigning these patterns of reasoning to activities on exploring the problem situation, and (b) selecting appropriate thinkLets that can create these patterns of reasoning among stakeholders during the execution of such activities. Sections 5.3 – 5.5 discuss how this was done.

SSM literature[30] provides techniques summarized in table 4 that can enable exhaustive analysis of aspects in the problem and desired situations. Thus, we made the design choice of adopting these techniques in the architecture creation context such that architects and stakeholders can be able to explore various dimensions of the baseline and target contexts of the enterprise. Furthermore, literature was silent on how to use the SSM techniques in table 4 along with a particular selected thinkLet. Thus, we made the design choice of formulating a diagram template that is based on a given SSM technique, and providing facilitation notes on how to use a particular diagram template along with a given thinkLet. This is because we conjectured that effective facilitation of sessions in which SSM techniques are used requires proper and clear guidance that can be availed via thinkLets. The diagram templates and the scripts on how they are used are provided in section 5.5.

4.2.5. *Requirements to address problem E – lack of a clear decision making process and architecture governance*

To solve problem E, R12 states that there is need to ensure that stakeholders determine and select members that constitute the decision making unit or architecture governance board prior to commencing any activities on architecture creation. This helps to have stakeholders who are mandated to (a) be responsible or accountable for all decisions that will be made during architecture creation, (b) give a clear mandate to architects to make decisions within agreed boundaries, (c) ensure architecture compliancy such that what was promised/required is what is delivered or that the created architecture is not be too complex for the decision making unit or organization maturity level, (d) work with architects to define short-term and long-term benefits of architecture and develop an architecture roadmap that fits to the organization's overall maturity, ambitions levels and change proficiency, and (e) oversee and support the realization of the architecture by translating it into program start architectures. Thus, R12 aims at addressing issues labeled E1 – E6, K1, and K3 in sections 3.2.2 and 3.2.4.

Design decisions made to address the requirement implied by problem E: Collaboration engineering literature[15] provides the *generate*, *organize*, and *build consensus* patterns of reasoning (defined in table 3). Thus, to address requirement R12, we made the design choice of assigning these patterns of reasoning to the activity of determining members of the architecture governance board or decision making unit of an organization. We then made the design choice of selecting appropriate thinkLets to create these patterns of reasoning during the execution of this activity. Section 5.3 – 5.5 discuss how this was done.

In addition, SSM literature[30] provides the Analysis One Two Three technique which can help one to explore problem owners, social factors, and political factors in a given situation (defined in table 4). Thus, we further made the design choice of adopting this technique to help us determine all current and possible problem (and solution) owners, and then select members that constitute the decision making unit of an enterprise. Furthermore, literature was silent on how the Analysis One Two Three technique can be used in a collaborative context, so we made the design choice of formulating the Analysis One Two Three diagram template and providing facilitation notes on how to use the template (see figure 11 in section 5.5). This is because we conjectured that the diagram template would offer a holistic overview of all problem and solution owners, and give stakeholders insight into who would be chosen to constitute the decision making unit or architecture governance board.

4.3. *Addressing problem statements associated with tools*

This section presents requirements that must be fulfilled in order to address problem statements and recommendation statements that are associated with the *methods, tools, and techniques* that architects use when executing collaborative tasks with stakeholders. Thus, it takes into account problem statement F in section 3.2.2. It

also considers weaknesses of interviews and workshops (that were presented in figure 3 in section 3.2.3) because these are the most widely used methods (as indicated by the percentages in figure 3).

Problems in this category can be addressed by requirement R13, which states that there is need to address weaknesses of methods currently used to execute collaborative tasks by findings ways of supplementing output obtained using one method with output obtained using another method. For example, in the left and right parts of figure 3 it can be noted that the strengths of using well prepared and facilitated workshops may help one to overcome some of the weaknesses of using only interviews when collaborating with stakeholders. Also, weaknesses of using only workshops can be overcome by specifying how one can properly prepare and conduct workshops and supplement them with interviews and/or other tools and techniques.

Design decisions made to address the requirement implied by problem F: Literature[43,17,18,19] shows that collaboration engineering is 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 implying that they only have to learn the functionality and operation of a collaboration technology (such as EMSs) rather than its dynamics; (2) predictable, i.e. where different practitioners can execute the processes and get similar or predictable results; and (3) repeatable, i.e. where the collaboration processes can be reused to minimize development time for new similar processes. Repeatable and predictable collaboration processes have been designed for tasks such as usability testing of software applications,[5] strategic decision making in multi organizational collaborations,[32] incident response planning[33]. Thus, we made the design choice of adopting collaboration engineering to develop a repeatable and predictable collaboration process that architects can use during the execution of collaborative tasks. This helps to overcome the following weaknesses of using workshops that were reported by architects (as shown in the right part of figure 3).

(1) *Workshops produce insufficiently detailed information and informal results.* With collaboration engineering thinkLets, various tools and techniques can be deployed to support in eliciting detailed information from workshops, and to provide clues or guidance on how to seek formal approval of workshop results. Thus, we made the design choice of selecting appropriate thinkLets and preparing tools and scripts that would enable detailed information gathering (see diagram templates in section 5.5).
(2) *The success of workshops depends on skills of professional facilitators.* Section 4.2.3 discusses the benefit and cost of having professional facilitators. It shows that we made the design choice of developing a repeatable and predictable collaboration process (known as CEADA) for enterprise architects to successfully execute by themselves, such that the success of a workshop is not dependent on the presence of a professional facilitator. In addition, it is reported 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.[31] Thus, we made the design choice of selecting appropriate thinkLets (or collaboration techniques) to prevent these issues from happening in meetings. This is because we conjectured that this would help to address some issues under social complexity, which if not addressed may frustrate the execution of collaborative tasks. The set of selected thinkLets is discussed in section 5.5.

(3) *The process of preparing for workshops and processing results from workshops is time consuming.* To address this, we made the design choice of developing a repeatable CEADA process because we conjectured that this would help to reduce the preparation time for workshops, since what will be required is to customize the collaboration process so that it suits the situation of a given organization. Section 6.3.2 shows that CEADA can be customized to be used in a particular enterprise.

(4) *It is difficult for workshop participants to stay focused on the agenda.* To address this, we also made the design choice of selecting thinkLets that help workshop stakeholders to stay focused on the agenda, and not to go into sharp diversions. For example, in Ref.[32] a collaboration process was developed to help stakeholders to stay focused during a strategic decision making initiative. The set of selected thinkLets is discussed in section 5.5.

(5) *It is often difficult to enable anonymous contributions in traditional workshops.* Literature on EMSs[18,19,5,31] shows that one of their key advantages is that they offer support for anonymity of participants in group sessions during tasks of brainstorming, evaluation, and voting. Thus, we further made the design choice of deploying an EMS in order to allow anonymous contributions in workshop sessions. Details of the EMS that was considered and its configuration are provided in section 5.5.

SSM literature[30] provides the multi-level thinking (defined in table 4). Thus, we further made the design choice of adopting this technique to devise a structure for communicating architecture creation aspects and for executing collaborative activities in architecture creation. In the execution structure, the multi-level thinking technique also guided us in selecting tools and techniques that we could adopt at each level of thinking, e.g. at the *what* level, *how* level, *why* level. Literature was silent on how to formulate the communication structure and the activity execution structure, so we made the design choice of supplementing Simon's[38] three phases of decision making (discussed in section 4.2.2) with the multi-level thinking technique. This is because we conjectured that the multi-level thinking technique would enable us to determine the type of information that should be communicated or processed in each phase of Simon's decision making process. The results of this resign choice are discussed in section 5.1.

4.4. *Summary of requirements and design choices*

Table 6 presents a summary of requirements derived from survey issues (that were reported in sections 3.2.2 – 3.2.4) and design choices taken to address them (as discussed in sections 4.1 – 4.3). From column 3 of table 6, it can be noted that the design choices need to be categorized or grouped because they belong to a given approach. Thus, three key categories of design choices can be seen, i.e. (a) those associated with collaboration engineering, (b) those associated with SSM, and (c) others (e.g. those associated with both SSM and collaboration engineering). Section 5 discusses how these design choices were orchestrated to yield CEADA.

Table 6. Summary of requirements and design choices

#	Short description of the requirement	Design choice that was made to address a requirement or problem
R1	Provide means of communicating in a common & understandable vocabulary	- Assign the clarify & organize patterns of reasoning to activities associated with defining business strategy, goals, & stakeholders' problems; & select suitable thinkLets to create these patterns during the execution of these tasks. - Adopt Multilevel thinking technique to formulate a semi-structured communication schedule; & other SSM techniques to document & communicate business & architectural concepts in an easily understandable way.
R2	Provide a semi-structured & regular communication schedule	
R3	Provide means of documenting knowledge in an understandable way	
R4	Provide means of demonstrating abstract long term consequences of development/transformation projects	- Assign the organize and evaluate patterns of reasoning to activities associated with assessing short & long term consequences of baseline & target situations. - Supplement thinkLets with root definitions, activity models, & CATWOE
R5	Provide a detailed procedure that architects can follow to create a shared understanding & vision	Follow the steps of developing a collaboration process to design a detailed procedure that architects can follow to create a shared understanding among stakeholders during the execution of collaborative tasks.
R6	Provide ways of building consensus on architecture aspects among stakeholders	Assign the evaluate and build consensus patterns of reasoning to activities associated with seeking consensus on aspects in the target situation.
R7	Ensure that the first information to gather is on business goals & problems	Adopt the Multilevel thinking technique and Simon's generic decision making process to formulate a schedule of activities that starts with information gathering.
R8	Provide means of aligning individual goals with group goals	- Design a collaboration process that can be followed by architects to gradually align individuals' goals to the group goals. - Schedule interviews that elaborate output from workshops, and schedule workshops that elaborate output from interviews. - Assign the generate, reduce, clarify, organize, & evaluate patterns of reasoning to activities that require architects to listen & understand stakeholders' views - Supplement selected thinkLets with Analysis One Two Three and activity models. Adapt techniques for dividing group labour during execution of activities
R9	Provide schedules of interview sessions, small group sessions, & plenary sessions; & devise ways of supplementing output from these sessions	
R10	Provide means that architects can use to listen to & understand clients' concerns	
R11	Provide means of exploring the breadth & depth of a client's problem situation	- Assign the clarify, organize, evaluate, & build consensus patterns of reasoning to activities that involve exploring the problem, & select appropriate thinkLets - Formulate diagram templates based on SSM techniques that are used to explore problem and desired situations.
R12	Ensure that members of the decision making unit are selected before architecture creation activities begin	- Assign the generate, organize, & build consensus patterns of reasoning to activities that involve exploring the problem, & select appropriate thinkLets - Formulate diagram templates based on Analysis One Two Three technique.
R13	Supplement workshops with interviews & other tools & techniques	Adopt collaboration engineering approach such that various tools and techniques can be deployed to address some of the weaknesses of workshops

5. Design of CEADA

This section presents the design of CEADA, which is an orchestration of design choices that are discussed in section 4 and summarized in table 6. Section 5.1 gives an overview on earlier developments of CEADA, and highlights amendments that this paper makes to the design of CEADA so as to address requirements implied by survey findings. Sections 5.2 – 5.5 discuss the design of CEADA that has been refined to cater for issues discussed in section 4.

5.1. *Evolution of CEADA*

In Ref.[3] we discussed how the multi-level thinking technique[30] and the generic decision making process[38] were adopted to structure collaborative tasks that occur

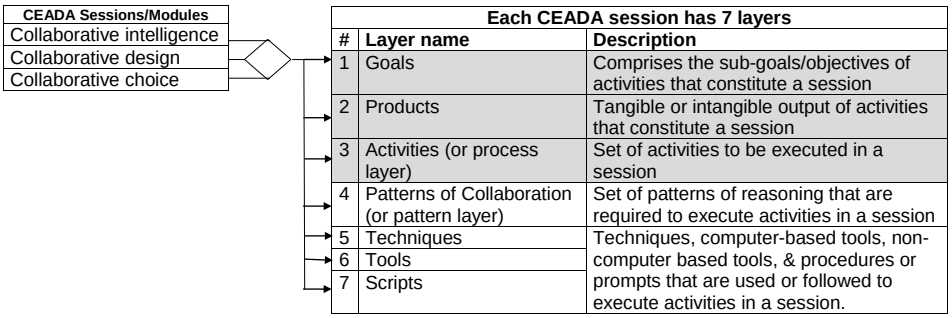

Fig. 5. Overview of CEADA and its composition

in enterprise architecture creation into three sessions (i.e. collaborative intelligence, collaborative design, collaborative choice). Figure 27 in the appendix provides a coarse-grained model of the activities involved in these three sessions. Following the collaboration engineering design approach,[51,43,34] CEADA process was developed to provide explicit support for executing collaborative tasks in these three sessions. Basing on the seven-layer model of collaboration,[51] each of CEADA's three sessions comprises seven layers (see figure 5). The shaded rows in the right part of figure 5 indicate that the goals layer, products layer, and activities layer of CEADA were formulated in our earlier work (see Ref.[3]). In order to ensure that requirements discussed in section 4 are addressed, this section of the paper focuses on: (a) refining the activities layer of CEADA by providing explicit topics of discussion or focus in each activity; (b) refining the pattern layer of CEADA to cater for changes in the activity layer; and (c) refining the techniques layer, tools layer, and scripts layer of CEADA by providing detailed operational guidelines on how to create the required patterns of reasoning for each activity.

Figure 5 shows that each of the three CEADA sessions comprises several activities, which have specific objectives and must yield specific deliverables. Basing on the design concepts presented in figure 4, it can be concluded that the full set of activities for all the three sessions forms the activities or process layer of CEADA. The execution of collaborative activities requires team members to undergo several patterns of reasoning or collaboration.[43,17] Thus, basing on the design concepts presented in figure 4, the full set of patterns of reasoning assigned to activities in the process layer forms the pattern layer of CEADA. Creating a pattern of reasoning that is required to execute an activity involves using particular techniques, tools, and scripts.[51] The full set of techniques, tools, and scripts required to create patterns of reasoning that are needed during the execution of CEADA activities are discussed in section 5.5.

In this section the design of CEADA's three sessions is provided in two formats, i.e. a summarized tabular format (see tables 7, 8, and 9), and a detailed format (see figures 15 – 22). The detailed script-like format provides information associated with the thinkLets selected to support each activity by showing (a) the questions that

can be used to gather the required data, (b) the format to be used when providing answers to the questions raised, and (c) the EMS tools and non computer-based tools that are to be used when executing each activity. Examples of non computer-based tools used, see lines starting with a subtitle of "*Other Tools*" in figures 15 – 22.

The sequence of activities in both formats is mainly based on information required to execute a given activity, whereby deliverables of some activities are used as input for executing other activities. However, neither formats implies linearity in executing CEADA activities. This is because the order of executing CEADA activities in a real organization depends on the organization's architecture maturity level. According to Ref.,[36] an organization is at: (a) architecture maturity level 0 if it does not have any architecture program; (b) level 1 if it has an informal ongoing IT architecture program with ad hoc and localized processes, but without a unified architecture process; (c) level 2 if it is implementing its architecture; (d) level 3 if it has fully established its architecture; (e) level 4 if it is maintaining the architecture; and (f) level 5 if it is continuously improving its architecture. Given these levels of architecture maturity, CEADA is mainly useful in organizations with architecture maturity level 0 or 1. However, the order of executing CEADA activities in organizations with maturity level 0 may (slightly) differ from the order of executing CEADA activities in organizations with maturity level 1. Thus, if an organization's architecture maturity level is recognized, then it is possible to appropriately define the needs of the architecture process.[1] This is why it is vital that executing CEADA starts with collaborative intelligence session because deliverables of activities therein give insight into an organization's architecture maturity level.

5.2. *Goals layer of CEADA*

The goals layer of CEADA comprises goals of collaborative intelligence, collaborative design, and collaborative choice sessions. Although each of these sessions aims at addressing particular requirements (as discussed below), some requirements must be addressed in all the three sessions, i.e. R1 – R3, R5, R8 – R10, and R13. Details of what is done to achieve these goals are provided in section 5.3, and details of how these goals are achieved are provided in sections 5.4 and 5.5.

Goals of collaborative intelligence session. This session aims at ensuring that CEADA supports enterprise architects and top/senior management stakeholders to analyze the problem (or as-is) and the solution (or desired or to-be) contexts of the organization. Subgoals include determining the organization problem and its scope, the desired solution and the internal and external constraints associated with it, and the purpose of the architecture effort. With respect to the requirements discussed in section 4, activities in this session collectively aim at ensuring that CEADA addresses requirements R7, R11, and R12 by considering the design choices associated with these requirements (see sections 4.2.4 and 4.2.5). This session also aims at ensuring that enough information is gathered that helps architects

to determine the organization's architecture maturity level, which is a key input for designing the organization's architecture roadmap (this helps to solve issues labeled K2 and K3 in section 3.2.4).

Goals of collaborative design session. This session intends to ensure that CEADA supports the creation of a shared understanding of the problem situation and a shared vision of the desired situation, among stakeholders and architects. Thus, in this session CEADA aims at enabling a detailed analysis to be done on the aspects which were defined in the collaborative intelligence session. This is done to create a shared understanding of problem and solution aspects defined in the collaborative intelligence session among the problem owners and subject matter experts that are not part of the organization's senior management. Therefore, while the intention of the collaborative intelligence session is to create a vision that is shared by top management (see issue H2 in section 3.2.4), this session intends to ensure that the understanding and vision of the problem and solution aspects is also shared by other organizational stakeholders. In addition, in this session CEADA aims at enabling stakeholders to define requirements and quality criteria for the enterprise architecture, and to formulate solution scenarios for the desired or target situation. With respect to the requirements discussed in section 4, activities in this session collectively aim at ensuring that CEADA addresses requirements R4 – R7 and the design choices associated with these requirements (see section 4.2.2).

Goals of collaborative choice session. This session aims at ensuring that CEADA supports stakeholders and architects to collaboratively evaluate possible architecture design alternatives, and choose an appropriate enterprise architecture design alternative. Moreover, in this session a high level of consensus among stakeholders is an indication that CEADA effectively supports the execution of activities in the collaborative intelligence and collaborative design sessions. This is because these two sessions indirectly aim at gradually building consensus among stakeholders (on the organization's problem and solution aspects), and creating commitment among stakeholders so as to realize the intended organization transformation. With respect to the requirements discussed in sections 4.2.1 – 4.3, activities in this session collectively aim at ensuring that CEADA addresses requirements R4, R6, R8, and the design choices associated with these requirements (see sections 4.2.2 and 4.2.3). Thus, this session ensures that stakeholders have a sense of ownership of the results of architecture creation process, and get motivated and committed to implement the architecture.

5.3. *Activities and products layers of CEADA*

Activities layer and products layer of CEADA comprise activities in, and products of, collaborative intelligence, collaborative design, and collaborative choice sessions. Activities in these sessions are named according to their goals or intended products. Details of how these activities were derived are given in Ref.[3], this section refines the activities layer by specifying the focus topics of each activity such that survey issues

are addressed. Details of how these activities are executed to obtain the products are provided in sections 5.4 and 5.5.

Activities and products in collaborative intelligence session. Activities that are carried out in this session (to address requirements discussed in section 4) are shown in column 2 of table 7.

Table 7. Collaborative intelligence session of CEADA

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	-	-

Activity A.1.0 in table 7 involves preliminary dialogs (via email, interviews, and/or presentations) between the organizational stakeholders and architects on matters concerning: enterprise architecture, its benefits, and information about the organization's background, current, and desired situations. A.1.0 partly addresses communication requirement R1 (in section 4.2.1) by increasing awareness (among stakeholders) of architecture and its benefits to the business. In other words, A.1.0 partly addresses issues labeled A1 – A3 in section 3.2.2.

Activity A.1.1 in table 7 is decomposed into A.1.1.1 and A.1.1.2. These involve describing the existing operational processes and services offered, identifying factors that describe the organization problem, assessing the relationships of those factors, determining units affected by the problem, and determining the core problem factors. Since it is vital to document an explanation of how the architecture project relates to other frameworks in the organization,[2] A.1.1.1 also involves determining the completed and ongoing programmes and projects in the organization. The breadth and depth of the problematic aspects defined in A.1.1.2 are then determined in activity A.1.2. Topics of discussion in these activities are provided in figures 15

and 16. A.1.1 partly addresses issue labeled A4 in section 4.2.1.

Activity A.1.3 in table 7 involves identifying possible ways (i.e. business solution alternatives) to solve the organization problem aspects. *Activity A.1.6* involves evaluating the possible business solution alternatives against the business principles, strategy, and goals. A.1.6 also involves seeking stakeholders' agreement on the most appropriate business solution alternative (i.e. that one that will address the organization's problem aspects with respect to attaining the business strategy and goals). Topics of discussion in these activities are provided in figures 17 and 18.

Activity A.1.4 in table 7 is decomposed into A.1.4.1 and A.1.4.2. These activities involve specifying, reviewing, and verifying constraints that are imposed by: the existing business and architecture principles that relate to the organizational problem and its scope; and the business strategy and goals that are already existing or have been set to overcome the problem. Topics of discussion in these activities are provided in figure 17. *Activity A.1.5* in table 7 involves deriving constraints (from principles dictated by regulatory authorities and corporate unions that govern the organization's line of business) that are associated with the possible business solution alternatives from activity A.1.3, and the defined business strategy and goals from of activity A.1.4.2. Topics of discussion in this activity are provided in figures 17 and 18.

Activity 1.7 involves specifying and agreeing on what the architecture results will be used for, or the problems that will be solved by creating the architecture. According to Ref.[1], the purpose of the enterprise architecture effort can be: to guide decision making regarding a planned business transformation; to determine the business strategy impact; to specify (business) requirements; and to inform and contract service providers. Stakeholders need to choose among these architecture purposes and agree on the ultimate purpose of creating the architecture, since the architecture purpose partially determines the scope of the architecture. Details associated with this activity are provided in figure 18.

Activity 1.8. 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 chosen business solution alternative. The organization problem scope (i.e. output of A.1.2) influences the solution specifications and scope of the architecture. For example, if all enterprise units are affected by the problem (this implies that very many stakeholders will be involved in the architecture effort), then one of the high level solution specifications can be to develop federated architectures. Since federated architectures are developed independently and integrated in a meta-architecture framework, they help to manage architecture complexity in large organizations, and to gain buy-in from large numbers of stakeholders.[2] This activity also uses the strategic drivers and goals (i.e. output of A.1.4.2) and purpose of the architecture (i.e. output of A.1.7). This is because defining the scope of the architecture (e.g. architecture domains and level of detail to cover) involves considering the business strategic drivers, goals, and the purpose of the architecture.[2] Topics of discussion in this activity are provided in figures 18 and 19.

Activity 1.9 uses aspects about the organization problem, business strategy and goals, and high level solution specifications from activities A.1.1, A.1.4.2, A.1.8 respectively. It involves identifying key stakeholders and decision makers that should participate in the architecture creation activities, and defining their roles. This activity yields a comprehensive list of problem owners and solution owners. It involves seeking a shared understanding (among stakeholders) that the enterprise architecture effort is worth a collaboration effort between stakeholders and architects. Although this activity uses output from activity A.1.8, an exhaustive analysis of problem and solution owners may result in the need to modify and refine solution specifications in activity A.1.8. This is because new identified problem and solution owners may suggest more ideas that are vital to consider as high level solution specifications. Topics of discussion in this activity are provided in figure 19.

Activity A.2.1 involves using output of A.1.1 to determine the organization's architecture maturity level and to link the enterprise architecture project to other frameworks existing in the organization. Output of A.1.1 is relevant for finding out any architectural assets that are already existent from other projects and can be reused. This is vital because architecture practitioners highly recommend the reuse of available resources or architectural assets in an organization's enterprise continuum (e.g. organization-specific and industry-specific frameworks, system models).[2] In addition, A.2.1 involves using output of A.1.0 – A.1.9 to prepare an organization's architecture creation roadmap and seeking formal endorsement of the roadmap and output of A.1.1 – A.1.9 (from top management). In preparing the roadmap, architects use the guidelines in enterprise architecture approaches. Since it is vital to determine whether the time period articulated for the architecture effort makes sense in terms of practicality and resources,[2] this activity specifically use scope details defined in activity A.1.8. For example, if the output from activities A.1.8 and A.1.9 shows that stakeholders preferred federated architectures to single enterprise-wide architectures, then the architects draw a development plan that is tailored to the most preferred option.

Activity A.2.2 involves using output of A.1.0 – A.2.1 to customize the agendas of collaborative design and collaborative choice sessions of CEADA such that an enterprise-specific CEADA process can be obtained. A.2.2 also involves developing a communication plan for the remaining tasks in the subsequent architecture creation activities. *Activity A.2.3* involves scheduling subsequent collaborative sessions on architecture creation. This is done by: communicating the calendar of upcoming events in the architecture effort; communicating expectations of architect team; finding out stakeholders' expectations of upcoming collaborative sessions and of the enterprise architecture effort; inviting all relevant stakeholders for the collaborative design session; and distributing information templates (provided in section 5.5) to invited stakeholders.

Activities and products in collaborative design session. Activities that are carried out in this session (to address requirements discussed in section 4) are shown in column 2 of table 8.

Table 8. Collaborative design session or 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

Activity 3.0. Communication here specifically involves sensitizing all stakeholders who are not in the senior or line management range, about the problem and solution aspects that the architecture effort intends to address. It also involves clarifying aspects in templates that indicate the kind of information that is processed in collaborative design session. This activity was amended because from a field evaluation of CEADA (discussed in Ref.[3]), stakeholders preferred to receive and study output from earlier sessions prior to executing activities in a given session.

Activities A.3.1 – A.3.3. Activity A.3.1 involves giving other stakeholders who are not in top and line management an opportunity to share their concerns about the problem and solution aspects defined in the collaborative intelligence session. Thereafter, *activity A.3.2* involves categorizing stakeholders' concerns (on problem and solution aspects) by type or organization units or departments. Clarifying and organizing concerns helps stakeholders to acquire a shared understanding of concerns and problem aspects. *Activity A.3.3* involves validating stakeholders' concerns with respect to business principles, strategy, goals, and external and internal solution constraints (i.e. output from activities A.1.4.1, A.1.4.2, A.1.5, and A.1.8 of table 7). Topics of discussion in these activities are provided in figures 19 and 20.

Activities A.4.0 – A.4.6. These activities deal with specifying the business requirements and quality criteria that the enterprise architecture must fulfil. In A.4.1 identifying business requirements involves defining functionalities that the organization needs to have in order to achieve its business strategy and goals. In A.4.2 the requirements can be categorized according to organizational units or departments.

In A.4.3 validating business requirements involves examining whether the requirements fulfill the external and internal constraints associated with implementing particular functionalities. Besides, the role of an architect is to identify and refine the concerns and requirements of stakeholders, develop views that show how the concerns and requirements are addressed in the architecture, and perform a tradeoff analysis to resolve conflicting concerns of different stakeholders.[2] The later roles imply that when designing the architecture there are various ways of addressing a set of (related) concerns and requirements. Also, in decision making it is vital to first evaluate possible courses of action in order to choose a *satisficing* one or one that is "*good enough*".[38,37] Therefore, activities A.4.4 – A.4.6 of table 8 involve prompting stakeholders to define quality criteria that will be used to evaluate possible enterprise architecture design alternatives. Topics of discussion in these activities are provided in figures 20 and 21.

Activities A.5.1 – A.5.8 involve stakeholders and architects formulating and discussing solution scenarios so as to acquire a shared understanding and a shared vision of the desired or target situation. Solution scenarios are possible ways through which an organization problem can be addressed, or textual and graphical descriptions of the desired organization situation. They can also be perceived as detailed definitions of requirements that the enterprise architecture must address. Thus, they are an understandable way through which stakeholders define the detailed aspects of the desired situation. According to Ref.[2], it is vital that the following aspects are clearly defined such that there is a good understanding of the capabilities and desires of the organization: (a) where the organization needs to differentiate from its competitors in a given business line and how; and (b) incidences where the organization prefers a business model of adequacy with minimal cost implications. To specify such details, as shown in table 8, activity A.5.1 involves identifying types of solution scenarios that need to be defined such that business requirements and solution specifications are addressed. The term solution scenarios as used in CEADA, is equivalent to the term Architecture Building Blocks (ABBs) that is used in enterprise architecture approaches like TOGAF. ABBs are capabilities an organization requires in order to be able to execute its business strategy.[2]

Activity A.5.7 involves evaluating the feasibility and possible impacts of the solution scenarios. Determining the 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.[2] Activity A.5.8 involves choosing and agreeing on the most appropriate solution scenarios for the desired situation. Topics of discussion in activities A.5.1 – A.5.8 are provided in figures 20 – 22.

Activities and products in collaborative choice. Activities A.7.0 – A.7.4 involve discussing enterprise architecture design alternatives so as to enable stakeholders to understand the positive and negative implications of possible design alternatives for each solution scenario that was chosen in the collaborative design session. They also involve stakeholders evaluating enterprise architecture design al-

ternatives using the requirements or quality criteria that were defined in the collaborative design session. After evaluating, stakeholders agree on the most appropriate architecture design alternative.

Table 9. Collaborative choice session or 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

5.4. *Patterns of reasoning layer of CEADA*

CEADA's pattern layer comprises patterns of reasoning assigned to activities in the collaborative intelligence, collaborative design, and collaborative choice sessions. These patterns of reasoning are presented in column 3 of tables 7 – 9. Meanings of these patterns of reasoning are provided in table 3 in section 4.2.1. The converge pattern of reasoning, as used in tables 7 – 9 comprises the reduce and clarify patterns of reasoning.[43,17,50] For some activities (e.g. in table 7) a pair or a set of patterns of reasoning is assigned to a given activity. This is because there are various subtasks involved in executing those activities (see A.1.1 – A.1.9 in figures 15 – 19).

To assign a given activity an appropriate pattern of reasoning, four aspects were considered. These include (a) the goal of an activity, (b) the input required to execute an activity, (c) the intended output of an activity, and (d) the definitions of the six patterns of collaboration in table 3 in section 4.2.1. Thus, the *generate* pattern of reasoning was assigned to activities that required stakeholders to brainstorm or identify or list aspects that serve as answers to a given topic or question. The *converge* (or reduce and clarify) patterns of reasoning was assigned to activities that required stakeholders to clean up a list or collection of brainstormed aspects by removing duplicates and elaborating unclear contributions or aspects. The *organize* pattern of reasoning was assigned to activities that required stakeholders to categorize aspects into meaningful generalizations or to discover and communicate relationships between or among aspects associated with a given topic. The *evaluate* pattern of reasoning was assigned to activities that required stakeholders to examine the significance of (or benefits and costs associated with) a given aspect with respect to other related aspects. The *build consensus* pattern of reasoning was assigned to activities that required stakeholders to agree on particular aspects associated with a given topic. Column 3 in tables 7 – 9 shows CEADA's pattern layer.

5.5. *Techniques, tools, and scripts layers of CEADA*

The core technique adopted in the techniques layer of CEADA is the thinkLet (defined in section 4.2.1). Column 4 of tables 7, 8, and 9 shows the thinkLets that

were selected to create the patterns of reasoning required to execute activities in the collaborative intelligence, collaborative design, and collaborative choice sessions.

Selected thinkLets. Criteria for selecting thinkLets are discussed in Refs.[20,34,50] From these articles, appropriate thinkLets for CEADA activities were chosen basing on: (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. In CEADA eight thinkLets were selected, whereby the set of thinkLets selected to create the generate pattern include *LeafHopper, DealersChoice, and FreeBrainstorm*. The set of thinkLets selected to create the convergence pattern include *FastHarvest, Concentration, and ReviewReflect*. The set of thinkLets selected to create evaluate and build consensus patterns include *StrawPoll, and CrowBar*. Below we briefly discuss why these thinkLets were chosen.

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.[18,19,20] Activities supported by LeafHopper are shown in tables 7 and 8 or figures 15 – 19. These activities have many topics (which are at times represented in form of diagram templates) that need to be discussed (see figures 15 – 19). Thus, LeafHopper was mainly chosen to help save time during the execution of these activities because it allows stakeholders to simultaneously comment on a diagram template or topic of their interest.

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.[20] Activities supported by FreeBrainstorm are shown in tables 7 and 8 or figures 15, 17, and 20 – 22. These activities have one question or topic of discussion (or one diagram template) that is likely to result in several answers or contributions. Since LeafHopper deals with multiple questions that are simultaneously answered,[19] it was not appropriate for these activities. Thus, since FreeBrainstorm deals with one question and helps one to control contributions on that question so that they are not overwhelming to process,[20] it was chosen for these activities.

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.[20] 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 on architecture creation aspects must attend suffers several postponements and disappointments (see incidences in section 6.3.1). These are mainly caused by busy work schedules of stakeholders and at times

due to organizational politics to frustrate the architecture effort. Thus, we adapted the techniques of dividing group labour to define four ways of involving various types of stakeholders into the architecture creation effort (see table 5 in section 4.2.3). Thus, most brainstorming activities in CEADA that require stakeholders with particular expertise to be consulted are executed by invoking a specialization-driven division (this is defined in table 5 in section 4.2.3). This implies that brainstorming and/or validation interviews and or small group sessions can be scheduled to execute various types of tasks. Thus, DealersChoice can be invoked in small group sessions to execute activities like A.1.5 by dealing with aspects in a particular order. For instance, in A.1.5.1 external policies are first discussed and then their implications or constraints are discussed.

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.[50] FastHarvest was chosen to support execution of CEADA activities that involve converging (i.e. reducing and clarifying) ideas on baseline and target aspects of an enterprise. This was done to enhance awareness and create a shared understanding of such information within subgroups and then eventually within the whole group. This is possible because FastHarvest 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.[50]

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.[20] In CEADA Concentration was chosen to support activities that follow either a LeafHopper or FreeBrainstorm supported activity (see tables 7 and 8). Since Concentration is suitable for activities where contributions need to be processed as a whole rather than in subsets (and need to be processed by the group as a whole rather than subgroups), it was chosen for activities shown in tables 7 and 8. In most incidences we chose Concentration followed by ReviewReflect. 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.[50] 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.[20] 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, principles, business strategy, business goals) and (b) existing regulations from governing or regulatory bodies. These activities are shown in tables 7 and 8

StrawPoll and CrowBar in CEADA. StrawPoll is used when one wants to mea-

sure consensus within a group, to reveal patterns of agreement or disagreement within a group, to assess or evaluate a set of concepts.[20] In CEADA StrawPoll was chosen to support activities that involve evaluation of items. 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.[20] Figures 15 – 22 show the various evaluation or voting methods and evaluation or voting criteria that are used in CEADA. 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.[20] Thus, CEADA activities that involve evaluation and build consensus patterns are supported by both StrawPoll and CrowBar thinkLets (see tables 7 – 9).

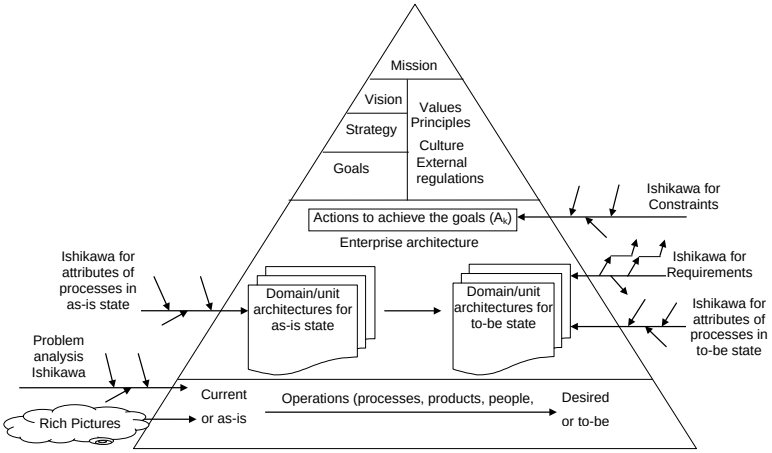

Fig. 6. Holistic data capture pyramid template (Based on Refs. 1,10)

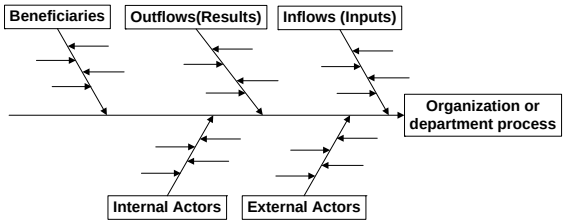

Fig. 7. Diagram template for process attributes

Tools and scripts. Details of the thinkLets selected in tables 7 – 9 are provided in figures 15 – 22. These details include the tools used and the scripts that are followed to execute activities in CEADA's collaborative intelligence session. The tools used include an EMS (i.e. Meetingworks^{TM}) and non computer-based tools

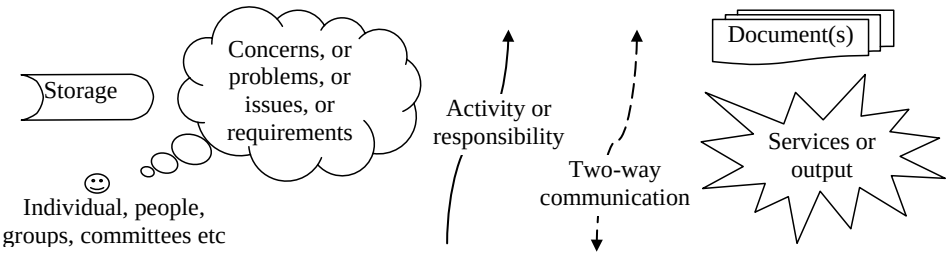

Fig. 8. Symbols to use during the CEADA Sessions to draw a Rich Picture

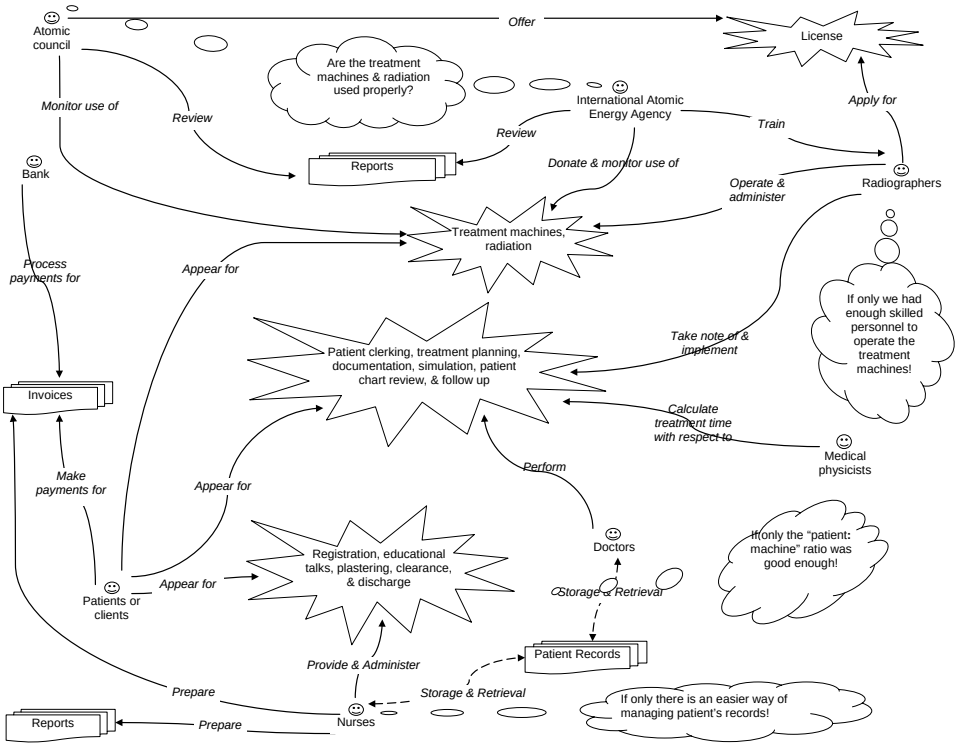

Fig. 9. An illustration of how the symbols in figure 8 were used to formulate a Rich Picture of the as-is situation of the Radiotherapy Department

(i.e. paper, pen, marker, flip chart, and *diagram templates*). To formulate the diagram templates, SSM techniques such as Rich Picture, Analysis One Two Three, Root Definitions, CATWOE analysis, and Activity Models (see meanings of these techniques in table 4 in section 4.2.1). Another key technique that was used to formulate diagram templates is the Ishikawa[42] or fish-bone diagram. The diagram templates were formulated to be used when there is need for stakeholders undergo the reduce, clarify, and organize patterns of reasoning because the templates provide a systematic and holistic way of categorizing and organizing data about an orga-

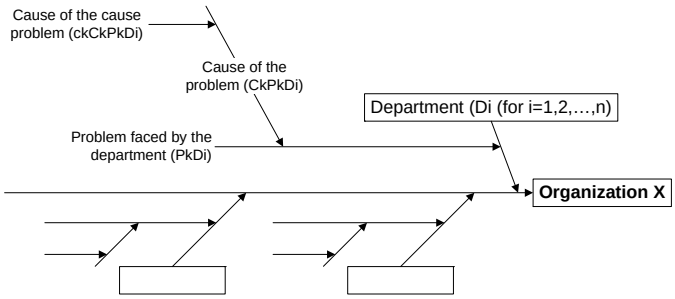

Fig. 10. Diagram template for problem analysis

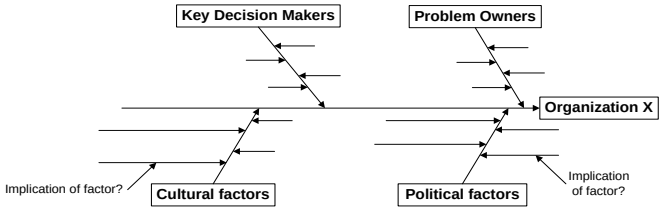

Fig. 11. Diagram template for Analysis One Two Three

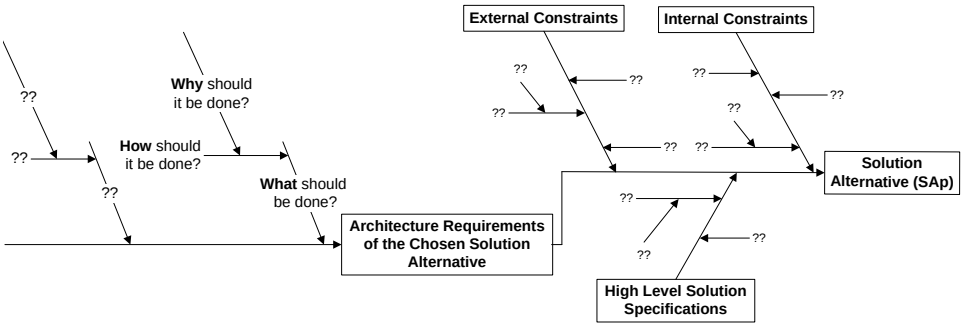

Fig. 12. Diagram template for constraints and requirements

nization's baseline and target contexts during CEADA sessions.[41] These templates are presented in figures 6 – 14.

Figure 6 shows the holistic data capture pyramid template, which gives an overview of aspects discussed in the enterprise architecture effort. Figure 7 shows the diagram template that is used for capturing attributes of operational processes or programs and projects in an enterprise. Figure 8 shows the set of symbols that

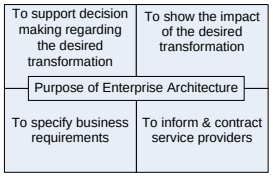

Fig. 13. Diagram template for specifying purpose of the architecture effort (based on Ref. 1)

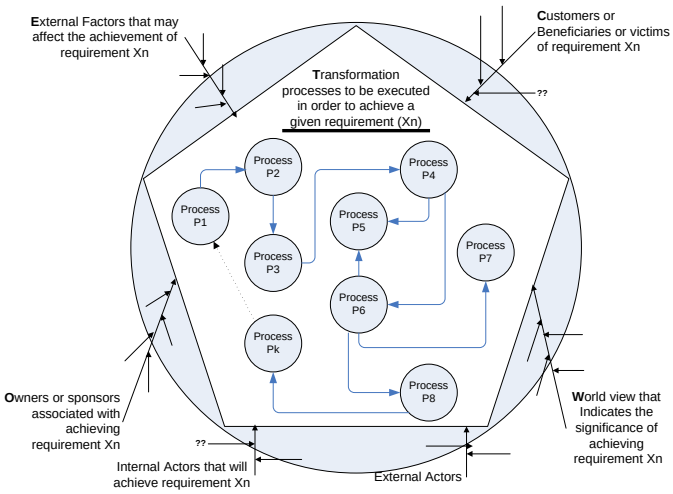

Fig. 14. Diagram template for scenarios formulation or for requirements elaboration

we chose for drawing a Rich Picture in CEADA sessions. Figure 9 shows an example of a Rich Picture (drawn using the symbol set) of the baseline operations in one of the organizations in which CEADA was evaluated. Figure 10 shows the diagram template that is used for capturing problematic aspects or challenges confronting an enterprise. Figure 12 shows the diagram template for defining constraints, and specifications and requirements that are to be fulfilled by the enterprise architecture. Figure 11 shows the diagram template for defining stakeholders that need to be involved in the architecture effort, and the social and political factors that may affect the architecture effort. Figure 13 shows the diagram template for specifying the purpose of the architecture effort. Figure 14 shows the diagram template that is used for elaborating business requirements by formulating solution scenarios that are to be supported by the enterprise architecture.

The diagram template in figure 14 was formulated by adapting SSM's technique of activity models that is presented by Checkland[30] and Hopkins et al[39]. Diagram templates in figures 7, 10, 12, were formulated by adapting the Ishikawa[42] diagram. These diagram templates enhance visualization when clarifying and organizing aspects of the baseline and/or target contexts of an enterprise. Figures 15 – 22 answer questions of *when* and *how* to use these diagram templates. The detailed script-like format of CEADA's design (in figures 15 – 22) shows information that could not all be represented in the tabular format, i.e. the name of activity, pattern of collaboration, required input, name of thinkLet to support the activity, EMS tools to use, non computer-based tools or diagram templates to be used, facilitator notes or script that the facilitator will follow when using the specified tools.

5.6. *Bridge between collaborative design and collaborative choice*

There is a bridge between the collaborative design and collaborative choice sessions, which we refer to as the expert-driven design session. In the expert-driven

COLLABORATIVE INTELLIGENCE SESSION/MODULE

A.1.0: Communicate purpose of session
Input: Some information on the organization's baseline & target contexts; & business-IT architecture concepts
EMS Tool Name: Manual **Other Tools:** Holistic data capture pyramid template
Facilitator Notes: The purpose of this session is to gather information on the organization's problem & solution aspects, which are going to be used to fill the **holistic data capture pyramid template** for architecture creation. Display the holistic data capture pyramid template & explain its structural layout & content to stakeholders.
Product: Stakeholders' awareness of architecture & its benefits & how it can be aligned to the business.

A.1.1.1: Define processes, projects, programmes, and services/products of the organization
Pattern of collaboration: Generate **Input:** Output from A.1.0.
ThinkLets/Techniques: Leafhopper
EMS Tool Name: Generate *Step Specific Information:* Tick the check boxes in the dialog box to allow the following: (A) unlimited no. of items per topic; (B) participants to view input from other participants; & (C) participants to control topic selection. This basic configuration applies to all activities supported by the generate tool in this process but slightly varies depending on the thinkLet assigned to support a given CEADA activity, i.e.: for activities supported by LeafHopper, tick options A, B, C; for activities supported by DealersChoice, tick only options A & B because topic selection is controlled by facilitator to ensure that questions are answered is a given order; for activities supported by FreeBrainstorm, tick options A & B and give out copies of the appropriate diagram template for the activity at hand so as to push stakeholders into thinking about aspects in terms of breadth and/ or depth.
Other Tools: Diagram template for process attributes, set of symbols for Rich Picture formulation
Topic List: (1) What are the services offered by, & the processes executed in, this organization? (2) What are the organization's information inflows associated with each operational process? (3) What are the organization's information outflows associated with each operational process? (4) Who are the external partners of this organization (e.g. unions, consortiums, sponsors, etc), & which departments do they collaborate with? (5) What are the completed and ongoing projects in the organization?
Facilitator Notes: Explain the data capture functions (or answering formats) for each question to participants, i.e.: (1) {Department} - {services it offers} - {Processes it executes to offer its services}; (2) {type of information inflow} - {information sender}; (3) {type of information outflow} - {information recipient}; (4) {Department} - {External partner(s)}; (5) {project name} - {project status} - {where to find documentation about the project} _ _ _
Subtask A.1.1.1.1: Clarify and organize attributes of processes and programmes in the organization
Patterns of collaboration: Converge (Reduce, Clarify), Organize **Input:** Output from preceding step
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for process attributes, set of symbols for Rich Picture formulation
Facilitator Notes: Display the generated list of processes & invoke a **specialization-driven-division** (i.e. divide stakeholders into pairs or into small groups based on their departments/specialization). This enables detailed assessment of the as-is situation & enhances communication, shared understanding, & homogeneity in a pair or in a subgroup. Guide each subgroup to do the following:
(1) Clean & clarify items in the processes list under their department
(2) Distribute copies of the **diagram template for process attributes** to all subgroups. Guide them to fill in the required prompts in the template, using the cleaned list of processes in their department.
(3) Display key symbols you have chosen for drawing a Rich Picture. With each subgroup, use the symbols to draw a **Rich Picture of the as-is situation** of its department, by showing the (internal & external) actors in the department and how they relate, their roles, their concerns, their output, and any other information.
(4) Converge subgroups & encourage representatives of each subgroup to discuss their department-specific diagram templates for processes; & department-specific Rich Pictures. This helps the group to acquire a shared understanding of the as-is situation. All the filled department-specific diagram templates for processes can be plugged onto an organization-wide diagram template for processes. All the department-specific Rich Pictures can be merged to form an organization-wide high level Rich Picture. These diagram templates can then be aligned to the **holistic data capture pyramid template** to show how the information described relates to other information in the organization.
Products: (Partially) filled diagram templates for process attributes, Rich-picture models representing baseline organization processes, services, programs, projects, & operations at unit level and organization level.

A.1.1.2: Define the major problematic aspects in the organization
Pattern of collaboration: Generate **Input:** Output from sub task A.1.1.1.1.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for problem analysis
Topic List: What are the challenges or problems faced in this organization?
Facilitator Notes: Explain the answering format: {Department} - {challenge(s) faced by the department}

Fig. 15. Detailed format of the design of CEADA

design, enterprise architects translate solution scenarios into architecture design alternatives. Enterprise architecture design alternatives are alternative ways through which the solution scenarios describing the desired situation can be implemented or realized. This translation involves technical details that are handled by enterprise architects. According to Ref.[2], Solution Building Blocks (SBBs) are the components (i.e. processes, data, application software, technology) that are used to implement

Subtask A.1.1.2.1: Determine the root problem cause
Patterns of collaboration: Converge, Organize **Input:** Output from preceding step
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for problem analysis
Facilitator Notes: Display the generated list of challenges, & invoke a specialization-driven-division (this is explained in subtask A.1.1.1.1). Guide each subgroup to do the following:
(1) Clean & clarify items in the challenges list under their department
(2) Distribute copies of the **diagram template for problem analysis** to all subgroups. Guide them to perform a cause-effect analysis of problems in their department, i.e. to determine which challenge(s) are causes of other challenge(s), & to document their analysis by filling in the required prompts in the template. The department-specific Rich Pictures from subtask A.1.1.1.1 can be used as a source of information.
(3) Converge subgroups & encourage representatives of each to discuss their department-specific diagram templates for problem analysis & the identified root problem cause(s). Clean & organize the challenges list using output from the subgroups. Map all the department-specific diagram templates for problem analysis onto an organization-wide diagram template for problem analysis, & identify the general root problem cause(s).
Subtask A.1.1.2.2: Identify un-captured problem aspects & any anomalies in output of subtask A.1.1.2.1
Pattern of collaboration: Generate **Input:** Output from subtask A.1.1.2.1.
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for problem analysis, diagram template for process attributes
Topic List: (1) What concerns do you have about any of the Ishikawa diagrams for problem analysis? (2) Which effects & causes of problems (or organizational weaknesses & threats) have not been represented?
Facilitator Notes: Explain answering format: {Department} - {cause/effect/weakness/threat}
Subtask A.1.1.2.3: Assess amendments to the problem analysis outcome
Pattern of collaboration: Converge, Organize **Input:** Output from subtasks A.1.1.2.1 - A.1.1.2.2.
ThinkLets/Techniques: Concentration
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for problem analysis, diagram template for process attributes
Facilitator Notes: Encourage stakeholders to discuss the listed un-captured problem and solution aspects.
Subtask A.1.1.2.4: Seek consensus on outcomes of problem analysis
Pattern of collaboration: Build consensus **Input:** Output from subtasks A.1.1.2.1 - A.1.1.2.3.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input Topic List Items* - [Yes, I agree with the problem analysis results; No, I do not agree with the problem analysis results]; *Evaluation Method* - [Vote (Yes/No)]; Display Variability - [Yes].
Other Tools: (Partially) filled diagram template for problem analysis
Facilitator Notes: Encourage participants who do not agree to comment on their votes. Discuss the comments & re-vote to enable participants to reach a realistic level of shared understanding of problem aspects.
Products: (Partially) filled diagram templates for problem analysis.

A.1.2: Define scope of the organization problem
Pattern of collaboration: Generate **Input:** Output from subtask A.1.1.1.
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for problem analysis, diagram template for process attributes
Topic List: (1) Which processes or stakeholders (i.e. current problem owners) are affected by the problems? (2) Which processes or stakeholders (i.e. possible problem owners) are likely to be affected by the problems?
Facilitator Notes: Use the filled diagram template for problem analysis as a source of information.
Subtask A.1.2.1: Clarify & organize the generated aspects on the problem scope
Pattern of collaboration: Converge, Organize **Input:** Output from preceding step
ThinkLets/Techniques: Concentration
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for problem analysis, diagram template for process attributes, flipchart
Facilitator Notes: Encourage stakeholders to arrange listed processes and/or stakeholders so as to determine the departments or units that are affected by the problem and solution aspects (or desired transformation).
A.1.2.2: Evaluate & agree on aspects that define the organization's problem scope
Pattern of collaboration: Build consensus Input: Output from A.1.2.1
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input topic file* – [Filename with output from A.1.2.1]; *Evaluation Method* - [Select (Mark all that apply)]; Display Variability - [Yes]
Other Tools: Diagram template for problem analysis, diagram template for process attributes, flipchart
Facilitator Notes: Prompt stakeholders to comment on their selections/choices regarding the problem scope.
Products: Specification of organization problem scope & stakeholders' consensus on problem scope

Fig. 16. Detailed format of the design of CEADA (Contd.)

the required capabilities or ABBs (ABBs are discussed in section 5.3). Thus, architecture design alternatives in CEADA are equivalent to SBBs as used in architecture approaches. To design the architecture, architects must select reference models, architectural patterns, tools and techniques for presenting the baseline and target business, data, applications, and technology architectures.[2] In selecting these, archi-

A.1.3: Determine possible business solution alternatives
Pattern of collaboration: Generate **Input:** Output from A.1.1.1 – A.1.2.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for constraints and requirements
Topic List: What can the organization do in order achieve its business strategy & goals?
Facilitator Notes: Prompt stakeholders to suggest ways of how organization's problem aspects can be solved.
Subtask A.1.3.1: Clarify & organize the generated business solution alternatives
Pattern of collaboration: Converge, Organize **Input:** Output from preceding step
ThinkLets/Techniques: Concentration, ReviewReflect
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for constraints and requirements
Facilitator Notes: Guide stakeholders to: identify which business solution alternatives can be treated as specifications of a given solution alternative; & assess each solution alternative by filling in the required prompts in the **diagram template for constraints and requirements** of a given business solution alternative.
Products: Possible business solution alternatives

A.1.4.1: Reaffirm key principles associated with the problems and/or business solution alternatives
Pattern of collaboration: Generate **Input:** Output from A.1.3.
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for constraints and requirements
Topic List: (1) Which business (& architecture principles, if they exist) are associated with the problems the organization is facing or with any possible solutions to the problems? (2) What are the accepted practices in the organisation? (3) What are the existing management or governance frameworks in this organization? (4) Which constraints do the organization principles (and accepted practices and existing frameworks) imply on the each of the possible business solution alternatives?
Facilitator Notes: answering format is: {name of principle/practice/framework} - {source of information about it}; {name of principle/practice/framework} - {implied constraints on a given business solution alternative}
Subtask A.1.4.1.1: Clarify & validate the generated key organization principles
Pattern of collaboration: Converge, Organize **Input:** Output from preceding step
ThinkLets/Techniques: Concentration, ReviewReflect
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for constraints and requirements
Facilitator Notes: Categorize business goals according to the business strategy that is to be achieved.
Products: Constraints (from organizational principles) on each of the possible business solution alternative

A.1.4.2: Specify existing information on business strategy & business goals
Pattern of collaboration: Generate **Input:** Output from A.1.3.
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for constraints and requirements
Topic List: What are the constraints that the existing business strategy and goals impose on the business solution alternatives? OR Which business strategy & goals are in place to solve the organization problems?
Facilitator Notes: Explain the answering format: {strategy: goals}. If the business strategy & goals are already documented, provide a seed file listing them & prompt participants to give their views about the constraints imposed by the business strategy & goals.
Subtask A.1.4.2.1: Clarify & validate aspects on business strategy & goals
Pattern of collaboration: Organize **Input:** Output from preceding step
ThinkLets/Techniques: Concentration, ReviewReflect
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for constraints and requirements
Facilitator Notes: Categorize business goals according to the business strategy that is to be achieved.
Subtask A.1.4.2.2: Evaluate & agree on the business strategy & goals
Pattern of collaboration: Evaluate, Build consensus **Input:** Output from subtask A.1.4.2.1
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input topic file* – [Filename of Output from subtask A.1.4.2.1]; *Evaluation Method*: [Rank from 1 to N (Use each value only once)]; *Display Variability*: [Yes]
Other Tools: Diagram template for constraints and requirements
Facilitator Notes: Prompt stakeholders to prioritize or rank aspects describing (or derived from) the business strategy & goals. Repeat this activity until variability among participants on priorities or ranks is low.
Products: Constraints (from business strategy & goals) on each of the possible business solution alternative

Fig. 17. Detailed format of the design of CEADA (Contd.)

tects endeavor to create an enterprise architecture that addresses all stakeholders' concerns and requirements that are portrayed in the solution scenarios of the desired situation. Tasks in the expert-driven session are fully supported by enterprise architecture approaches. With respect to the requirements discussed in section 4, the expert-driven session allows architects to have ample time to: (a) design an architecture that is linked to all frameworks in an enterprise; and (b) translate ad-

A.1.5: Define external constraints associated with the possible business solution alternatives
Pattern of collaboration: Generate **Input:** Output from A.1.3.
ThinkLets/Techniques: DealersChoice
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for constraints and requirements
Topic List: (1) What are the policies or laws from regulatory authorities that relate to the business solution alternatives? (2) What are the policies or laws from the organization's consortiums, donors or sponsors, unions etc, that relate to the business solution alternatives? (3) What constraints do these regulations impose?
Facilitator notes: Explain answering format: {name of body} - {external principle} - {implied external constraint}.
Subtask A.1.5.1: Clarify & organize the identified external constraints
Pattern of collaboration: Converge, Organize **Input:** Output from preceding step
ThinkLets/Techniques: Concentration, ReviewReflect
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for constraints and requirements
Facilitator notes: Use the generated aspects to fill in (or add details to) the external constraints node in the **diagram template for constraints and requirements** of the chosen business solution alternative.
Products: External constraints on each the possible business solution alternatives

A.1.6: Choose the most appropriate business solution alternative
Pattern of collaboration: Evaluate, Build consensus **Input:** Output from A.1.3 – A.1.5
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: List of Alternatives* - [Filename of output from A.1.3]; *Input Criteria List Items* -[Suitability with respect to: (1) satisfying organization principles i.e. internal constraints; (2) constraints from (or of achieving) business strategy and goals; (3) satisfying external constraints]
Other Tools: (partially) filled diagram template for constraints and requirements
Facilitator Notes: Prompt stakeholders to choose the appropriate business solution alternatives with respect to the internal and external constraints defined in A.1.4.1, A.1.4.2, & A.1.5. Encourage stakeholders to comment on their scores of the business solution alternatives. Output from A.1.6 is key input for activity A.1.8.1 & A.1.8.2.
Products: chosen business solution alternative & its (partially) filled template for constraints and requirements.

A.1.7: Agree on the purpose of architecture in implementing the chosen business solution alternative
Pattern of collaboration: Evaluate, Build consensus **Input:** Output from A.1.6.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information:* list of items – [the list of possible purposes for architecture are adaptation of the general uses of enterprise architecture defined in Op 't Land et al (2008)), i.e. enterprise architecture will be used for: (a) supporting decision making regarding the chosen business solution alternative; (b) showing the impact of the business strategy and the chosen business solution alternative; (c) specifying business requirements; (d) informing & contracting service providers]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: Diagram template for specifying purpose of the architecture effort
Facilitator notes: Guide participants to specify the purpose of the architecture by selecting among the 4 major purposes of architecture. Their selections can be plotted onto the **diagram template for purpose of the architecture initiative**, which shows these 4 major purposes of enterprise architecture.
Products: Clearly filled diagram template for specifying purpose of the architecture effort.

A.1.8.1: Determine high level solution specifications of the chosen business solution alternative
Pattern of collaboration: Generate **Input:** Output of A.1.1, A.1.2, A.1.4.2, A.1.6, A.1.7
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Topic List: (1) Which business services, functions, departments or areas of the organisation should the architecture creation effort focus on? (2) Which of the existing business functions should not be considered in the desired state? (3) Which architecture domains (i.e. business, data, applications, & technology) should be covered during architecture creation? (4) What is the desired level of detail that the architecture creation effort should focus on? (5) From the completed & ongoing projects in the organization, which architectural resources are available in the organisation, and can be considered for use during architecture creation? (6) List any constraints (i.e. enterprise-wide or project-specific constraints) that the organization principles impose on the implementation of the defined business strategy or chosen business solution alternative
Other Tools: (Partially) filled diagram template for constraints and requirements of the chosen business solution alternative in A.1.6; filled diagram template for specifying purpose of the architecture effort.
Facilitator notes: Answering format: {business services/functions/departments} - {name of business service}; {business services or units not to consider} – {list of business services or units that shouldn't be considered}; {domains to cover} – {list of domains to cover}

Fig. 18. Detailed format of the design of CEADA (Contd.)

vantages and disadvantages of architecture design alternatives into a language that stakeholders understand (see issues J2 and K2 in section 3.2.4).

5.7. *Summary on the design of CEADA*

As shown in figure 23, the CEADA process comprises three modules which synergically address various issues associated with involving client stakeholders during

Subtask A.1.8.1.1: Clarify & assess the defined high level solution specifications or scope dimensions
Pattern of collaboration: Converge **Input:** Output of preceding step
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: (Partially) filled diagram template for constraints and requirements of the chosen business solution alternative in A.1.6
Facilitator notes: Assess aspects with respect to problem scope (A.1.2) & the purpose of architecture (A.1.7). Use the generated aspects to fill in (or add details to) the high level solution specifications node in the **diagram template for constraints** of the chosen business solution alternative.

Subtask A.1.8.1.2: Agree on high level solution specifications
Pattern of collaboration: Evaluate, Build consensus **Input:** Output of subtask A.1.8.1.1
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input topic file* – [Filename of Output from subtask A.1.8.1.1]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: (Partially) filled diagram template for constraints and requirements of the chosen business solution alternative in A.1.6
Facilitator notes: Encourage stakeholders to comment on their selections for particular specifications
Products: Solution specifications plotted on the diagram template for constraints and requirements of the chosen business solution alternative in A.1.6

A.1.9: Determine key stakeholders & their roles in the architecture effort
Pattern of collaboration: Generate **Input:** Output of A.1.1, A.1.4.2, A.1.8
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for Analysis One Two Three
Topic List: (1) List all stakeholders who are (or will be) affected by, or will benefit from, or participate in the implementation of, the desired solution; & what will be the roles of that stakeholder in the enterprise architecture effort? (2) Who are the key decision makers in the organization?
Facilitator Notes: Answering format: {problem/solution owner} - {Role in the architecture development effort}; {position in the organization} - {decision making responsibility}. Stakeholders can use the diagram template for process attributes (that was filled in A.1.1.1), as the source of information required in this activity.

Subtask A.1.9.1: Clarify & organize list of current & possible problem owners and solution owners
Pattern of collaboration: Converge **Input:** Output from preceding step
ThinkLets/Techniques: Concentration
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for Analysis One Two Three
Facilitator Notes: Encourage stakeholders to plot the generated types of stakeholders on to the nodes of the diagram template for Analysis One Two Three.
Products: Current & possible key stakeholders specified on the template for analysis One Two Three

Subtask A.1.9.2: Agree on list of problem owners, solution owners, & decision makers
Pattern of collaboration: Build consensus **Input:** Output from A.1.9.1
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Organize *Step Specific Information: Input topic file* – [Filename of output from subtask A.1.9.1]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: Diagram template for Analysis One Two Three
Facilitator Notes: Encourage stakeholders to comment on their selections.
Products: Key stakeholders and decision makers in the architecture effort.

COLLABORATIVE DESIGN SESSION/MODULE

A.3.0: Communicate purpose of session
EMS Tool Name: Manual **Other Tools:** (partially) diagram templates from collaborative intelligence
Facilitator Notes: Give a recap of output from collaborative intelligence session, i.e. the (partially) populated diagram templates.

A.3.1: Define concerns about (or elaborate) problems that were defined in collaborative intelligence
Pattern of collaboration: Generate **Input:** Output of A.1.1.1, A.1.1.2, A.1.9
ThinkLets/Techniques: LeafHopper
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: (partially) diagram template for problem analysis, Rich Pictures (of unit & organizational level)
Topic List: (1) What concerns do you have regarding the problem aspects?; (2) What has not been captured in the problem aspects? (3) Which problem & solution owners have not been included?
Facilitation notes: (1) Display the Rich Picture that was formulated & diagram template for problem analysis that was filled, in collaborative intelligence session. Otherwise follow facilitator notes in A1.1.11 to fill the template & draw the Rich Picture; (2) Prompt stakeholders to post or share their comments regarding aspects in the diagrams; (3) Explain the data capture functions (or answering formats) for the questions in this activity to the participants, i.e.: {problem aspects} - {additional concern or missing aspect}

Fig. 19. Detailed format of the design of CEADA (Contd.)

enterprise architecture creation. Each CEADA module comprises activities that yield specific deliverables, several patterns of reasoning that stakeholders undergo in order to execute the activities in that module, and thinkLets (and tools and scripts) required to create the patterns and execute the activities. Sections 5.2 –

A.3.2: Clarify & organize concerns about (& additional issues to) the problem aspects
Pattern of collaboration: Converge, Organize **Input:** Output of A.3.1.
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: (partially) diagram template for problem analysis, Rich Pictures (of unit & organizational level)
Facilitator Notes: Discuss the concerns on the diagram template for problem analysis & Rich Pictures.

A.3.3: Validate & agree on the concerns about (& additional issues to) the problem aspects
Pattern of collaboration: Evaluate, Build consensus **Input:** Output of A.3.2.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input topic file* – [Filename of output from subtask A.3.2]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: (partially) diagram template for problem analysis, Rich Pictures (of unit & organizational level)
Facilitator Notes: Encourage stakeholders to comment on their selections
Products: Fully populated diagram template for problem analysis

A.4.0: Communicate solution/desired aspects in the target situation that were defined in collaborative intelligence session
EMS Tool Name: Manual **Other Tools:** (Partially) diagram templates for constraints and requirements
Facilitator Notes: Give a recap of output from collaborative intelligence session, i.e. the (partially) populated diagram templates.

A.4.1: Define business requirements that the enterprise architecture must fulfill
Pattern of collaboration: Generate **Input:** Output of A.1.6, A.1.7, A.1.8, A.1.9
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: (partially) diagram templates for constraints and requirements
Topic List: To move from the current to the desired state, define WHAT should be done to address a given set of related concerns or to solve a given problem? HOW should it be done? & WHY should it be done?
Facilitator Notes: Answering format is an adaptation of the Root Definitions of SSM, i.e.: {WHAT should be done}; {HOW it should be done}; & {WHY it should be done}

A.4.2: Clarify & organize requirements for the enterprise architecture
Pattern of collaboration: Converge, Organize **Input:** Output of A.4.1.
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: (partially) diagram templates for constraints and requirements
Facilitator Notes: Invoke a specialization-driven-division & guide stakeholders to:
(1) Identify and delete all duplicate root definitions; determine which root definitions should be sub root definitions of other root definitions.
(2) Fill in the requirements prompts in the (partially) diagram templates for constraints and requirements. Converge all subgroups & prompt stakeholders to identify any incomplete requirement (i.e. one which is not in the format of: {WHAT should be done}; {HOW it should be done}; & {WHY it should be done}.

A.4.3: Validate & agree on the requirements for the enterprise architecture
Pattern of collaboration: Evaluate, Build Consensus **Input:** Output of A.4.2.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input topic file* – [Filename of output from subtask A.4.2]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: (partially) diagram templates for constraints and requirements
Facilitator Notes: Encourage stakeholders to comment on their selections.
Products: Fully populated diagram template for constraints and requirements

A.4.4: Define quality criteria or assurance principles with respect to achieving business requirements
Pattern of collaboration: Generate **Input:** Output of A.1.4.1, A.1.4.2, A.1.5, A.4.3.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: (partially) diagram templates for constraints and requirements
Topic List: In achieving the business requirements, how do you want to gain a competitive advantage over your competitors (or which quality goals do you aim to achieve given the internal and external constraints)?
Facilitator Notes: Encourage stakeholders to use the (partially) diagram templates for constraints and requirements to determine quality criteria for the architecture design alternatives.

A.4.5: Clarify & categorize quality criteria by type
Pattern of collaboration: Converge, Organize **Input:** Output of A.4.4.
ThinkLets/Techniques: Concentration, ReviewReflect
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: (partially) diagram templates for constraints and requirements
Facilitator Notes: Guide stakeholders to classify quality criteria into those that are governance quality criteria, operational quality criteria, & business quality criteria.

Fig. 20. Detailed format of the design of CEADA (Contd.)

5.5 discuss these aspects as the seven layers of CEADA. In figure 23, 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 selected thinkLets to support execution of each activity is represented as TAq.

Figure 23 further shows that for CEADA to be applied in a given enterprise

A.4.6: Evaluate, discuss, validate, & agree on quality criteria
Pattern of collaboration: Evaluate, Build consensus **Input:** Output from A.4.5.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Organize *Step Specific Information: Input topic file* – [Filename of output from subtask A.4.5]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
Other Tools: (partially) diagram templates for constraints and requirements
Facilitator Notes: Encourage stakeholders to comment on their selections
Products: Clearly defined governance quality criteria, operational quality criteria, & business quality criteria

A.5.1: Define names of transformation process(es) required to achieve the business requirements
Pattern of collaboration: Generate **Input:** Output from A.4.5.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: (partially) diagram templates for constraints and requirements
Topic List: Which transformation or operational processes can be identified from each business requirement?
Facilitator Notes: answering format: {name/label/type of requirement} – {How the requirement can be achieved or processes that can be implemented or revised to achieve the transformation or operational process}

A.5.2: Clarify and organize names of required transformation process(es)
Pattern of collaboration: Converge, Organize **Input:** Output from A.5.1.
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Generate *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: diagram template for scenarios formulation
Facilitator Notes: Invoke a specialization-driven division and encourage stakeholders to fill the requirements prompts of the **diagram templates for constraints and requirements.**

A.5.3: Elaborate business requirements using CATWOE analysis technique of SSM
Pattern of collaboration: Generate **Input:** Output from A.5.2.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Generate *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Diagram template for scenarios formulation
Topic List: (1) For each requirement, who are the **C**ustomers or beneficiaries? (2) Who are the **A**ctors responsible for realizing each requirement? (3) What are the required inputs to realize the **T**ransformation process described in each requirement, and what are the expected outputs from the transformation process? (4) What are the **W**orld views that make each requirement meaningful or rational? (5) Who are the owners or sponsors responsible for sponsoring the realization of each requirement or stopping it? (6) What are the **E**nvironmental & external issues or constraints that may hinder the realization of each requirement?
Facilitator Notes: Prompt stakeholders to give their ideas regarding the CATWOE dimensions of each agreed on business requirement. Inform stakeholders that these dimensions are the five sides and the inner top corner of the pentagon presented in the diagram template for scenarios formulation. Note that the WHAT component of a given requirement represents the Transformation process in the CATWOE analysis of the requirements.

A.5.4: Clarify & organize elaborated aspects on business requirements
Pattern of collaboration: Converge, Organize **Input:** Output from A.5.3.
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Diagram template for scenarios formulation
Facilitator Notes: (1) Invoke a specialization-driven division and encourage stakeholders to clean generated aspects on elaborating requirements (2) Guide stakeholders to use the cleaned CATWOE aspects to fill in the information prompts on the five sides of the pentagon in the **diagram template for scenarios formulation**.

A.5.5: Sketch solution scenarios of the solution/desired or target situation
Pattern of collaboration: Generate **Input:** Output from A.5.4.
ThinkLets/Techniques: FreeBrainstorm
EMS Tool Name: Organize *Step Specific Information:* see configuration notes in A.1.1.1.
Other Tools: Partially filled diagram template for scenarios formulation
Topic List: (1) What are the organization-wide business functions (or capabilities or activities) that the organization needs to have in order to achieve its business requirements, AND how will they interact or support each other in order to achieve a given business requirement? OR (2) What are the possible ways or options to realize the transformation or operational processes defined in A.5.2 – A.5.4?
Facilitator Notes: Encourage stakeholders that the clue to defining & sketching the flow of these processes is to determine what activities or roles will **A**ctors defined in A.5.4 fulfill in achieving the business requirement. Draw the models by representing the activities with circles and their dependences with lines whose arrows imply the dependence identified (as shown in the **diagram template for scenarios formulation**). Only two symbols are used to avoid complexity & to encourage stakeholders to formulate informal models of the desired situation. Flip charts are used here to describe the desired organization-wide capabilities or processes, unit-level processes, and the sub processes involved in achieving a given business requirement.

Fig. 21. Detailed format of the design of CEADA (Contd.)

architecture creation effort, its (generic) activities are customized basing on mainly 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 enterprise. This results in an enterprise-specific CEADA process for creating

A.5.6: Analyze and refine each formulated solution scenario of the desired situation
Pattern of collaboration: Converge, Organize **Input:** Output from A.5.5.
ThinkLets/Techniques: FastHarvest
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Partially filled diagram templates for scenarios formulation
Facilitator Notes: Invoke a specialization-driven-division. Guide stakeholders to: clean the sketches of activities or processes; identify & remove any duplicate names or labels in the processes presented in the sketches; identify & justify dependencies among the activities. Assemble models or sketches that lead to complete execution of a given business function (or transformation process). Note that the sketch models are formulated within the pentagon in the **diagram template for scenarios formulation**.

A.5.7: Validate solution scenarios of the desired situation
Pattern of collaboration: Organize **Input:** Output from A.5.6.
ThinkLets/Techniques: Concentration
EMS Tool Name: Organize *Step Specific Information:* Step will run in Outliner Mode.
Other Tools: Partially filled diagram templates for scenarios formulation
Facilitator Notes: Guide stakeholders to compare how all the processes in the formulated solution scenarios interact and synchronize with each other. Also, identify the strengths & weaknesses of each solution scenario.

A.5.8: Agree on solution scenarios for the desired situation
Pattern of collaboration: Evaluate, Build consensus **Input:** Output from A.5.7.
ThinkLets/Techniques: StrawPoll, CrowBar
EMS Tool Name: Evaluate *Step Specific Information: Input Topic List Items* - [Yes, I agree with the problem analysis results; No, I do not agree with the problem analysis results]; *Evaluation Method* - [Vote (Yes/No)]; Display Variability - [Yes].
Other Tools: filled diagram template for scenarios formulation
Facilitator Notes: Encourage stakeholders to comment on their votes. Repeat activity until variability among stakeholders is low.
Products: Agreed on solution scenarios that the enterprise architecture must fulfill. These are later translated into enterprise architecture design alternatives in the expert-driven design session that mainly involves enterprise architects only.

Fig. 22. Detailed format of the design of CEADA (Contd.)

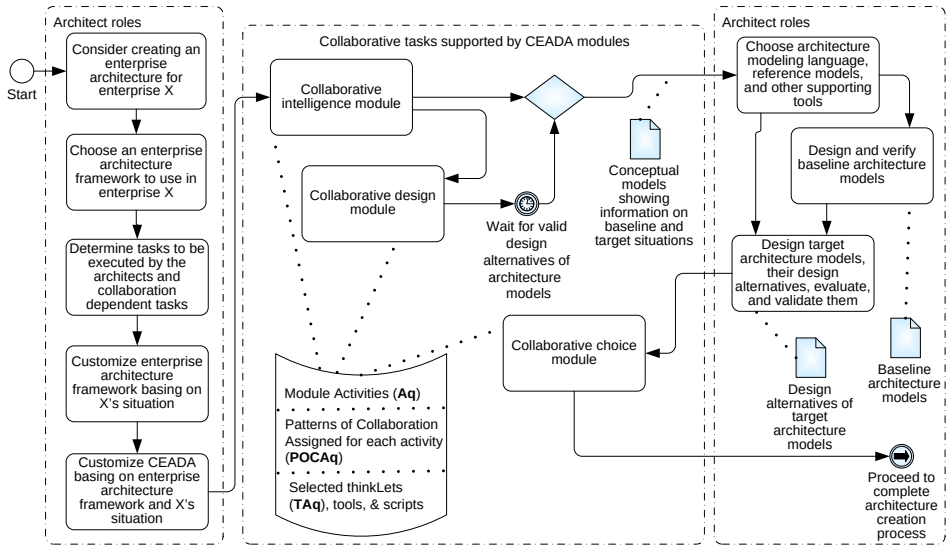

Fig. 23. Using CEADA along with an enterprise architecture framework

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 6 discusses how CEADA was used along with TOGAF ADM in two organizations.

6. Evaluation of CEADA and its use in TOGAF ADM

In section 2.2 it was highlighted that CEADA was evaluated in two organizations using Action Research. Evaluating CEADA in these organizations required the use of an enterprise architecture framework. This section describes how CEADA was used along with TOGAF ADM, and presents evaluation findings of CEADA's performance in the two organizations. Since CEADA focuses on supplementing architecture approaches with support for collaborative tasks, herein it is used in TOGAF's ADM. TOGAF was chosen because it is a detailed industry-driven approach comprising a set of tools and methods that support enterprise architecture development.[2] 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.[2] TOGAF's ADM comprises of 12 phases, namely: preliminary phase, architecture vision (phase A), business architecture (phase B), information systems architectures (phase C), and technology architecture (phase D), opportunities and solutions (phase E), migration planning (phase F), implementation governance (phase G), architecture change management (phase H), and requirements management. The use of CEADA in the ADM was limited to only four phases A, B, C, and D. In sections 6.1 and 6.2 we discuss how the output or deliverables of each of these four ADM phases can be gathered and validated by executing CEADA activities.

6.1. *Creating architecture vision*

According to TOGAF,[2] 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 10 shows how CEADA has been embedded in this phase. Column 2 of table 10 shows TOGAF's ADM guidelines for this phase, which are a summary of the detailed discussion in.[2] 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 10, 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 5. In addition, for the sake of making the following discussion (of how CEADA can be used in TOGAF ADM) readable, the output of a given CEADA activity is stated in brackets after the code of the activity is stated. For example, A.1.2 (problem scope) or A.1.5 (external constrains).

Establish the architecture project in the organization. Guideline 1(a) in table 10 involves using accepted practices and existing project management or IT governance frameworks.[2] 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 bod-

Table 10. ADM guidelines for phase A and CEADA activities that can support collaborative tasks 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

ies). Moreover, in guideline 1(b) in table 10, it is advised that enterprise-specific procedures should be conducted in order to secure enterprise-wide support and commitment.[2] 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 10) 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 10 involves engaging key stakeholders when scoping the architecture and defining its candidate components.[2] 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 10 involves engaging key stakeholders to de-

fine business requirements that must be addressed by the architecture. For defining business requirements, TOGAF recommends the use of business scenarios.[12,2] However, facilitation support for business scenario workshops is implicit (as discussed in section 2.1). 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 10, 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 10) 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.[2] 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 10, 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.[2] Thus, guideline 3(b) in table 10 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,[1] 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.[2] Thus, in guideline 4(a) in table 10, 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 10, 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 10 involves identifying (and analyzing and prioritizing) readi-

ness factors for assessing the organization's readiness for change, and then assessing the organization using those factors.[2] 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 10).

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.[2] As indicated in table 10, 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.[2] As indicated in table 10, 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.[2] As shown in table 10, the actual *design* of baseline and target architecture models is beyond the scope of CEADA. The translation of output from the collaborative 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 richly support it. However, the architecture vision models are created using information such as stakeholders' concerns, business capability requirements, scope, constraints, and principles.[2] Therefore, output from activities in the collaborative intelligence module of CEADA (e.g. activities 1.1, 1.2, 1.5, 1.8, 2.1, and 3.1 – 3.4) is vital for formulating high level views of baseline architecture models, and output from activities in the collaborative design module of CEADA (e.g. activities 1.3, 1.4, 1.7, 1.9, 4.3, 4.6, and 5.5) is vital for formulating high level views of target architecture vision models. Moreover, in the two organizations, 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.

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.[2] 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 10). 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).[2] 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.[2] 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 10, the statement of architecture work comprises output from activities in all the three modules of the CEADA process.

6.2. *Creating domain architectures*

According to Ref.[2], the business, data, application, and technology aspects of the organization's architecture vision are developed further in phases B, C, D of the ADM as follows. Phase B aims at developing a business architecture that will support the architecture vision. Phase C aims at developing target architectures that cover either or both of the data and application systems domains. 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). Phase D, known as technology architecture, 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 11 shows how CEADA has been embedded in phases B, C, and D. Column 2 shows the ADM guidelines for these phases (as defined in Ref.[2]), while column 3 shows the activities in the process layer of CEADA, whose corresponding patterns of collaboration and thinkLets can offer collaboration support for each guideline. Following is a discussion of the criteria and assumptions used in assigning CEADA activities to the ADM guidelines in table 11.

Table 11 shows how CEADA has been embedded in phases B, C, and D. Column 2 of table 11 shows the TOGAF ADM general guidelines for these three phases, which are a summary of the detailed discussion in.[2] 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 11 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 11 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 5. Following is a discussion of the criteria or assumptions used in assigning CEADA activities to the ADM guidelines in table 11. Like in section 6.1, 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 11. ADM guidelines for phases B, C, D and CEADA activities that can support collaborative 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 11 involves revisiting the architecture principles to review the data and application principles (when developing information systems architectures), or technology principles (when developing technology architecture).[2] 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.[2]. 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 11 involves selecting relevant viewpoints that demonstrate how stakeholders' concerns are to be addressed in the business, data, application, and technology architectures of the organization.[2] 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, in TOGAF 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).[2] 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,[2] 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.[2] 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 11. 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.[2] 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.[2] 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.[2] As shown in table 11, 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.[2] 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 11 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.[2] 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.

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.[2] As indicated in table 11, 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.[2] 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.[2] 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).

Perform gap analysis, define architecture roadmap, and determine wider impact. Table 11 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,[2] 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 11, 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[2], 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 11, 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).

6.3. *Evaluation of CEADA using action research*

Action research method is useful in evaluating design science artifacts.[28,46] According to Baskerville[53], action research steps involves the following steps: (a) *Diagnosing* – identifying the root cause of the desire for change in an organization; (b) *Action planning* – determining possible actions to address the diagnosed problem; (c) *Action taking* – researchers collaborating with stakeholders (and practitioners) to implement the planned action so as to realize the desired changes in the organization; (d) *Evaluating* – researchers and stakeholders (and practitioners) determining whether the (practical and theoretical) effects of the action taken were achieved; (e) *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. These steps were undertaken in two enterprises as summarized in table 12 and described in sections 6.3.1 – 6.3.3 below.

Table 12. Action research in the two enterprises

#	Action Research	Radiotherapy Department in Mulago (RDM)	Joint Clinical Research Center (JCRC)
1	Problem Diagnosis	The desire to enhance service delivery in the department with IT capabilities	The need for insight into the existing way of operation and challenges faced, so as to determine how to customize and implement a new open source Laboratory Information Management System
2	Action Planning	Determine ways in which IT capabilities can enhance processes of cancer treatment and patient care	To develop an architecture vision showing the existing way of operation in JCRC laboratories, and indicate activities that will be highly dependent on the Laboratory Information Management System
		Create an enterprise architecture vision to guide and inform the desired enterprise transformation	
3	Action Taking	(a). CEADA modules were customized to support collaborative tasks that were executed by the researchers and the stakeholders in each of the enterprises.	
		(b). TOGAF ADM was the guiding architecture method and Business Process Modeling Notation (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 CEADA.	

6.3.1. *Problem diagnosis and action planning in the two enterprises*

Selection of enterprises. In the search for enterprises in which CEADA could be evaluated, formal requisitions were sent to various enterprises in Uganda. 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. Two criteria were considered in the selection of enterprises for CEADA evaluation. First, *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 section 5.1). 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. Second, *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 enterprises, some enterprises were eliminated (based on the architecture maturity level criterion) and two were selected because their architecture maturity level was in the range of range $0 - 1$ and they had provided a positive response.

Radiotherapy Department at Mulago (RDM). RDM is one of the various departments in Mulago hospital (a National referral hospital in Uganda). RDM 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. Column 3 of table 12 shows the output of the diagnosis and action planning steps of action research in RDM.

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. Column 4 of table 12 shows the output of the diagnosis and action planning steps of action research in JCRC.

6.3.2. *Action taking in the two enterprises*

Action taking in 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 exe-

cuted. In this enterprise, the (partially) populated diagram templates were used to trigger discussions. 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 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.

6.3.3. *Discussion on evaluate and specify learning steps in RDM and JCRC*

In the two enterprises, 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 to trigger discussions and elicit more information on problem and solution aspects from stakeholders in CEADA sessions. 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. Also, in the two enterprises, the resultant models were only architecture vision models and not detailed domain-specific models. Below we discuss evaluation results of CEADA's performance and lessons learned from the evaluation.

Evaluation criteria and performance indicators. Evaluation criteria are shown in column 2 of table 13 and performance indicators are shown in columns 4 and 5 of table 13. CEADA's performance was measured using a post-session questionnaire to stakeholders who participated in the collaborative sessions. The use of such a questionnaire was adopted from Ref.[56] A sample of the post-session evaluation questionnaire that was used is provided in figure 28 in the appendix. Using the post-session questionnaire, stakeholders evaluated the performance of CEADA under various aspects (or evaluation criteria). Table 13 shows the performance evaluation results of using CEADA along with TOGAF ADM. The *mean* performance indicator in column 4 of table 13 was obtained by taking the mean of CEADA scores under each evaluation criterion (as indicated by stakeholders during their judgement of CEADA's performance).

The standard deviation performance indicator represents the level of consensus

Table 13. Performance Evaluation of CEADA used along with TOGAF ADM

#	Evaluation criteria for CEADA	Organization	Performance Indicator	
			Mean score	Standard deviation of scores
1	Support for creating a shared understanding (among stakeholders) of the problem and solution aspects of the organization	RDM	4.36	0.50
		JCRC	4.67	0.50
	a Support for enabling stakeholders to understand the concerns of other stakeholders about the current and future operations in the organization	RDM	4.36	0.84
		JCRC	4.56	0.53
	b Support for enabling stakeholders to understand why some of their concerns/views would not apply in some contexts	RDM	4.15	0.55
		JCRC	3.89	1.27
	c Support for enabling stakeholders to understand the results of the architecture process	RDM	4.25	0.45
		JCRC	4.33	0.50
2	Support for enabling stakeholders to freely express their views about the current operations in the organization	RDM	4.43	0.94
		JCRC	4.67	0.50
3	Support for attaining stakeholders' satisfaction with the activities done in the collaborative session(s)	RDM	4.50	0.52
		JCRC	4.11	0.60
4	Support for attaining stakeholders' satisfaction with the outcome(s) of the collaborative session(s)	RDM	4.23	0.60
		JCRC	4.44	0.73
	a Support for enabling constructive critiquing of ideas generated by the participating stakeholders	RDM	1.50	0.52
		JCRC	4.56	0.73
	b Support for enabling stakeholders to understand the objectives of the session(s)	RDM	4.29	0.61
		JCRC	4.78	0.44
The scale used in the post-session questionnaire that stakeholders filled to evaluate the sessions is a 5 point Likert scale with responses ranging from strongly disagree (point 1) to strongly agree (point 5)				

among stakeholders regarding the performance of CEADA under a given criterion.[56] Thus, a low value of standard deviation shows a high level of consensus on the mean score of CEADA under a given criterion. Also, a high value of standard deviation shows a high level of consensus on the mean score of CEADA under a given criterion. The results in columns 4 and 5 of table 13 show a fairly good performance of CEADA under all criteria except 1(b) and 4(a) (see table 13). These criteria seem related whereby criterion 4(a) is likely to lead to criterion 1(b) (see table 13). These criteria fall under the social complexity aspects discussed in section 4.2.3 and section 3.2.2. This implies the need to improve the performance of CEADA under criteria 1(b) and 4(a) by devising ways of addressing issues under social complexity. This is because the performance of CEADA under these criteria may be considered good in one enterprise, but may be considered neutral or poor in another enterprise. As a result, it can be claimed that CEADA is not repeatable under these two criteria but so far repeatable under other criteria in table 13.

Summary of lessons from the evaluation. Key lessons are discussed below.

Using diagram templates to gather data on baseline and target aspects quickens the processing of results from interviews and group sessions. The use of diagram templates to gather data on problem and solution aspects in the enterprises 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 14). Information in this template is then used to formulate a corresponding view in a business architecture model. Thus, the CEADA diagram templates partially helped to overcome challenges faced when translating interview notes or group session data logs into architecture models. This was one of the

issues enterprise architects raised in the exploratory survey (see weaknesses of using workshops in figure 3 in section 3.2.3).

If congested with a lot of details, the Rich Picture is not self guiding and becomes hard to follow. To some stakeholders in large enterprises like JCRC, the organization-wide Rich Picture was too congested, so they preferred to have department/unit specific Rich Pictures. Thus, in CEADA we avoid having a congested Rich Picture for large enterprises, by ensuring that the organization-wide Rich Picture only shows operations between units rather than unit operations. The unit operations are then represented in a unit-specific Rich Picture. In addition, some stakeholders complained that the organization-wide detailed Rich Pictures were not self guiding and are hard to follow without explanations from the researchers. 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 a given department or organization.

In tables 10 and 11 (that show how CEADA can support TOGAF ADM guidelines), a set of CEADA activities need to be assigned to offer 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 first be used. Examples of CEADA activities executed in form of clusters are in the collaborative design session, i.e. specifying concerns (activities A.3.1 – A.3.3), requirements (A.4.1 – A.4.3), quality criteria (A.4.4 – A.4.6), and formulating solution scenarios (A5.1 – A.5.8). In addition, as tables 10 and 11 show, in each of the four architecture creation phases (i.e. A, B, C, and D), all CEADA sessions are executed. This is mainly because collaborative tasks recur in the creation phases of the ADM.

7. Conclusions

This paper is an effort towards supplementing enterprise architecture approaches with support for executing collaborative tasks. In aiming to achieve this, Design Science research methodology was adopted to design an artifact that can be used along with existing enterprise architecture approaches to support execution of collaborative tasks. Accordingly, to understand practice-based problems that are encountered during the execution of collaborative tasks in architecture creation, an exploratory survey was conducted among enterprise architects. Basing on collaboration engineering and SSM (and other techniques, tools, and methods that support collaborative work practices), requirements and design choices for an artifact that can address findings from the survey were determined. Thereafter, the seven-layer model of collaboration processes was adopted in order to extend the earlier design of CEADA process such that it can fulfil the requirements and design choices implied by the survey findings. The refined design of CEADA artifact herein is presented in both a summarized tabular format and in a detailed script-like format. The refined design of CEADA was further evaluated using action research in two enterprises. This involved following the steps of action research to examine the use of CEADA

along with the TOGAF ADM in the two enterprises.

Results of CEADA's performance are promising in terms of repeatability and predictability under all criteria except criteria 1(b) and 4(a) which are associated with the social complexity issue. Although the performance of CEADA under other evaluation criteria is fairly good, it is based on an evaluation that was done based on using CEADA in only TOGAF ADM and in only two enterprises. Thus, there is need to extend CEADA by devising ways of addressing social complexity and creativity issues so as to fully address issues from survey findings. Also, there is need to further evaluate the use of CEADA along with other architecture approaches and in other real enterprises so as to confirm its repeatability and predictability regarding the support for executing collaborative tasks in enterprise architecture approaches.

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References

1. M. Op 't Land, H. A. Proper, M. Waage, J. Cloo and C. Steghuis, *Enterprise Architecture - Creating Value by Informed Governance* (Springer, Germany, 2008).
2. The Open Group Architecture Forum, *TOGAF Version 9* (Van Haren Publishing, The Netherlands, 2009).
3. A. Nakakawa, P. van Bommel and H. A. Proper, Definition and validation of requirements for collaborative decision making in enterprise architecture creation. International Journal of Cooperative Information Systems (IJCIS), Vol. 20, No. 1 (2011) 83 - 136. DOI: 10.1142/S021884301100216X
4. S. A. Bernard: An Introduction to Enterprise Architecture – Linking Business and Technology (2nd edition). AuthorHouse, Indiana (2005)
5. G. J. de Vreede, A. Fruhling and A. Chakrapani, A Repeatable Collaboration Process for Usability Testing, in *HICCS* (IEEE Press, 2005)
6. Gartner, Inc., Gartner Identifies Ten Enterprise Architecture Pitfalls. Gartner Enterprise Architecture Summit 2009, http://www.gartner.com/it/page.jsp?id=1159617.
7. T. W. Rehkopf and N. Wybolt, Top 10 Architecture Land Mines. IT Professional 5 (6) pp. 36 - 43 (2003). doi:10.1109/MITP.2003.1254967
8. S. H. Spewak, *Enterprise Architecture Planning: Developing a Blue Print for Data, Applications, and Technology* (John Wiley & Sons Inc, New York, 1992).
9. S. H. Kaisler, F. Armour and M. Valivullah, Enterprise Architecting: Critical Problems, in HICSS (IEEE Press 2005)
10. M. Lankhorst et al., *Enterprise Architecture at Work: Modeling, Communication, and Analysis* (Springer, Germany, 2005).
11. J. Zachman, A framework for information systems architecture. IBM Systems Journal, 26, (3) (1987) 276 - 292
12. T. Blevins, J. Spencer and The Open Group Architecture Forum, Manager's Guide to Business Scenarios. The Open Group. (2002) ISBN: 1-931624-15-1
13. M. Janssen and A. Cresswell: The Development of a Reference Architecture for Local Government, HICSS 38, 223-233. (2005) ISBN: 0-7695-2268-8
14. B. van der, Raadt, S. Schouten and H. van Vliet, Stakeholder Perception of Enterprise Architecture. Lecture Notes in Computer Science: Vol. 5292. European Conference on Software Architecture (pp. 19-34). Springer Heidelberg: Germany. (2008).

15. G. J. de Vreede and R. O., Briggs, Collaboration Engineering: Designing Repeatable Processes for High-Value Collaborative Tasks, IEEE: HICSS (2005).
16. Holland ASE Team, *The Power of Group Dialog: Accelerated Solutions Environment* (Capgemini, The Netherlands, 2005).
17. R. O., Briggs, G. L., Kolfschoten, G. J. de, Vreede and D. L., Dean, Defining Key Concepts for Collaboration Engineering. 12th Americas Conference on Information Systems (pp. 1-10). Acapulco, Mexico: Technologica de Monterrey. (2006).
18. R. O., Briggs, G. J. de, Vreede and J. F. Jr. Nunamaker, Collaboration Engineering with ThinkLets to Pursue Sustained Success with Group Support Systems. Journal of Management Information Systems, 19, 31-64 (2003)
19. R. O., Briggs, G. J. de, Vreede, J. F. Jr. Nunamaker and D. Tobey, ThinkLets: Achieving Predictable, Repeatable, Patterns of Group Interaction with Group Support Systems. HICSS 34, 1057-1066. ISBN: 0-7695-0981-9 (2001).
20. R. O., Briggs and G. J. de. Vreede, ThinkLets – Building Blocks for Concerted Collaboration. Nebraska: Briggs and de Vreede (2009).
21. P. Sallant and D. A. Dillman, *How to Conduct your Own Survey* (John Wiley & Sons Inc, New York, 1994).
22. V. M., Sue and L. A. Ritter, *Conducting Online Surveys* (SAGE Publications, Calfonia, 2007)
23. M. Q. Patton, *Qualitative Evaluation and Research Methods* (SAGE Publications, Beverly Hills, 1980).
24. B. Nardi, *Context and Consciousness: Activity theory and Human Computer Interaction* (MIT Press Cambridge, Massachusetts, 1996).
25. R. G. Lomax, *An Introduction to Statistical Concepts for Education and Behavioral Sciences* (Lawrence erlbaum associates, New Jersey, 2001).
26. D. Mwanza and Y. Engestrom, Managing content in e-learning environments. Britisch Journal of Educational Technology, 36(3), 453 – 463.
27. L. Kish, *Survey Sampling* (John Wiley & Sons Inc, New York, 1965).
28. A. R. Hevner, S. T. March, J. Park and S. Ram: Design Science in Information Systems Research. MIS Quarterly, 28(1), 75-105. (2004).
29. H. A. Proper, S. J. B. A. Hoppenbrouwers and G. E. V. van Zanten: Communication of enterprise architectures, in *Enterprise Architecture at Work: Modeling, Communication and Analysis*, ed. M. Lankhorst (Springer, Germany, 2005), pp. 67-82.
30. P. Checkland, *Systems thinking, systems practice* (John Wiley & Sons Ltd, New York, 1999).
31. J. F. Jr. Nunamaker, R. O. Briggs, D. D. Mittleman, D. R. Vogel and P. A. Balthazard, Lessons from a dozen years of group support systems research: a discussion of lab and field findings. MIS, 13(3), 163 - 207. (1996).
32. J. Bragge, H. Merisalo-Rantanen, A. Nurmi and L. Tanner, A Repeatable E-Collaboration Process Based on ThinkLets for Multi-Organization Strategy Development. Group Decision and Negotiation, 16, 363-379. (2007).
33. M. Kamal, A. J. Davis, L. R. Pietron, J. Nabukenya, G. J. de Vreede and T. V. Schoonover, Collaboration Engineering For Incident Response Planning: Process Development and Validation. IEEE: HICCS. (2007).
34. G. L. Kolfschoten and G. J. de Vreede, The Collaboration Engineering Approach for Designing Collaboration Processes. Groupware: Design, Implementation, and Use. Lecture Notes in Computer Science: Vol. 4715. CRIWG (pp. 95-110). Berlin, Germany: Springer. (2007).
35. E.A.J.A. Rouwette and J.A.M. Vennix, System Dynamcis and Organisational Interventions. *Systems Research and Behavioral Science* **23** (2006) 451–466.

36. Government of the United States of America, Department of Commerce, Introduction – IT Architecture Capability Maturity Model. (2003) http://ocio.os.doc.gov/groups/public/doc/os/ocio/oitpp/documents/content/prod01_002340.pdf. Accessed Jan 13th 2011.
37. H.A. Simon, *The Sciences of Artificial* (MIT Press Cambridge, Massachusetts, 1996).
38. H.A. Simon, *The New Science of Management Decision* (Harper and Row, New York, 1960).
39. T. Hopkins, I. Whitford, M. Pidd and M. Winter, *Tutorial on Handling Strategic Problems: Methodologies – Soft Systems Methodology*, http://www.orsoc.org.uk. Accessed on March 1st 2011
40. G. Susman and R. Evered, An Assessment of The Scientific Merits of Action Research. *Administrative Science Quarterly* **23** (4) (1978) 582 – 603.
41. A. Nakakawa, P. van Bommel and H. A. Proper: Applying Soft Systems Methodology in Enterprise Architecture Creation. In: Nuttgens, M., Thomas, O., Weber, B. (eds.), Enterprise Modelling and Information Systems Architectures (EMISA), Hamburg, Germany. LNI vol. 190, pp. 37–50, GI (2011)
42. K. Ishikawa, *Guide to Quality Control*, 2nd Edn. (Asia Productivity Organization, Tokyo, 1986).
43. G.J. de Vreede, R. O. Briggs, A. P. Massey, Collaboration Engineering – Foundations and Opportunities. *Editorial to the Special Issue on the Journal of the Association of Information Systems* **10** (3) (2009) 121 – 137.
44. E. Turban, E.A. Jay, Decision Support Systems and Intelligent Systems. New Jersey, Prentice Hall (1998)
45. D.R. Anderson, D.J. Sweeney, T.A. Williams, Statistics for Business and Economics (11th edition). South-Western College Pub (2010)
46. J. Iivari, A Paradigmatic Analysis of IS as a Design Science. *Scandinavian Journal of Information Systems* **19** (2) (2007) 39–64.
47. R.A. Stebbins, Exploratory Research in the Social Sciences: What is Exploration? SAGE research methods. (2001) 1 – 19
48. H. Jonkers, M.M. Lankhorst, H.W. ter Doest, F. Arbab, H. Bosma, R.J. Wieringa, Enterprise architecture – Management tool and blueprint for the organisation. Information Systems Frontiers. 8(2), 63–66 (2006)
49. J. Conklin, Dialogue Mapping: Building Shared Understanding of Wicked Problems. Wiley (2005)
50. A.J. Davis, G.J. de Vreede, R.O. Briggs: Designing ThinkLets for Convergence. Proceedings of the 13th Americas Conference on Information Systems (AMCIS), Keystone, Colorado, pp. 359. Association for Information Systems (2007)
51. R.O. Briggs, G. Kolfschoten, G.J. de Vreede, C. Albrecht, D.R. Dean, A Seven Layer Model of Collaboration: Separation of Concerns for Designers of Collaboration Systems. 30th International Conference on Information Systems. Phoenix, Arizona, Association for Information Systems. 1–14 (2009)
52. G.L. Kolfschoten, R.O. Briggs, J.H. Appelman, G.J. de Vreede, ThinkLets as Building Blocks for Collaboration Processes: A Further Conceptualization. In: G.J. de Vreede, L.A. Querrero, G.M. Raventos (eds.), CRIWG 2004, San Carlos, Costa Rica. LNCS, vol. 3198, pp. 137–152. Springer (2004)
53. R. Baskerville, Investigating Information Systems with Action Research. Communications of the Association for Information Systems. 2(3), 1–32 (1999)
54. Wakiso District Council: Three Year Development Plan for Wakiso District (2008–2011). Wakiso District Local Government, Wakiso (2008).
55. H. Raiffa, J. Richardson, D. Metcalfe, Negotiation Analysis – The Science and Art of

Collaborative Decision Making. Harvard University Press, Cambridge (2002)
56. R.O. Briggs, B.A. Reinig, G.J. de Vreede: Meeting Satisfaction for Technology-Supported Groups: An Empirical Validation of a Goal-Attainment Model. Small Group Research. 37(6), 585–611 (2006)
57. M. Op 't Land, Applying Architecture and Ontology to the Splitting and Allying of Enterprises. PhD Thesis. Delft University of Technology. ISBN: 978-90-71382-32-1
58. D. Greefhorst, H.A.Proper: Architecture Principles – The Cornerstones of Enterprise Architecture. Springer (2011)

Appendix

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

Fig. 24. First Version of the Questionnaire for the Survey

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.

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) ……..

Fig. 25. Exploratory Questionnaire Survey (Page 1)

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) ……

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) …….

Fig. 26. Exploratory Questionnaire Survey (Page 2)

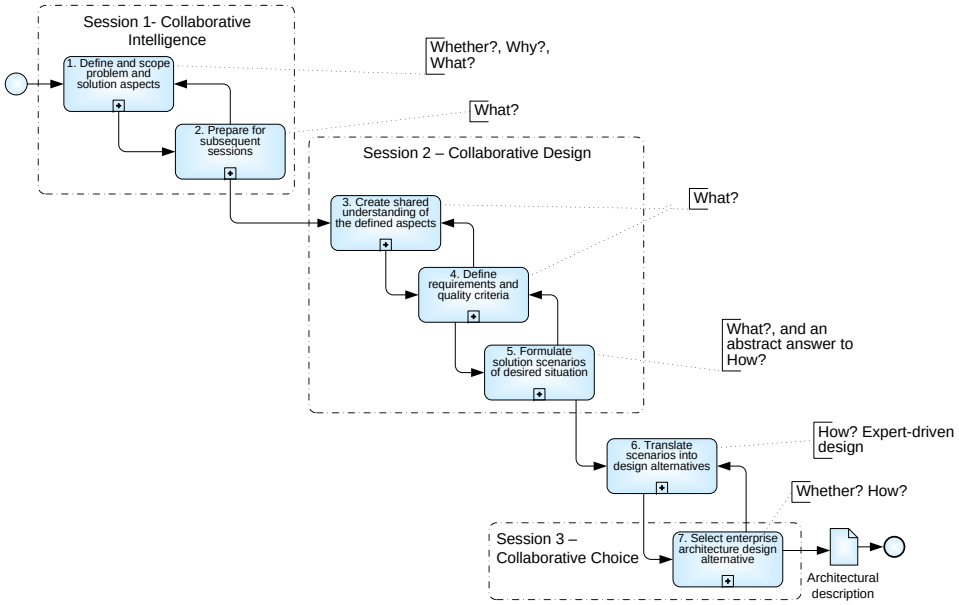

Fig. 27. CEADA sessions and their key activities (Source – Ref. 3)

Evaluation Questionnaire for the Session(s) of the CEADA Process

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	Respon se	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?

Fig. 28. Questionnaire that was used to evaluate CEADA sessions