On Supporting Collaborative Problem Solving in Enterprise Architecture Creation

Agnes Nakakawa[1], Patrick van Bommel[1], and H.A. Erik Proper[1,2]

[1] Institute of Computing and Information Sciences, Radboud University Nijmegen
P.O. Box 9010, 6500 GL Nijmegen, The Netherlands
[2] CITI, CRP Henri Tudor Luxembourg, Luxembourg
A.Nakakawa@science.ru.nl, pvb@cs.ru.nl, e.proper@acm.org

Abstract. Creating enterprise architecture can be perceived as a creative problem solving task, since it involves managing organizational complexity and inflexibility by devising a synergic solution from all organizational units. Creative (or collaborative) problem solving in several fields has been supported by supplementing domain specific techniques with functionalities of a Group Support System (GSS). This paper aims to demonstrate how GSSs can also be used to support collaborative problem solving in enterprise architecture creation. Using the Design Science research methodology, a method was designed to support collaborative problem solving during architecture creation. This method draws from enterprise architecture approaches that are used in practice, and collaborative problem solving theories in academia. It has been evaluated using an experiment and two real life cases. This paper presents findings from this evaluation. The findings were used to refine the method, and they indicate that the effectiveness of academia-based artifacts in addressing problems encountered in practice, can only be achieved through continuous and diverse evaluation of these artifacts in practice.

Keywords: Enterprise Architecture Creation, Collaborative Problem Solving.

1 Introduction

Alignment between an organization's business and IT strategies enables it to realize value (or improved business performance) from its IT investments [8]. However, this alignment is not enough, as there is need to align human, organizational, informational, and technological aspects of an organization [24]. Aligning all these aspects requires using enterprise architecture [29,24], or an integrated or multi perspective approach [15,36]. With enterprise architecture, an organization is able to manage the complexity and inflexibility of its business processes, information systems, and technology infrastructure [27]. Enterprise architecture addresses enterprise-wide integration [15]. Thus, creating enterprise architecture requires formulating a synergic solution from all organizational units. This synergy of the various capabilities in an organization enables it to acquire a sustainable competitive advantage [31].

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Creating enterprise architecture generally involves: creating a joint conceptualization of problems, strategies or solutions [24]; identifying and refining stakeholders' concerns and requirements; developing architecture views that show how these requirements will be addressed, trade-offs that need to be made to resolve any conflicts [35]; assessing alternatives; risk assessment and mitigation; making decisions [24]; and communicating the architecture [26,24]. On the other hand, collaborative problem solving (or decision making) involves: having direct and reciprocal communication (about the situation at hand) among parties involved; being creative in formulating solution strategies and new alternatives; making shared decisions; and reaping joint payoffs from the decisions made [28]. It can be noted that the enterprise architecture creation activities mentioned above, involve collaborative problem solving activities. Thus, enterprise architecture creation can be perceived as a collaborative (or creative) problem solving task. Collaboration of actors is faced with several challenges, e.g. lack of consensus, a poor grasp of the problem, ignored alternatives, groupthink, conflicts, digressions, distractions, hidden agendas, poor planning, wrong people, poorly defined goals, premature decisions, lack of focus, misunderstandings, fear of speaking, and waiting to speak while others are dominating [23]. These are the challenges one would certainly expect when executing enterprise architecture creation as a collaborative problem solving task.

However, despite the above difficulties, collaboration is still essential for solving complex problems since no single individual possesses all the prerequisites (i.e. experience, resources, information) for problem solving [3,23]. Several technologies are in place to support collaborative problem solving or collaborative work in general, e.g. Group Support Systems (GSSs), web conferencing, virtual work spaces, teleconferencing, videoconferencing, dataconferencing, web-based collaboration tools, e-mail, and proprietary groupware tools [3,25]. This paper aims to demonstrate how GSSs can be used to support collaborative problem solving in enterprise architecture creation.

Moreover, the paper also discusses the design and evaluation of a method that is being developed using the Design Science research methodology, to complement enterprise architecture approaches with GSS functionalities (and support for collaborative problem solving). Design Science is a research paradigm that is used to develop innovative artifacts (i.e. processes, methods, models, frameworks etc) that offer solutions to significant problems in industry [10]. This implies that Design Science encourages practice-driven research since according to Hevner et al. [9,10], problems encountered in the business environment (or in practice) are treated as the requirements of any Information Systems research (in academia) that is conducted using Design Science. This is why this methodology is suitable for this research. The evolving method focuses on supporting Collaborative Evaluation of (Enterprise) Architecture Design Alternatives (CEADA). The method is therefore referred to as CEADA, pronounced as 'Keda'. This artifact draws from enterprise architecture approaches used in industry and collaborative problem solving theories developed in academia.

The CEADA method was initially evaluated using an analytical approach (see [20,21]). It has been further evaluated using an experiment and two real cases. Findings from this evaluation have been used to refine the method. This paper reports these findings and the refined models that describe CEADA. The findings indicate that the relevance and effectiveness of academia-based artifacts in addressing problems encountered in practice, can only be achieved through continuous and diverse evaluation of these artifacts in practice.

The remainder of this paper is structured as follows. Section 2 discusses the need for collaborative problem solving in architecture creation, while section 3 discusses the extent to which GSSs can be used to address this need. Section 4 explains how Design Science is used in this research, while section 5 presents the design of CEADA before it was evaluated. Section 6 discusses the evaluation of CEADA using an experiment and 2 real cases, and presents the refined CEADA models, while section 7 concludes the paper.

2 Collaborative Problem Solving in Architecture Creation

Despite the numerous benefits of enterprise architecture, its value proposition and the role of an enterprise architect are not understood in organizations accustomed to reactive decision making [13]. Program managers of such organizations (or who are used to independently devising mission-specific solutions) perceive enterprise architecture as a "*hostile takeover*" and may resist its creation, for fear of the new language and planning processes associated with it [2]. However, it has been reported that involvement of organizational stakeholders during architecture creation, to ensure that their concerns are considered, helps to create stakeholders' commitment [12]. It has also been reported that increasing stakeholders' involvement in the architecture creation process implies increasing their control in the process, which along with strong executive sponsorship can overcome resistances of architecture creation [2].

Therefore, it is likely that co-creation of enterprise architecture (i.e. having architects and organizational stakeholders collaboratively define and specify the enterprise architecture without implementing it) is likely to positively influence the success rate of implementing the specified architecture. Although we take this assumption to be true, this research does not involve studying the longer term impact of co-creation on the success rate of the implementation of the architecture. Rather, it involves studying effective ways of achieving architecture co-creation, where we suppose that proper stakeholders' involvement in architecture creation (i.e. co-creation or creative/collaborative problem solving) can be achieved through effective and efficient collaboration between stakeholders and architects. This implies that collaboration is a core thread in enterprise architecture development. Therefore, enterprise architects need to have a standard way of successfully managing their collaboration with stakeholders, even in the absence of a professional facilitator. Thus, increasing stakeholders' involvement in architecture creation certainly demands for amendments in enterprise architecture approaches. It has even been advised that in architecture creation, in addition to choosing a suitable enterprise architecture framework/approach, there is need to choose supporting methods and techniques [31,35] for e.g. enabling collaborative problem solving involved in architecture creation.

This research is therefore motivated to offer enterprise architects with an approach that can be used to increase stakeholders' involvement (and control) during architecture creation, by enabling effective and efficient collaborative problem solving. Although this vision is yet to be fully achieved through continuous validation of our method, it indicates the relevance of this research in practice. Moreover, proper stakeholder involvement and getting more acceptance of architecture results, are the key drivers of this research.

3 Group Support Systems in Architecture Creation

A GSS is an "interactive computer-based environment which supports concerted and coordinated team effort towards completion of joint tasks" [23]. GSSs include: Problem Structured Methods (PSMs, also known as model-based traditions or model-driven approaches); and Electronic Meeting Systems (EMSs, also known as workstation approaches or technology based or technology-driven approaches) [30]. A PSM enables one to represent a given situation using a model(s) so that participants can be able "to clarify their predicament, converge on a potentially actionable mutual problem or issue within it, and agree commitments that will at least partially resolve it" [17]. On the other hand, an EMS supports task-oriented collaborative work in (face-to-face) meeting processes that involve problem solving, decision making, deliberation, generating alternatives, negotiation, consensus building, and planning [25].

Although PSMs focus on understanding a given problem context from the perspective of participants, a skilled facilitator has a mandatory role and evaluating the performance of PSMs is difficult because their support varies depending on the uniqueness of the situation at hand [30]. Yet collaborative problem solving (or collaborative work in general) may consist of a combination of several (unique but interrelated) meeting processes, and therefore requires support that is flexible enough to quickly and efficiently facilitate any process [25]. For example, the nature of collaborative problem solving involved in enterprise architecture creation varies across organizations, but involves all the types of meeting processes listed above. This calls for flexible facilitation support which can be offered by EMS technologies (e.g. GroupSystems, MeetingWorks, TeamFocus, VisionQuest, and Facilitate.com), since they are equipped with capabilities for increasing effectiveness and efficiency of, and user satisfaction with, group meetings [25]. This implies that the nature of collaborative problem solving in enterprise architecture creation can be best supported by EMSs.

However, EMSs or GSSs in general have not been widely adopted by organizations, despite their numerous benefits [4,25]. This is mainly because GSSs have a high conceptual load (i.e. one has to put in a lot of effort to understand the intended effect of GSS functionalities for the user), and so organizations resort to hiring or training professional facilitators in order to be able to successfully use the technology [4]. A sustainable way that enables organizations to benefit from GSSs functionalities is collaboration engineering, which involves developing collaborative processes that can be used to support recurring mission-critical tasks and can be executed by practitioners themselves [5,4]. Therefore, since this research focuses on achieving successful collaborative problem solving in architecture creation without overdependence on professional facilitators, collaboration engineering is the suitable approach to benefiting from GSS functionalities during architecture creation. Sections 4 and 5 explain the approach that is being used to achieve this.

4 Design Science Research Methodology

Design Science guides the creation of innovative artifacts (e.g. methods, processes, or models that are relevant to a given application domain) using existing scientific knowledge (i.e. frameworks, theories, methods etc), and the evaluation of those artifacts using observational, analytical, experimental, descriptive, and testing methods [10]. According to Hevner [9], Design Science begins with identifying problems in, or opportunities for improving, the application domain. The application domain therefore initiates research by providing business needs (or research requirements) and acceptance criteria that are used to evaluate the resultant artifact [10].

In this research, the identified problem in the application domain (as earlier reported in [19,20]) was the challenge of effectively supporting collaborative problem solving or decision making during enterprise architecture creation (see top left part of Fig. 1). Moreover, as Fig. 1 shows, the evolving artifact to address this problem (or business need) is the CEADA method. The contents of the theoretical knowledge base (i.e. scientific theories, frameworks, models, and

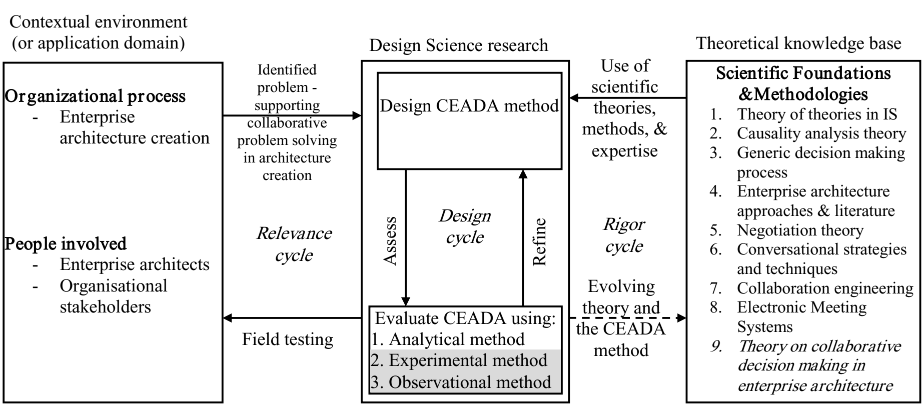

Fig. 1. Adapted Methodology - Design Science (based on [10] and [9])

methods) that were used to design CEADA are shown in the right part of Fig. 1. A discussion of how the contents of the theoretical knowledge base were adapted to design the CEADA method was earlier presented in [19,20,21,22], however section 5 gives a brief explanation of how the adaptation was done.

As shown in the middle part of Fig. 1, CEADA was designed and was first evaluated using an analytical method (i.e. structured walkthroughs) and findings were used to refine its design (see [20,21]). The design of CEADA was further evaluated using the experimental method (where a controlled experiment was used) and the observational method (where two real cases were used). This paper particularly reports the experimental and observational evaluation of CEADA.

According to Hevner et al. [10], observational design evaluation methods are: Case Study (i.e. conducting an in depth study of the designed artifact in a real business context); and Field Study (i.e. monitoring the use of the designed artifact in several projects). In this research, the Field Study method was used. Field Study evaluation of an artifact can be done using the action research method [9]. Action research, according to Susman and Evered [34], involves the following steps:

1. Diagnosing, i.e. identifying the main problem that is the root cause of the desire for change in an organization;
2. Action planning, i.e. specifying organizational actions that will address the main problem;
3. Action taking, which involves researchers collaborating with practitioners to implement the planned action so as to realize the desired changes in the organization;
4. Evaluating, which involves researchers and practitioners determining whether the theoretical effects of the action taken were realized;
5. Specifying learning, i.e. directing knowledge gained from the research (whether it was successful or not) to improve a theoretical framework or the organization's situation.

In action research, researchers actively participate with practitioners in the enquiry and change experiences involved in the research [1]. Since this was the first observational evaluation of CEADA, it was vital for the researchers to be actively involved in executing the method, before it could be evaluated in a setting where only practitioners are in charge of executing it. Action research was therefore the appropriate approach for undertaking the Field Study evaluation of CEADA. Details of how the above steps of action research were performed in this research are presented in section 6.3.

5 The CEADA Method

This section presents CEADA, its objectives, its design (i.e. components that address each objective), and its added value to the architecture approach. CEADA aims to enable collaborative problem solving to be successfully realized during enterprise architecture creation, even in the absence of a professional facilitator. It is designed using scientific knowledge i.e., the generic decision making theory [32], collaborative decision making (or negotiation) theory [28], the theory of theories in IS, casuality analysis theory [7], collaboration engineering [4,14], conversation strategies and techniques [26], enterprise architecture frameworks (particularly TOGAF [35]), literature on enterprise architecture creation, and the evolving theory on collaborative decision making in enterprise architecture creation [22]. An overview of how these theories apply to this research is given below.

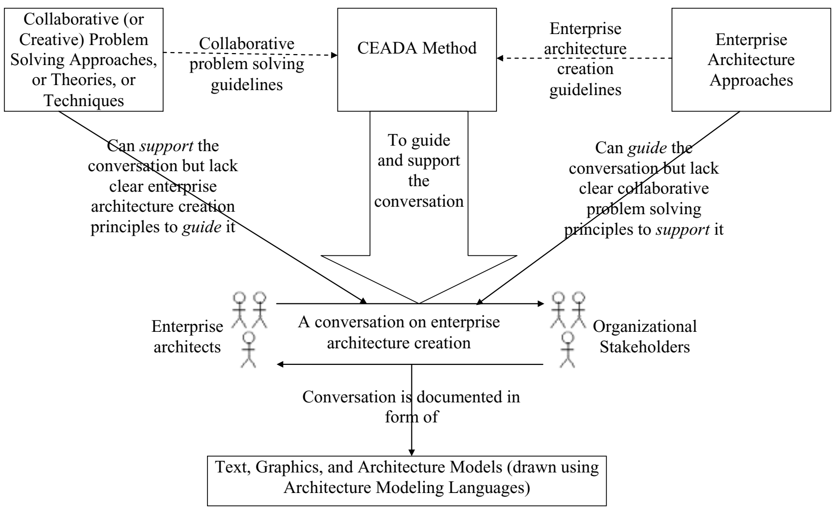

Fig. 2. The Added Value of CEADA to the Architecture Creation Methodology

Effective communication is essential for successful architecture creation among actors (i.e. stakeholders and enterprise architects) [22]. This communication can be perceived as a conversation [26], which in Fig. 2 we refer to as the architecture creation conversation. This conversation revolves about problem solving or decision making (as explained in section 2). Therefore, the conversation needs to be supported by the generic decision making process in [32]. Decision making in this conversation is collaborative in nature, since it includes stakeholders and architects. Therefore, the conversation needs to be supported by the collaborative decision making (or negotiation) theory in [28]. According to Simon [32] decision making involves studying the environment to identify the need for improvement/intervention (i.e. intelligence phase), devising possible decision alternatives (i.e. design phase), and choosing the most appropriate decision alternative (i.e. choice phase). Choosing a decision alternative involves assessing the possible decision alternatives and negotiating to agree on the most appropriate one. However, for negotiations to be successful there is need for effective collaboration among actors, which in turn creates a shared understanding among actors on the key issues in the conversation [22].

Fig. 2 justifies the need for a method that can: (1) support the conversation on enterprise architecture creation using collaborative decision making guidelines,

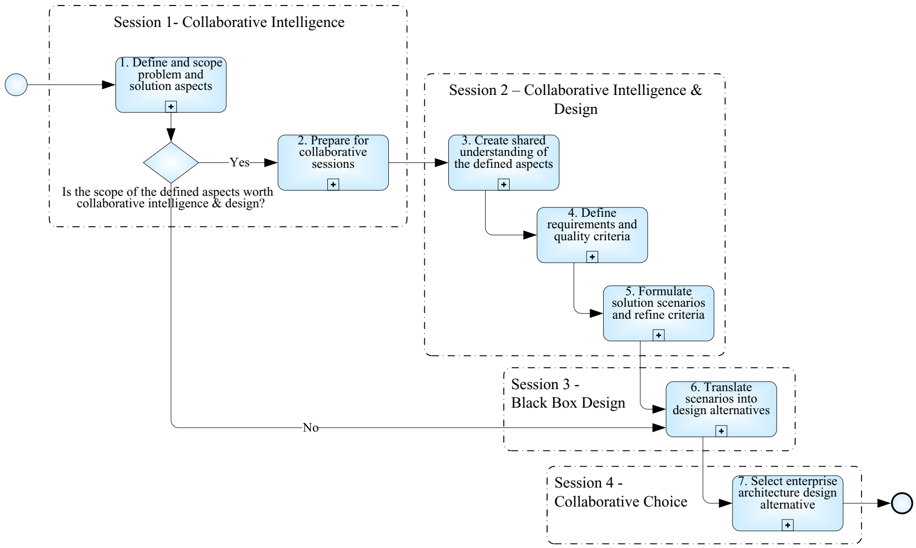

Fig. 3. Structure of the Architecture Creation Conversation

and (2) structure or guide the conversation using enterprise architecture creation guidelines. The latter are defined by The Open Group Architecture Framework (TOGAF) in [35] and the former can be realized by adapting (collaborative) decision making and other theories (see right part of figure 1) to suit architecture creation. Details of how this adaptation was done, to yield Fig. 3, were reported in [20,21,22], but in this section only a summary is given.

Fig. 3 shows the structural flow of the architecture creation conversation (which can also be perceived as the steps in, and requirements for, CEADA). It shows that the architecture creation conversation is divided into the following sessions.

1. *Collaborative intelligence session*, an adaptation of the intelligence phase (defined above) of the generic decision making process defined by Simon in [32]. It involves steps 1 and 2, i.e. define and scope problem and solution aspects and prepare for collaborative sessions with other stakeholders.
2. *Collaborative intelligence and design session*, an adaptation of Simon's intelligence and design phases. It involves steps 3, 4, and 5, i.e. create a shared understanding of the problem and solution aspects, define requirements and quality criteria, and formulate solution scenarios for the architecture.
3. *Black box design session*, an adaptation of Simon's design phase. It is essentially expert driven (involving enterprise architects only) and involves step 6, i.e. translate scenarios into enterprise architecture design alternatives.
4. *Collaborative choice session*, an adaptation of Simon's choice phase. It involves step 7, i.e. select a suitable (i.e. feasible, appropriate, and efficient) enterprise architecture design alternative. We consider an enterprise

architecture (or its design alternative) to be: appropriate if it is capable of addressing its planned purpose and realizing organization objectives; efficient if it addresses all stakeholders' concerns [24]; and feasible if it is achievable given the organization's resources.

The steps in Fig. 3 were decomposed to obtain the column labeled "activity description" in the design of CEADA that is shown in tables 1, 2, and 3. Collaboration engineering was then used to support the execution of the decomposed activities in the conversation.

Collaboration engineering approach (which was defined in section 3) introduces thinkLets, as building blocks for processes that can be executed by practitioners (in this case enterprise architects) to effectively manage collaborative recurring tasks, even in the absence of professional facilitators [14]. A thinkLet creates a pattern of thinking among people working toward a goal [5]. These patterns of thinking (or collaboration), according to Briggs et al. [5], include the following. (1) Generate (enables participants to move from having fewer concepts to more concepts that are shared by the group); (2) Reduce (enables participants to move from having many concepts to focus on fewer concepts that the group considers worthy of further attention); (3) Clarify (enables participants to move from having less to more shared understanding of concepts and phrases used to express them); (4) Organize (enables participants to move from less to more understanding of the relationships among concepts the group is considering); (5) Evaluate (enables participants to move from less to more understanding of the relative value of the concepts under consideration); and (6) Build consensus

Table 1. Design of Session 1 of CEADA

Session 1: Define and scope organization's problem and solution aspects (collaborative intelligence session)				
#	**Activity Description**	**Deliverable(s)**	**Pattern of collaboration**	**ThinkLet(s)**
1.1	Communicate purpose of the session and kind of information required from session	Guiding information	-	No ThinkLet required
1.2	Define basic information on business strategy, business objectives, and business requirements	Awareness of business strategy, objectives, and requirements	Generate, Reduce, Clarify	DealersChoice, FastFocus
1.3	Define organization's problem scope	Organization's problem scope		
	1.3.1 Identify aspects on the problem & its scope		Generate, Organize	OnePage, Concentration
	1.3.2 Agree on aspects of the problem & its scope		Build consensus	MoodRing
1.4	Identify external solution constraints (from e.g. regulatory authorities)	External constraints	Generate, Clarify	OnePage, FastFocus
1.5	Define purpose of the architecture effort	Purpose of the architecture effort		
	1.5.1 Generate ideas on purpose of architecture effort		Generate, Organize	OnePage, Concentration
	1.5.2 Agree on purpose of architecture effort		Build consensus	MoodRing
1.6	Define high level solution specifications	General solution specifications		
	1.6.1 Generate ideas on solution specifications		Generate	FreeBrainstorm
	1.6.2 Filer generated solution specifications		Reduce, Clarify	FastFocus
	1.6.3 Agree on solution specifications		Evaluate	StrawPoll, CrowBar
1.7	Seek shared understanding on the scope of the problem and its solution, and seek consensus on whether the scope of these aspects is worth a collaboration effort of organization key stakeholders	Understanding scope of problem and its solution, and appreciation of need for collaborative effort	Build Consensus	MoodRing
1.8	Select key stakeholders to participate in subsequent collaboration efforts with enterprise architects (and define their roles)	Other key stakeholders to collaborate with enterprise architects	Generate	No ThinkLet required
1.9	Reveal calendar of events, communicate the expectations of architect team, and find out stakeholders' expectations in the subsequent collaboration efforts during the architecture effort	Calendar of events and expectations of architects and stakeholders	-	

Table 2. Design of Session 2 of CEADA

Session 2: Seek shared understanding of problem and solution aspects, and define requirements & quality criteria (collaborative intelligence and design session)				
#	**Activity Description**	**Deliverable(s)**	**Pattern of collaboration**	**ThinkLet(s)**
2.1	Communicate the purpose of the session and kind of information required	Guiding information	-	No ThinkLet required
2.2	Stakeholders share their concerns about the problem and solution aspects	Stakeholders' concerns	Generate	LeafHopper
2.3	Categorize concerns by type and organization domains	Categories of stakeholders' concerns	Reduce, Clarify	Popcorn sort
2.4	Analyze and discuss concerns while seeking a shared understanding of the problem and solution aspects	Shared understanding of problem & solution aspects, refined concerns	Organize	BucketWalk, BucketBriefing
2.5	Validate stakeholders' concerns	Valid concerns	Evaluate	StrawPoll
2.6	Agree on amendments to problem and solution aspects (i.e. the as-is and to-be situation)	Refined problem and solution aspects	Build Consensus	StrawPoll, Red-Light-Green-Light
2.7	Brainstorm on requirements, based on valid stakeholder's concerns, that the architecture must address	Requirements for the architecture	Generate	Free-Brainstorm
2.8	Validate requirements for the architecture	Valid requirements	Reduce, Clarify, Organize	Popcorn sort
2.9	Agree on requirements for the architecture	Consensus on architecture requirements	Evaluate, Build Consensus	StrawPoll, BucketWalk
2.10	Brainstorm on business, governance, & operational quality criteria for evaluating design alternatives	Business, governance, & operational quality criteria	Generate	Free-Brainstorm
2.11	Validate quality criteria	Valid quality criteria	Reduce, Clarify, Organize	Popcorn sort
2.12	Agree on (business, governance, & operational) quality criteria	Consensus on quality criteria	Evaluate, Build Consensus	StrawPoll, BucketWalk
Session Break				
2.13	Communicate purpose of session and kind of information required	Guiding information	-	No ThinkLet required
2.14	Brainstorm on types of solution scenarios to be formulated	Required types of solution scenarios	Generate	Free-Brainstorm
2.15	Identify components of a solution scenario	Components of solution scenarios	Generate	Comparative Brainstorm
2.16	Assemble components of solution scenarios	Solution scenarios	Generate, Organise	Could-Be-Should-Be, BranchBuilder
2.17	Refine (business, governance, & operational) quality criteria	Detailed quality criteria	Clarify, Build Consensus	BucketWalk, Red-Light-Green-Light

Table 3. Design of Sessions 3 and 4 of CEADA

Session 3: Translate solution scenarios into architecture design alternatives (black box design session)				
Session 4: Select suitable enterprise architecture design alternative (collaborative choice session)				
#	**Activity Description**	**Deliverable(s)**	**Pattern of collaboration**	**ThinkLet(s)**
4.1	Communicate purpose of session and kind of information required	Guiding information	-	No ThinkLet required
4.2	Explain positive and negative implications of analyzed design alternatives to stakeholders	Positive and negative implications of the enterprise architecture design alternatives	-	
4.3	Seek shared understanding (among stakeholders) on the implications of the analyzed design alternatives	Shared understanding on relevant information for making the final decision	Evaluate	StrawPoll, CrowBar
4.4	Select feasible, appropriate, & efficient design alternative (using the quality criteria from sessions 1 and 2)	Consensus on feasible, appropriate, & efficient design alternative	Evaluate, Build Consensus	MultiCriteria, Red-Light-Green-Light

(enables participants to move from having fewer to more group members willing to commit to a proposal).

According to Kolfschoten and Vreede [14], a collaboration processes (that enables participants to undergo the above patterns of thinking) is designed using the following procedure. (1) Task diagnosis (which involves defining the goal and deliverables of the collaboration process); (2) task decomposition (which involves defining the basic activities for achieving the defined goal and deliverables); (3) ThinkLet choice (which involves using some criteria to assign each basic activity a suitable thinkLet that will guide its completion); (4) agenda building (which involves assembling the activities and their corresponding patterns of thinking as well as thinkLets so as to validate the process); (5) design validation and evaluation; and (6) documentation. In [20], it is reported how this procedure was applied in this research to obtain the design of CEADA presented in tables 1, 2, and 3.

6 Performance Evaluation of CEADA

This section reports the evaluation of the design and performance of CEADA in an experimental setting and in a real business setting. In this evaluation, CEADA was used along with TOGAF, Business Process Modeling Notation (BPMN), and ArchiMate modeling concepts to create only the architecture vision for each case.

6.1 Criteria for Evaluating the Performance of CEADA

The criteria for evaluating the performance of CEADA were derived from: the theory of collaborative decision making into architecture creation (see [22]); the requirements for deploying collaborative decision making into architecture creation (see [21]); and from the issues discussed in sections 2 and 3. The criteria are classified into effectiveness and efficiency. Effectiveness in this case refers to the ability of CEADA to support the following.

1. Creation of a shared understanding of the organization's problem and solution aspects among stakeholders and architects;
2. Creation of stakeholders' commitment towards the success of architecture creation;
3. Explicit description and agreement on the requirements, quality criteria, and solution scenarios that the architecture must address; and
4. Selection and agreement on a suitable enterprise architecture design alternative.

Efficiency criterion in this case refers to the ability of CEADA to satisfy criteria 1 - 4 above in the shortest possible time. The performance of CEADA under criteria 1 – 4 above was measured by the following indicators.

1. Shared understanding among stakeholders was measured by the level of consensus among stakeholders on concerns and requirements that the architecture must address;
2. Stakeholders' commitment was measured by stakeholders' dedication to accomplishing the activities in the CEADA method;
3. Agreement on requirements, quality criteria, and solution scenarios was measured by the level of consensus among stakeholders on these;
4. Selection of (and agreement on) the suitable design alternative was measured by the level of consensus on a chosen design alternative.

The level of consensus (in indicators 1, 3, and 4 above) was measured by the standard deviation of the priorities or weights that stakeholders assign to the items of interest in a given session. Data on the evaluation of CEADA was gathered using questionnaires, observation, and GSS data logs. Questionnaires were filled by all participants and observation of the execution environment of CEADA was done by the researchers. Meetingworks^{TM} was the GSS technology that was used to support the execution of CEADA. Stakeholders' dedication in indicator 2 above was measured by their attendance, participation, and enthusiasm in the collaborative sessions.

6.2 Experimental Evaluation of CEADA

In Design Science, prior to evaluating an artifact using real case studies, an experimental evaluation of the artifact is vital [11]. CEADA therefore was experimentally evaluated before it was evaluated using real cases. Experimental evaluation involves studying the usability qualities of a designed artifact in a controlled environment, and executing it with artificial data [10]. As discussed in section 4, the experimental evaluation of CEADA was implemented using action research.

In the experiment, the following steps of action research defined by Susman and Evered [34] (see section 4) were undertaken. At diagnosing step, a fictitious organization was chosen, whose main challenge was implementing its strategy of expanding from a national University to a networked European University. At action planning step, it was determined that the national university had to develop an enterprise architecture for the networked European university. The enterprise architecture would then guide and inform the transformation from a national university to a networked European university. Thus, the purpose of CEADA in experiment was to support collaborative creation of the enterprise architecture vision of the networked European university. At Action taking step, CEADA was used to support the architecture creation conversation in experiment. At evaluating step, the design and performance of CEADA were evaluated by the participants (who played the role of stakeholders in the national university) and the researchers. At the step of specifying learning, lessons learned from this evaluation have been used to improve CEADA.

Experiment Setup and Execution. In the experiment an example case was used and participants were 26 students undertaking the course of Information Architecture at Radboud University Nijmegen (The Netherlands). The experiment theme was to create an (enterprise) architecture for the education and examination institute of a networked European university. The architecture of this institute was to include the required business/operational processes, data flows, application systems, and technology infrastructure. Participants were divided into enterprise architects and stakeholders. The stakeholders were further divided into 6 groups, where each group took up any of the following roles: director, educational coordinator, lecturer, administrative staff, IT technical staff, and the students' representative.

Three collaborative sessions, each with a duration of 2 hours, were conducted supported by the design of CEADA shown in tables 2 and 3. The first session aimed at enabling participants to acquire a shared understanding of the problem and solution aspects involved in creating the architecture of the institute; and define the concerns, requirements, and quality criteria that must be addressed by the architecture. The second session aimed at enabling participants to formulate solution scenarios that the architecture must address. These scenarios were then used by participants playing the architects' role to create three possible architecture design alternatives. The third session aimed at enabling participants to select and agree on the suitable architecture design alternative of the institute. In the three sessions researchers played the role of facilitator and observer.

Results From the Experiment. The results in table 4 were obtained from the questionnaires that were used to gather data on the evaluation of the performance of CEADA in the experiment. This questionnaire survey approach to measuring participants' satisfaction with a collaboration process and its outcome was introduced by Briggs et al. [3]. In these questionnaires, we used the 5 point Likert scale questions, with responses ranging from strongly disagree (point 1) to strongly agree (point 5).

Lessons Learned From the Experiment. During the collaborative sessions all participants playing the stakeholders' role worked in one group when executing activities shown in tables 2 and 3. This immensely affected the level of consensus among stakeholders on: the requirements and solution scenarios that the architecture had to address; and on the suitable architecture design alternative. Moreover, from the questionnaires filled by participants it was noted that some stakeholders did not understand how their concerns and requirements were catered for in the three architecture design alternatives that the architects had designed (see table 4). Other stakeholders felt that their concerns were not addressed at all.

On reflecting upon how these issues could have been avoided, it was noted that when executing some activities in the collaborative sessions, participants or stakeholders would have been divided to work in small groups formed based on their specialization area. The activities that required stakeholders to be divided in small groups are 2.2, 2.3, 2.7, 2.8, 2.10, 2.11, 2.14 – 2.16, and 4.2 – 4.4

Table 4. Performance Evaluation of CEADA in the Experiment

#	Evaluation Criteria for CEADA	Indicator	
		Mean score	Standard deviation of scores
1	Satisfaction with the activities done in the collaborative sessions	2.00	0.88
2	Satisfaction with the outcome(s) of the collaborative sessions	2.05	0.91
3	Collaborative sessions helped to increase understanding of the concerns and requirements of all units in the organisation	3.89	0.94
4	Collaborative sessions helped stakeholders to freely express their views about the current operations in the organisation	3.53	1.22
5	Collaborative sessions helped stakeholders to understand why some of their concerns/views were not chosen/voted by others during the sessions	3.11	1.05

(see tables 2 and 3). This is because it was noted that stakeholders from a given specialization/unit would assign high priorities to concerns and requirements that pertain to their unit and then assign low priorities to those from other units. This is why when evaluating architecture requirements and design alternatives, results indicated that there was a low level of consensus on the concerns, requirements, and the design alternative that was chosen. Thus, the division of stakeholders into small groups during the execution of these activities will enable them to explicitly define and quickly reach consensus on the requirements of a given unit. Moreover, during the selection of architecture design alternatives (i.e. activities 4.2 – 4.4 in table 3), there was a need for architects to first explain the architecture to the small groups of stakeholders such that each stakeholder sub group can gain a shared understanding of how their concerns are addressed in the architecture viewpoint that pertains to them.

Furthermore, it was observed that at the completion of an activity that requires division of stakeholders, they can all meet together (in a short plenary session) to identify any overlapping requirements or ambiguities; and to acquire an understanding of requirements from other units or stakeholder subgroups. Lastly, activity 2.6 (see table 2) was a repetition of activity 2.5, it was therefore deleted. These lessons learned from the experiment were used to refine the design of CEADA, which was further evaluated as discussed below.

6.3 Field Study Evaluation of CEADA

As discussed in section 4, Field Study as a design evaluation method was used, and was implemented using action research. Since Case Study can be used to describe a unit of analysis (such as an organization) or a qualitative research method [18], Case Study as used in this section refers to the organization in which CEADA was evaluated, but not a qualitative research method.

Case Study 1: Nsambya Home Care (NHC). This is a donor funded organization whose mission is to offer free services to HIV positive patients in Uganda. It has the following units.

1. Medical unit, which is divided into the HIV medical unit – that clinically monitors HIV positive patients; and the Tuberculosis (TB) unit – a referral TB unit in Uganda, that treats TB patients and finds out how many of them are actually HIV positive.
2. Pharmacy unit, which dispenses prescribed drugs to patients and manages stock and orders of drugs.
3. Laboratory unit, which monitors laboratory investigations for patients.
4. Psychosocial unit, which manages relations between NHC and its patients, listens to patients' social and psychological issues, counsels, and sensitizes patients on the do's and don'ts of HIV.
5. Finance and administration unit, which manages incomes and expenditures, and oversees pharmacy, laboratory, and psychosocial units.

6. Monitoring and evaluation (or data) unit, which assembles and tracks all activities in NHC, collects reports from all units, compiles them and sends them to the right destinations. This unit reports to the assistant coordinator of NHC, who oversees the implementation of planned activities. NHC currently has a LAN which has 3 data servers and a few computers that are used in the pharmacy, laboratory, finance, cash office, and data units. The computers are mainly networked for Internet usage only.

In NHC, the following steps of action research defined by Susman and Evered [34] (see section 4) were undertaken. At diagnosing step, it was discovered that the main challenge NHC was facing is the hectic and time consuming process of capturing and retrieving records or data when compiling reports for the donors. At action planning step, it was determined that NHC has to refine its operational flow in order to ensure effective and efficient data capturing, retrieval, sharing, storage, and reporting. The best way to achieve this was through developing an enterprise architecture (vision) that would guide and inform the desired transformation in NHC. Consequently, the purpose of CEADA in NHC was to support collaborative creation of the enterprise architecture vision of NHC. At Action taking step, CEADA was used to support the architecture creation conversation in NHC. At evaluating step, the design and performance of CEADA were evaluated by the stakeholders and the researchers. The effects of the architecture that was created will only be determined after the architecture is implemented. However, architecture implementation is beyond the scope of this research. At the step of specifying learning, lessons learned from this evaluation have been used to improve CEADA. Moreover, after the architecture that was created is implemented, NHC's problematic situation will be addressed.

Results From Case Study 1. CEADA was used to support the architecture creation conversation in NHC, which involved 13 stakeholders (where 5 were from the data unit, 5 were from the pharmacy unit, and 3 were from the psychosocial unit). Table 5 summarizes the performance of CEADA under criteria 1, 3, and 4 of effectiveness that were explained in section 6.1.

The results in table 5 were obtained from the questionnaires that were used to gather data on the evaluation of the performance of CEADA in NHC. Like in the experiment, these questionnaires had the 5 point Likert scale questions, with responses ranging from strongly disagree (point 1) to strongly agree (point 5).

Table 5. Performance Evaluation of CEADA in NHC

#	Evaluation Criteria for CEADA	Indicator	
		Mean score	Standard deviation of scores
1	Satisfaction with the activities done in the collaborative sessions	4.20	0.42
2	Satisfaction with the outcome(s) of the collaborative sessions	4.20	0.42
3	Collaborative sessions helped to increase understanding of the concerns and requirements of all units in the organisation	4.50	0.53
4	Collaborative sessions helped stakeholders to freely express their views about the current operations in the organisation	4.50	0.53
5	Collaborative sessions helped stakeholders to understand why some of their concerns/views were not chosen/voted by others during the sessions	3.30	1.25

The business, data, applications and technology architecture models that constitute the selected design alternative for the architecture vision of NHC, and some photos of the group sessions are shown in Fig. 4, 5, and 6.

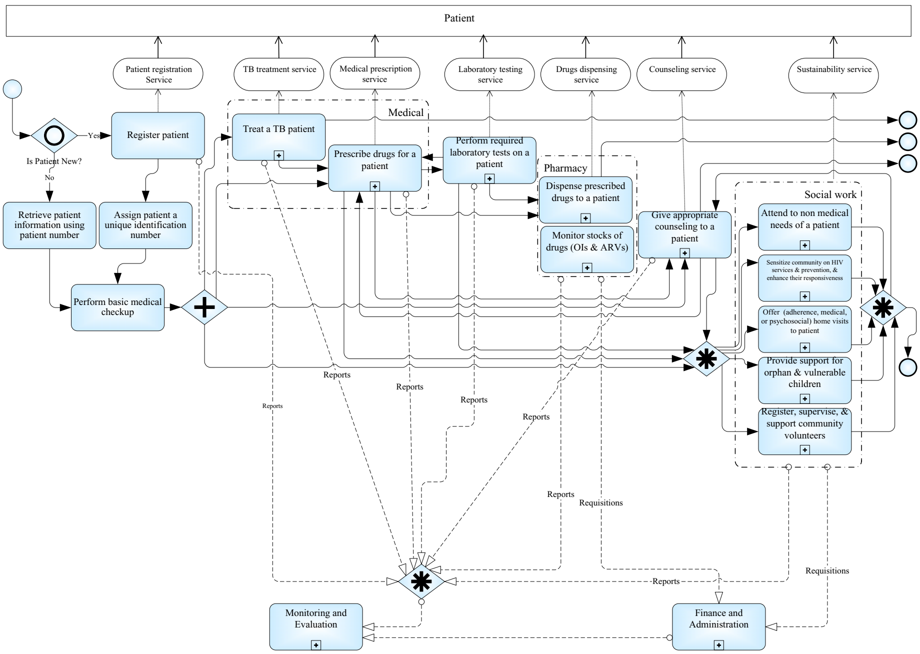

Fig. 4. Architecture Vision - Processes in NHC

Refinement of CEADA Using Lessons Learned From Case Study 1. In NHC, activities 1.1 – 1.8 in session 1 of CEADA (see table 1) did not require support from a GSS, instead they were executed using interviews with an executive member. This implies that, in practice, session 1 can be executed as a "collaborative intelligence session" or "intelligence interview session" (see figure 7). The latter means that in the architecture creation conversation, one well informed stakeholder represents others (to define and scope the organization's problem and desired solution), and the former means that several stakeholders have to be involved in this session of the conversation. If session 1 has to be executed as a collaborative intelligence session, then there is need for support from a GSS. Note that if session 1 has to be executed as an intelligence interview session, this does not affect the performance of CEADA, since the problem and solution aspects defined in session 1 are refined and elaborated by all key stakeholders in session 2. Furthermore, the division of stakeholders into small groups (as a lesson learned from the experiment) enabled session 2 to be successful,

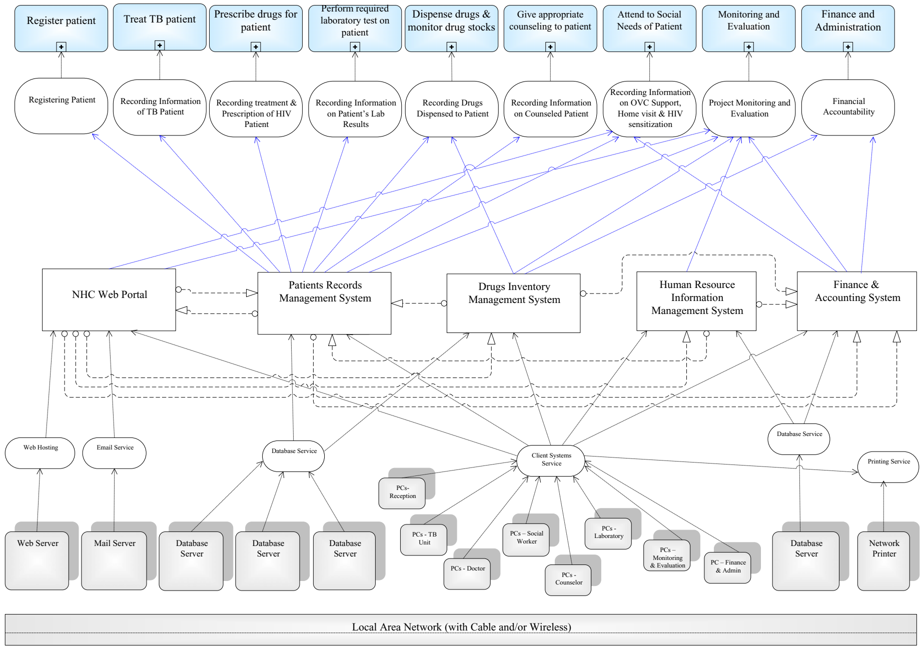

Fig. 5. Architecture Vision - Processes, Application Systems, and Technology in NHC

Fig. 6. Group Session Scenes

in the sense that stakeholders quickly reached a high level of consensus on the requirements that the architecture had to address.

In NHC, it was noted that enterprise architecture design alternatives can be divided into 2 levels, i.e. organization wide level and departmental/unit level architecture design alternatives. Organization wide architecture design alternatives involve considering, e.g., whether a given business process in a given department can be outsourced or not, or whether two/more departments or business processes can be merged into one. For NHC examples of organization wide architecture design alternatives include the following.

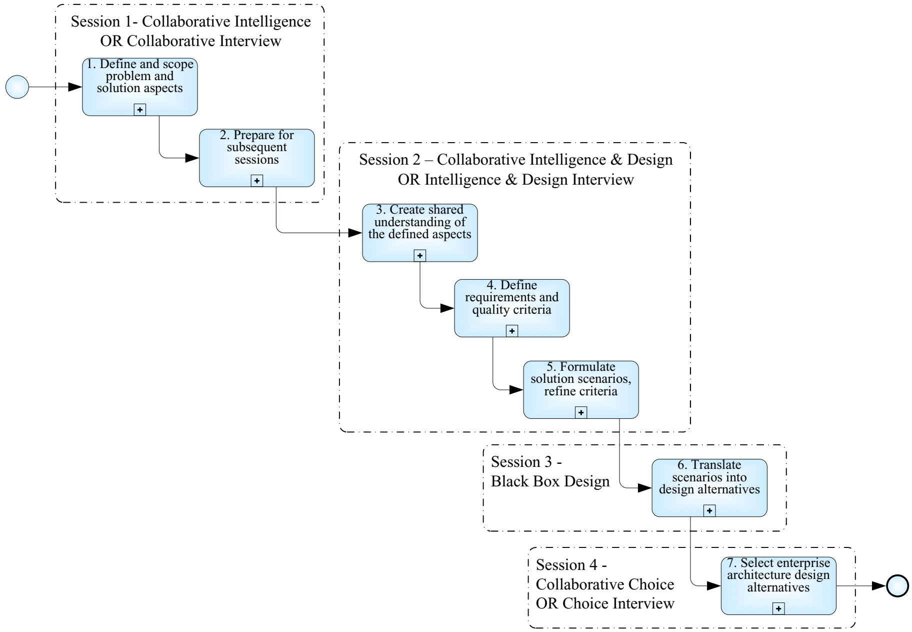

Fig. 7. Refined Structure of the Architecture Creation Conversation

1. Excluding the operational processes of the TB unit from the NHC architecture since the TB patients are treated separately from the HIV positive patients, in terms of medical prescriptions and geographical proximity of the TB unit to other NHC units.
2. Including all operational processes in NHC in the architecture (as shown in figures 4 and 5).
3. Avoiding the risk of unauthorized users hacking into the patient's records management system, by not connecting it to the NHC web portal. The limitation of this alternative was that the patient's records management system could then not be accessed by the staff who offer home visiting services or treatment to patients.
4. Connecting the patient's records management system to the web portal and ensuring high quality security and authentication measures (which definitely has financial implications).

Departmental/unit level architecture design alternatives represent different ways in which things can be done within a given unit to achieve effectiveness. The organization board may not be very relevant at this level, provided the chosen way of operation in a given unit is within the policies of the organization. For NHC, examples of unit level architecture design alternatives include the following. (1) Having a new or improved format of forms for capturing patient data into the patient records management system rather than the format of the existing paper based forms that are currently being frequently forwarded to the data unit for data entry. (2) Retaining the format of the existing paper based forms and simply using the same forms to capture patient data into the patient's records management system.

The two levels of design alternatives explained above, justify the need for stakeholders to be divided into small groups (based on their specialization) when formulating solution scenarios and evaluating architecture design alternatives (i.e. activities 2.14 – 2.16, and 4.2 – 4.4 in tables 2 and 3). Furthermore, the two levels of architecture design alternatives indicate that activities in session 4 (see table 3) have to be further decomposed so that evaluation of design alternatives is done at two levels.

It was also noted that when formulating solution scenarios (i.e. activities 2.14 – 2.16 in table 2), there is limited use of GSS in CEADA. What was required was more hands on and negotiation rather than GSS usage. This is because when executing these activities stakeholders don't see the need for punching their ideas into the GSS. They instead simply start sketching out what they mean rather than to describe it. The main use of GSS in activities 2.14 – 2.16 then remains to store comments or remarks made during these activities, so that they can be discussed by the group.

It was also noted that there is a need to identify a suitable negotiation model to improve the negotiation process required when executing activities 2.5, 2.8, 2.11, 2.14, 2.15, 4.4, and 4.5 (in tables 6 and 7) of the collaborative sessions. This is because thinkLets alone were not enough to fully support the negotiation required

Table 6. Refined Design of Session 2 of CEADA

Session 2: Seek shared understanding of problem and solution aspects, and define requirements & quality criteria (collaborative intelligence and design session)				
#	**Activity Description**	**Arrangement of stakeholders**	**Pattern of collaboration**	**ThinkLet(s)**
2.1	Communicate the purpose of the session and kind of information required	All	-	-
2.2	Stakeholders share their concerns about the organizational problem and solution aspects	Divide based on specialization	Generate	LeafHopper
2.3	Categorize concerns by type and organization domains/units/departments	Divide based on specialization	Reduce, Clarify	Popcorn sort
2.4	Analyze and discuss concerns while seeking a shared understanding of all problem and solution aspects	All	Organize	BucketWalk, BucketBriefing
2.5	Validate stakeholders' concerns	All	Evaluate, Build Consensus. Need for in-depth negotiation	StrawPoll, Red-Light-Green-Light
2.6	Based on the valid stakeholders' concerns, brainstorm on (business) requirements that the architecture must address	Divide based on specialization	Generate	Free-Brainstorm
2.7	Categorize and discuss requirements for the architecture	Divide based on specialization	Reduce, Clarify, Organize	Popcorn sort
2.8	Validate and agree on requirements for the architecture	All	Evaluate, Build Consensus Need for in-depth negotiation	StrawPoll, BucketWalk
2.9	Brainstorm on business, governance, & operational quality criteria for evaluating design alternatives	Divide based on specialization	Generate	Free-Brainstorm
2.10	Categorize and discuss quality criteria	Divide based on specialization	Reduce, Clarify, Organize	Popcorn sort
2.11	Validate and agree on (business, governance, & operational) quality criteria	All	Evaluate, Build Consensus Need for in-depth negotiation	StrawPoll, BucketWalk
Session Break				
2.12	Communicate purpose of session and kind of information required	All	-	-
2.13	Brainstorm, clarify, & agree on the possible organization wide solution scenarios that address the organization wide concerns and requirements	All	Generate, organize, Build Consensus Need for in-depth negotiation	Free-Brainstorm, Could-Be-Should-Be, BranchBuilder
2.14	Brainstorm, clarify, & agree on the possible departmental/unit level solution scenarios that address the unit specific concerns and requirements	Divide based on specialization	Generate, organize, Build Consensus Need for in-depth negotiation	Comparative Brainstorm, Could-Be-Should-Be, BranchBuilder
2.15	Evaluate all unit specific solution scenarios in context of the organization wide solution scenario that was chosen in 2.13	All	Organize, Build Consensus Need for in-depth negotiation	Could-Be-Should-Be, BranchBuilder
2.16	Refine (business, governance, & operational) quality criteria based on the formulated solution scenarios	All	Clarify, Build Consensus	BucketWalk, Red-Light-Green-Light

Table 7. Refined Design of Sessions 3 and 4 of CEADA

Session 3: Translate solution scenarios into architecture design alternatives (black box design session)				
Session 4: Select suitable enterprise architecture design alternative (collaborative choice session)				
#	**Activity Description**	**Arrangement of stakeholders**	**Pattern of collaboration**	**ThinkLet(s)**
4.1	Communicate purpose of session and kind of information required	All	-	-
4.2	Explain the architecture design alternatives for each unit specific solution scenario, and the positive and negative implications of each alternative, to only the group of stakeholders who are affected by a given solution scenario	Divide based on specialization	-	-
4.3	Seek shared understanding (among stakeholders in each small group/unit) of the implications of each architecture design alternative of each unit specific solution scenario	Divide based on specialization	Evaluate	StrawPoll, CrowBar
4.4	Choose a suitable architecture design alternative for each unit in the organization	Divide based on specialization	Evaluate, Build Consensus Need for in-depth negotiation	MultiCriteria, Red-Light-Green-Light
4.5	Assess and discuss the compatibility of all the chosen architecture design alternatives for all unit specific solution scenarios	All	Need for in-depth negotiation	-
4.6	Choose the suitable (i.e. feasible, appropriate, and efficient) enterprise architecture design alternative	All	Evaluate, Build Consensus	MultiCriteria, Red-Light-Green-Light

when executing those mentioned activities. This explains why results in table 5 indicate that the majority of the stakeholders were not sure whether they understood why some of their concerns were not chosen by others during the collaborative sessions (see the last 3 rows in table 5). All findings from Case Study 1 were used to refine the design of CEADA as shown in Fig. 7 and tables 6 and 7.

Case Study 2: Makerere University Guest House (MUKGH). This offers hotel services to the Makerere University community, to the guests visiting the University, and to the general public. The mission of MUKGH is to offer the most distinguished and customer responsive services that ensure repeat customers and loyalty. The vision of MUKGH is to become the most preferred referral guest house in Kampala city (Uganda). MUKGH has defined strategic business objectives that it will strive to achieve in its efforts to serve its clientele. Its financial business objectives include: increasing gross revenue by 50% by 2011; increasing the profit margin to 25% by 2011; increasing revenues in the medium term plan by four fold by 2016; and increasing the room occupancy to 95%. Its service delivery business objectives include: improving the quality of its products and services to competitive standards; improving the efficiency and effectiveness in the operations of the business; upgrading to a 100 room 3 star hotel by 2016, automating its booking system; and implementing an internship program that will enable the university to tap into the large student pool.

Like in Case Study 1, the following steps of action research defined by Susman and Evered [34] were undertaken in MUKGH. At diagnosing step, it was discovered that the main challenge MUKGH was facing is the lack of the basic infrastructure and management to deliver the quality service desired by her clients. At action planning step, it was determined that MUKGH has to address this issue by tapping into its unexploited potential through pursuing the following strategic goals. (1) Upgrading to a 3-star hotel in order to provide quality services and increase its customer base. This will entail restructuring of the current facilities and the way of working, so as to meet the minimum industry requirements and market demands. (2) Improving business efficiency and effectiveness through adoption of modern hospitality business management practices. (3) Product and service diversification. The best way for MUKGH to achieve its strategic goals was through developing an enterprise architecture (vision) that would guide and inform its desired transformations. Therefore, the purpose of CEADA in MUKGH was to support collaborative creation of the enterprise architecture vision of MUKGH. At Action taking step, CEADA was used to support the architecture creation conversation in MUKGH. At evaluating step, the design and performance of CEADA were evaluated by the stakeholder who participated in the conversation and the researchers. At the step of specifying learning, the lessons learned from the evaluating step have been used to refine CEADA. The problem in MUKGH will be addressed after the architecture that was created is implemented.

Results From Case Study 2. In MUKGH, session 1 of CEADA was also supported by interviews (where the manager represented all other key stakeholders) to define the problem and solution aspects. In other words, it was executed as an intelligence interview session (which is explained under lessons learned from Case Study 1). On completing session 1, a situational application of CEADA was encountered. This situational application is indicated by a gateway after step 1 of CEADA (see Fig. 3 in section 5). The "no" arrow in this gateway means that in a situation where the scope of the problem and solution aspects does not require a collaborative intelligence and design session, architects are to design the architecture in a black box session. However, for MUKGH, a collaborative intelligence and design session was not necessary not because of the scope of the problem and solution aspects, but due to political and operational issues that cannot be discussed here due to confidentiality reasons. Therefore, although collaborative intelligence and design may not be necessary, there is still need for architects to collaborate with at least one of the well informed stakeholders. Thus, there was need to refine the structure of the conversation to indicate that the "no" arrow in the gateway means that in some situations, there might not be need to execute session 2 as "collaborative intelligence and design", but rather as "intelligence and design interview session". Similarly, in some situations (like in MUKGH) session 4 can also be executed as a "choice interview session" rather than a "collaborative choice session". Fig. 7 shows these refinements in the structure of the collaborative architecture creation conversation. The business, data, applications and technology architecture models that constitute the selected design alternative for the enterprise architecture vision of MUKGH are shown in Fig. 8, 9, and 10.

Refinement of CEADA Using Lessons Learned From Case Study 2. The two levels of architecture design alternatives that were identified in Case Study 1 (i.e. organization wide architecture design alternatives and departmental level architecture design alternatives) were also identified in Case Study 2. This confirmed that there was need to cater for the two types of architecture design alternatives in the design of CEADA. This refinement was made in activities 2.13 – 2.15 in table 6. All findings from Case Study 2 (as discussed above) were used to refine the design of CEADA as shown in Fig. 7 and tables 6 and 7.

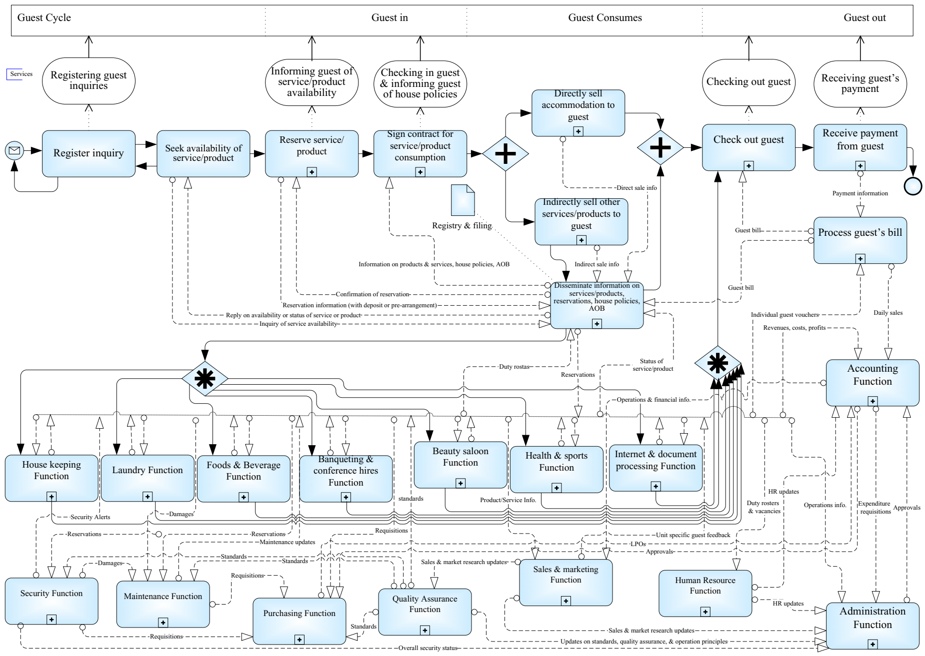

Fig. 8. Architecture Vision - Processes in MUKGH

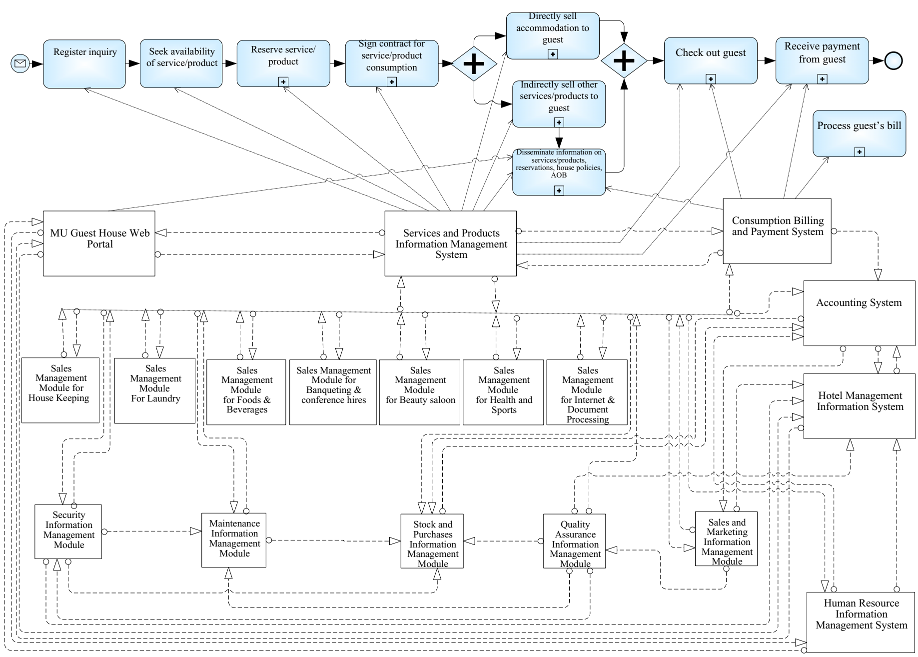

Fig. 9. Architecture Vision - Processes and Application Systems in MUKGH

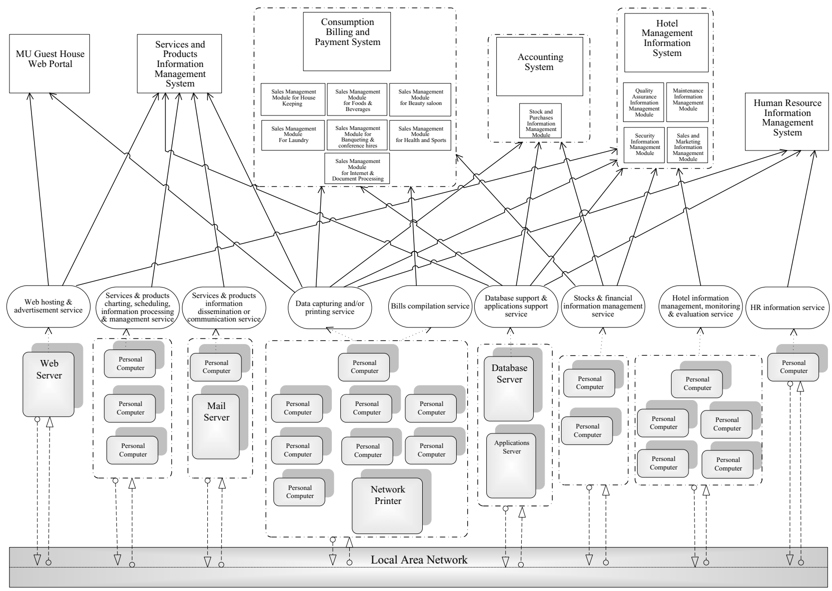

Fig. 10. Architecture Vision - Application Systems and Technology in MUKGH

7 Conclusions and Future Work

The evaluation of the design and performance of CEADA, using the experiment and Case Studies, generally helped to improve its design. Although the performance of CEADA in the experimental evaluation was not good, the experiment revealed a major weakness of the method. From the experimental evaluation, it was observed that it is vital to divide stakeholders into small groups (based on their area of specialization) when executing some activities. This observation was used to refine CEADA, and was tested in Case Study 1. The results from Case Study 1 indicated an improvement in the performance of CEADA. The results indicate that CEADA successfully supported the architecture creation conversation in NHC (i.e. Case Study 1).

Moreover in Case Study 1, two levels of enterprise architecture design alternatives were encountered i.e., organization wide architecture design alternatives and departmental level architecture design alternatives. The two levels of design alternatives were also encountered in Case Study 2. Consequently, the design of CEADA for session 2 of the architecture creation conversation was modified to cater for evaluation of the two levels of design alternatives. Case Study 2 was a situational application of CEADA, in which the architecture creation conversation was done using interviews rather than support from GSS. This was mainly due to the political and operational issues that were encountered in MUKGH. Therefore, the evaluation of CEADA specifically helped to: (1) identify the situational applications of CEADA; and (2) identify the weaknesses (and strengths) of CEADA, which were worked on to improve its design.

The future refinement of CEADA involves identifying and adapting a suitable negotiation model that will support negotiations required when executing some activities in the collaborative sessions of CEADA. Moreover, CEADA will be evaluated in parallel with other methods so as to compare its advantages and disadvantages in relation to other methods.

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References

1. Baskerville, R.: Investigating Information Systems with Action Research. Communications of the Association for Information Systems, 2 Article 19 (1999)
2. Bernard, S. A.: An Introduction to Enterprise Architecture - Linking Business and Technology. AuthorHouse, Indiana (2005) ISBN 1420880500
3. Briggs, R.O., Reinig, B.A., de Vreede, G.J.: Meeting Satisfaction for Technology-Supported Groups: An Empirical Validation of a Goal-Attainment Model. Small Group Research 37, 585–611 (2006), doi:10.1177/1046496406294320
4. Briggs, R.O., de Vreede, G.J., Nunamaker Jr., F.: Collaboration Engineering with ThinkLets to Pursue Sustained Success with Group Support Systems. Journal of Management Information Systems. 19, 31–64 (2003)
5. Briggs, R.O., de Vreede, G.J., Nunamaker Jr., J.F., Tobey, D.: Achieving Predictable, Repeatable, Patterns of Group Interaction with GSS. In: HICSS (2001)
6. Brynjolfsson, E., Saunders, A.: Wired for Innovation: How Information Technology is Reshaping the Economy. MIT Press, Cambridge (2010)
7. Gregor, S.: The Nature of Theory in Information Systems. MIS Quaterly 30(3), 611–642 (2006)
8. Henderson, J., Venkatraman, N.: Strategic alignment: Leveraging information technology for transforming organizations. IBM Syst. Journal 32(1), 4–16 (1993)
9. Hevner, A.R.: A Three Cycle View of Design Science Research. Scandinavian Journal of Information Systems 19(2), 87–92 (2007)
10. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design Science in Information Systems Research. MIS Quarterly 28(1), 75–105 (2004)
11. Iivari, J.: A Paradigmatic Analysis of Information Systems as a Design Science. Scandinavian Journal of Information Systems 19(2), 39–64 (2007)
12. Janssen, M., Cresswell, A.: The Development of a Reference Architecture for Local Government. In: HICSS. IEEE Press, Los Alamitos (2005)
13. Kaisler, S.H., Armour, F., Valivullah, M.: Enterprise Architecting: Critical Problems. In: HICSS. IEEE Press, Los Alamitos (2005)
14. Kolfschoten, G.L., de Vreede, G.J.: Collaboration Engineering Approach for Designing Collaboration Processes. In: Haake, J.M., Ochoa, S.F., Cechich, A. (eds.) CRIWG 2007. LNCS, vol. 4715, pp. 95–110. Springer, Heidelberg (2007)
15. Lankhorst, M., et al.: Enterprise Architecture at Work: Modelling, Communication, and Analysis. Springer, Berlin (2005)

16. Lankhorst, M., van Drunen, H.: Enterprise Architecture Development and Modelling, `http://www.via-nova-architectura.org`
17. Mingers, J., Rosenhead, J.: Problem structuring methods in action. European Journal of Operational Research 152, 530–554 (2004)
18. Myers, M.D.: Qualitative Research in Information Systems. MIS Quarterly 21(2), 241–242 (1997)
19. Nakakawa, A.: Collaboration Engineering Approach to Enterprise Architecture Design Evaluation and Selection. In Proceedings of 15th CAiSE-DC (Doctoral Consortium) held in conjunction with CAiSE 2008, CEUR-WS, Montpellier, France vol. 343, pp. 85–94 (2008)
20. Nakakawa, A., van Bommel, P., Proper, H. A.: Quality Enhancement in Creating Enterprise Architecture: Relevance of Academic Models in Practice. In: E. Proper, F. Harmsen, and J.L.G. Dietz (Eds.): PRET 2009, LNBIP 28, pp. 109–133 (2009)
21. Nakakawa, A., van Bommel, P., Proper, H.A.: Requirements for Collaborative Decision Making in Enterprise Architecture. In: Proceedings of the 4th SIKS/BENAIS Conference on Enterprise Information Systems, The Netherlands, Nijmegen (2009)
22. Nakakawa, A., van Bommel, P., Proper, H.A.: Towards a Theory on Collaborative Decision Making in Enterprise Architecture. In: Winter, R., Zhao, J.L., Aier, S. (eds.) Global Perspectives on Design Science Research. LNCS, vol. 6105, pp. 538–541. Springer, Heidelberg (2010)
23. Nunamaker Jr., J.F., Briggs, R.O., Mittleman, D.D., Vogel, D.R., Balthazard, P.A.: Lessons from a dozen years of group support systems research: a discussion of lab and field findings. MIS 13(3), 163–207 (1996)
24. Op 't Land, M., Proper, H.A., Waage, M., Cloo, J., Steghuis, C.: Enterprise Architecture - Creating Value by Informed Governance. Springer, Berlin (2008) ISBN: 978-3-540-85231-5
25. Pervan, G., Lewis, L.F., Bajwa, D.S.: Adoption and use of electronic meeting systems in large Australian and New Zealand organizations. Group Decision and Negotiation 13, 403–414 (2004)
26. Proper, H.A., Hoppenbrouwers, S.J.B.A., Veldhuijzen van Zanten, G.E.: Communication of Enterprise Architectures. In: Lankhorst, M. (ed.) Enterprise Architecture at Work: Modeling, Communication and Analysis, pp. 67–82. Springer, Berlin (2005)
27. van der Raadt, B., Schouten, S., van Vliet, H.: Stakeholder Perspective of Enterprise Architecture. In: Morrison, R., Balasubramaniam, D., Falkner, K. (eds.) ECSA 2008. LNCS, vol. 5292, pp. 19–34. Springer, Heidelberg (2008)
28. Raiffa, H., Richardson, J., Metcalfe, D.: Negotiation Analysis - Science & Art of Collaborative Decision Making, Belknap Harvard, Cambridge, Massachusetts (2003)
29. Ross, J., Weill, P., Robertson, D.: Enterprise Architecture as Strategy: Creating a Foundation for Business Execution. Harvard Business School Press, Boston (2006)
30. Rouwette, E.A.J.A., Vennix, J.A.M., Felling, A.J.A.: On Evaluating the Performance of Problem Structuring Methods: An Attempt at Formulating a Conceptual Model. Group Decision and Negotiation 18(6), 567–587 (2007)
31. Schekkerman, J.: How to survive in the jungle of Enterprise Architecture Frameworks, Creating or Choosing an Enterprise Architecture Framework. Trafford Publishing, Canada (2004)
32. Simon, H.A.: The New Science of Management Decision. Harper and Row, New York (1960)

33. Spewak, S.H.: Enterprise Architecture Planning: Developing a Blue Print for Data, Applications, and Technology. John Wiley & Sons Inc., New York (1992)
34. Susman, G., Evered, R.: An Assessment of The Scientific Merits of Action Research. Administrative Science Quarterly 23(4), 582–603 (1978)
35. The Open Group Architecture Forum. TOGAF Version 9. Zaltbommel. Van Haren Publishing, The Netherlands (2009) ISBN: 978-90-8753-230-7
36. Zachman, J.: A framework for information systems architecture. IBM Systems Journal 26(3), 276–292 (1987)