Applying Soft Systems Methodology in Enterprise Architecture Creation Workshops

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Abstract: Lack of effective involvement of stakeholders is one of the main drawbacks of enterprise architecture initiatives. Ongoing attempts to overcome this involve using Collaboration Engineering to develop a collaboration process that enterprise architects can execute to facilitate collaborative sessions with stakeholders during architecture creation. However, a field study evaluation of this process revealed that it offered inadequate support for stirring vigorous and rigorous discussions during activities that required organizing and assessing problem or solution aspects that resulted from brainstorming activities. Since Soft Systems Methodology (SSM) helps to structure rational thinking about messy situations, its techniques can be adapted to supplement the design of the collaboration process with support for triggering discussions and creating a shared understanding and vision among stakeholders. This paper therefore presents a script that shows how this can be done, and discusses its evaluation in a real case.

1 Introduction

The common drawbacks of enterprise architecture development include the lack of: effective involvement of stakeholders; support and commitment from top management; effective communication; and a mutual understanding of the purpose of the architecture effort [Ben05, Gar09, Sta95]. Enterprise architects have reported various challenges that hinder effective stakeholder involvement during architecture creation (see [NBP10]). The challenges are mainly caused by two issues. First, the success of collaborative sessions that involve enterprise architects and stakeholders mainly depends on the presence of a professional (or skilled) facilitator. Second, there is lack of a clear, predictable, and repeatable way of managing tasks that require effective stakeholder involvement. Ongoing attempts to overcome these issues involve using Collaboration Engineering to develop a collaborative process that enterprise architects can execute (by themselves) so as to manage tasks that require effective collaboration with stakeholders during enterprise architecture creation. Collaboration Engineering was chosen because it offers affordable facilitation to practitioners (in this case enterprise architects) of recurring high-value tasks (like enterprise architecture creation), by enabling the development of repeatable processes that

practitioners can execute without hiring a professional facilitator [BVN03, VB05].

According to [KV07, VB05], a collaborative process for a given task is designed using the following procedure: specifying the goal and deliverables of the process; defining the activities that participants must execute so as to achieve the goal; specifying the reasoning phases participants must undergo in order to achieve the goal; and describing detailed facilitation support for each activity. Facilitation support is specified by articulating: (a) the Group Support System (GSS) tools that should be used (or alternative techniques) during the collaborative sessions; (b) how the tools should be configured; and (c) the message prompts that should be followed [BVN03]. This design approach was adapted when formulating the collaboration process for effectively involving stakeholders during enterprise architecture creation. This process is herein referred to as Collaborative Evaluation of Enterprise Architecture Design Alternatives (CEADA). The earlier version of CEADA was evaluated in a field study (of five organizations) where it was effective in supporting activities that required stakeholders to brainstorm, prioritize or rank or rate concerns and requirements for the architecture; and perform multi-criteria evaluation of possible enterprise architecture design alternatives. However, CEADA was still lacking adequate support for stirring vigorous and rigorous discussions when executing activities that required stakeholders and architects to reduce and organize aspects from brainstorming activities; and assess possible interrelationships and implications. This was reflected in the feedback (see section 2) from stakeholders who participated in the sessions supported by CEADA; the facilitator; and the observer of the sessions.

Since the main focus of this research is to offer effective stakeholder involvement in architecture creation, in this paper we propose to address the above weakness by supplementing CEADA with techniques for enhancing the creation of a shared understanding and vision during execution of activities that involve organizing and discussing brainstormed aspects. We focus on adapting Soft Systems Methodology (SSM) because of its reputation for managing complex and ill-structured organizational problems through structuring rational thinking about them [Che98]. We also adapt the cause-effect analysis diagram (or Fishbone or Ishikawa) technique because of its support for thorough problem analysis [Ish86]. Since SSM offers implicit facilitation support for collaborative workshops or discussion debates among problem owners and solver(s), Collaboration Engineering is further used in designing the facilitation script that shows how SSM and Ishikawa techniques can be used in enterprise architecture creation. For the remaining part of this paper, Section 2 presents the research methodology; Section 3 discusses the script that extends CEADA to address its weaknesses; Section 4 presents the evaluation results of CEADA's performance in a real organization; and Section 5 concludes the paper.

2   Research Methodology

This research adapts the Design Science methodology. In Design Science, significant organizational problems are solved by: designing suitable artifacts using knowledge derived from scientific theories and industrial experiences; evaluating those artifacts using experiment and real life environments; and refining the artifacts to address their inefficiencies

[BVN03]. In this research CEADA is the ultimate artifact, which was designed based on literature from the enterprise architecture development realm, collaborative problem solving and decision making realm, and expert advice from enterprise architects and professional facilitators. In our earlier work[NBP11], a field study evaluation of CEADA indicated that it is already successful in effectively supporting communication during the execution of tasks that involve brainstorming and evaluating problem and solution aspects. However, evaluation feedback also indicated the need to enhance CEADA's support for tasks that require stakeholders to filter, clarify, organize, and discuss problem and solution aspects that arise from a brainstorming activity. This is implied by the following three issues highlighted in the feedback from the field study.

First, more time in the sessions was spent seeking a shared understanding and shared vision of problem and solution aspects, and yet some stakeholders complained (at the end of the sessions) that they had less discussion time. Second, stakeholders suggested that using (simple) visual representations of their ideas (prior to discussing and evaluating the architecture models) would have helped them to better analyze and understand the problem and solution aspects and the architecture models. Third, the participation of stakeholders decreased during activities that involved organizing and discussing problem and solution aspects. This could have been caused by the less hands-on nature of the way the organize tasks were executed. These three issues indicate the need to devise a way that will improve the execution of CEADA activities that require explicit articulation, proper organization, and thorough discussion of the problem and solution aspects. Such activities require stakeholders and architects to undergo the *reduce*, *clarify*, and *organize* patterns of reasoning [1]. However, Collaboration Engineering research has widely addressed issues encountered in the other patterns of reasoning (i.e. generate, evaluate, and build consensus), but more research is needed in addressing issues encountered in the reduce, clarify, and organize patterns of reasoning such that the effectiveness of collaboration processes can be improved [VB05].

Therefore, this paper reports work on an extended version of CEADA that attempts to address the above issues by triggering purposeful discussions that help stakeholders to acquire a shared understanding of problem and solution aspects during enterprise architecture creation workshops. The extended CEADA comprises of a script designed by adapting knowledge from SSM, the Ishikawa diagram technique, and Collaboration Engineering. Thereby, the weaknesses of any of these methods in effectively supporting execution of activities in architecture creation workshops, are overcome by the strengths of the other methods. The extended CEADA has been evaluated in a real organization and findings are discussed in section 4.

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[1]According to [BVN03, BVN+06], there are six patterns of reasoning that a group may undergo, i.e.: *generate*, moving from a state of having few to more concepts through brainstorming; *reduce*, moving from a state of having many to few concepts that are worthy of further attention; *clarify*, moving from a state of having less to more shared understanding and meaning of concepts; *organize*, moving from a state of having less to more understanding of the relationships among concepts under consideration; *evaluate*, moving from a state of having less to more understanding of the value of concepts under consideration; and *build consensus*, moving from a state of having fewer to more group members agree and commit to proposed concepts.

3 Soft Systems Methodology in Architecture Creation

This section discusses the adaptation of SSM and Ishikawa diagram techniques to improve CEADA. In addition, the usability of the CEADA script has been demonstrated using scenarios from one of the organizations in which CEADA was earlier evaluated, i.e. Wakiso District Local Government (WDLG). WDLG is an administrative and service delivery organization that operates under the Ministry of Local Government in Uganda; and consists of 11 departments, each having a number of subsections [Wak08].
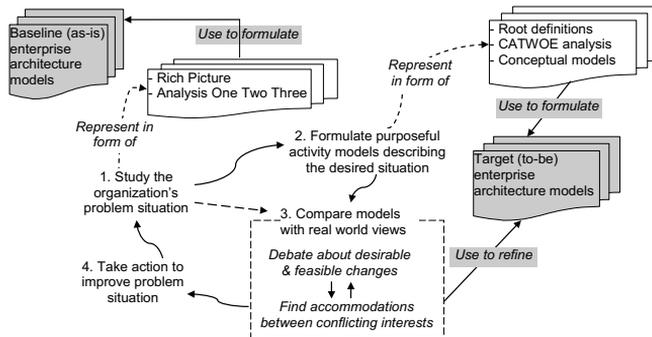

Figure 1: Adaptation of SSM in Enterprise Architecture Creation (Based on [Che98])

According to [Che98], SSM mainly comprises of the following four stages. Stage one involves studying the problem situation and representing it using: (a) *Rich Picture* – a holistic expression of aspects that describe the problem situation e.g. processes, actors and their thoughts or concerns; and (b) *Analysis One Two Three* – a description of all problem owners, cultural or social aspects (i.e. roles or norms or values), and political aspects of the problem situation. Stage two involves describing the desired situation by: (a) Formulating *Root Definitions* – explicit phrases that briefly describe the desired transformation in form of "*what* should be done", "*how* it should be done", and "*why* it should be done"; (b) Performing a *CATWOE* analysis of each Root Definition – assessing *C*ustomers who will be affected by the transformation, *A*ctors who will implement the transformation, *T*ransformation process(es) that will be affected, *W*orld views regarding the transformation, *O*wner(s) of the transformation, and *E*nvironmental and external issues that will affect the transformation; (c) Using the Root Definitions and their CATWOE analysis to assemble all proposed transformation processes into conceptual or purposeful activity models that describe the desired situation. Stage three involves comparing the conceptual models with real world views through holding debates which aim at: (a) defining desirable and feasible changes for improving the problem situation; (b) finding accommodations between conflicting interests regarding the problem situation and the desired changes. Stage four involves taking appropriate action to address the problem situation.

The adaptation of the SSM techniques defined in stages one to three into enterprise architecture creation workshops is shown in Figure 1. From figure 1, Rich Picture and Analysis One Two Three can be adapted as techniques for gathering information for formulating baseline architecture models (see section 3.1), whereas Root Definitions, CATWOE anal-

1. Communicate purpose of session 1
Tool Name: Manual   *Step Name:* [Activity 1.0]
Facilitator Notes: Purpose of session is to gather information on the organization's problem & solution aspects
2. Define services offered by, & processes executed in, the organization
Tool Name: Generate   *Step Name:* [Activity 1.1.1]   *Outline File Name:* GenOrgnProcesses.mw
Step Specific Information: Allow unlimited No. of items per topic; viewing other participant input; & participants to control topic selection. This configuration applies to all activities supported by the generate tool in this script.
Topic List: (1) What are the services offered by, & the processes executed in, this organization? (2) What are the organization's information inflows? (3) What are the organization's information outflows? (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 & ongoing projects in the organization?
Facilitator Notes: Explain the data capturing 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}
3. Clarify & organize attributes of processes in the organization
Tool Name: Organize   *Step Name:* [Activity 1.1.1.1]   *Output File Name:* OgzdProcesses.mw
Step Specific Information: Input file - [GenOrgnProcesses.mw]; Step will run in Outliner Mode.
Facilitator Notes: Display the generated list of processes & invoke a specialization-driven-division (i.e. divide stakeholders into small groups based on their departments/specialization). This enables detailed assessment of the as-is situation & enhances communication, shared understanding, & homogeneity 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 Ishikawa diagram **template for capturing 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. Guide each subgroup to draw a Rich Picture of the as-is situation of its department, showing the actors, their roles, their concerns etc.
(4) Converge subgroups & encourage representatives of each subgroup to discuss their department-specific Ishikawa diagrams for processes; & department-specific Rich Picture. To help the group to acquire a shared understanding of the as-is situation, map all the department-specific Ishikawa diagrams for processes onto an organization-wide Ishikawa diagram for processes; & merge all the department-specific Rich Pictures to form an organization-wide Rich Picture. Plug these diagrams on to the **holistic data capture template**.
4. Define the challenges or problems faced in the organization
Tool Name: Generate   *Step Name:* [Activity 1.1.2]   *Outline File Name:* GenOrgnChallenges.mw
Topic List: What are the challenges or problems faced in this organization?
Facilitator Notes: Explain the answering format: {Department}–{challenges faced by the department}
5. Determine the root problem cause
Tool Name: Organize   *Step Name:* [Activity 1.1.3]   *Output File Name:* OrgnRootProblemCauses.mw
Step Specific Information: Input file - [GenOrgnChallenges.mw]; Step will run in Outliner Mode.
Facilitator Notes: Display the generated list of challenges, & invoke a specialization-driven-division (this is explained in activity 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 Ishikawa diagram **template for problem analysis** to all subgroups. Guide them to perform a cause-effect analysis of problems in their department, by filling the required prompts in the template. The department-specific Rich Pictures from activity 1.1.1.1 can be used as a source of information.
(3) Converge subgroups & encourage representatives of each to discuss their department-specific Ishikawa diagrams for problem analysis & the identified root problem cause(s). Clean & organize the challenges list using output from the subgroups. Map all the department-specific Ishikawa diagrams for problem analysis onto an organization-wide Ishikawa diagram for problem analysis, & identify the general root problem cause(s).
6. Identify un-captured problem aspects & any anomalies in the output of problem analysis
Tool Name: Generate   *Step Name:* [Activity 1.1.4]   *Outline File Name:* CommentsOnProblemAnalysis.mw
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}

Figure 2: Facilitation Script for adapting SSM in Architecture Creation

ysis, and activity models can be adapted as techniques for gathering information for for-
mulating target architecture models (see section 3.2).

3.1   Creating Baseline Enterprise Architecture Models

SSM is a structured inquiry process which uses models as a source of questions about a
problem situation [Che98]. This section presents five structured and question-triggering
techniques that can be used in interviews and group sessions (or when reviewing orga-
nization documentation) to gather information for creating baseline architecture models.
These include: (a) the Ishikawa diagram, a technique useful for assessing problems and
their causes [Ish86]; (b) Rich Picture, and Analysis One Two Three [Che98] (these tech-

7. Assess Amendments to the problem analysis outcome
Tool Name: Organize   *Step Name:* [Activity 1.1.5]   *Output File Name:* AdditionsProblemAnalysis.mw
Step Specific Information: Input file - [CommentsOnProblemAnalysis.mw]; Step will run in Outliner Mode.

8. Seek consensus on outcomes of problem analysis
Tool Name: Evaluate   *Step Name:* [Activity 1.1.6]   *Output File Name:* ConsensusProblemAnalysis.mw
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].
Facilitator Notes: Encourage participants who do not agree to attach comments on their votes. Discuss the comments & re-vote to enable participants to reach a realistic level of shared understanding of problem aspects

9. Define aspects that describe the organization's problem scope
Tool Name: Generate   *Step Name:* [Activity 1.1.7]   *Output File Name:* GenAspectsProblemScope.mw
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: The filled Ishikawa diagram for problem analysis can be used as a source of information.

10. Clarify & organize the generated aspects on the problem scope
Tool Name: Organize   *Step Name:* [Activity 1.1.8]   *Output File Name:* OgzdAspectsProblemScope.mw
Step Specific Information: Input file - [GenAspectsProblemScope.mw]; Step will run in Outliner Mode.

11. Evaluate & agree on aspects that define the organization's problem scope
Tool Name: Evaluate   *Step Name:* [Activity 1.1.9]   *Output File Name:* AgreedProblemScope.mw
Step Specific Information: Input topic file - [OgzdAspectsProblemScope.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability - [Yes]

12. Reaffirm key organization principles associated with problem aspects
Tool Name: Generate   *Step Name:* [Activity 1.2.0]   *Outline File Name:* AssociatedOrgnPrinciples.mw
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 organisation?
Facilitator Notes: answering format is: {name of principle/practice/framework} - {source of information about it}

13. Specify business strategy & goals
Tool Name: Generate   *Step Name:* [Activity 1.3.0]   *Outline File Name:* GenBusinessStrategyGoals.mw
Topic List: Which business strategy & goals does the organization have so as to overcome its 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 strategy & goals.

14. Clarify & validate the business strategy & goals
Tool Name: Organize   *Step Name:* [Activity 1.3.1]   *Output File Name:* OgzdBusinessStrategyGoals.mw
Step Specific Information: Input file - [GenBusinessStrategyGoals.mw]; Step will run in Outliner Mode.
Facilitator Notes: Categorize business goals according to the business strategy that are intended to achieve. Plug results into the right section in the **holistic data capture pyramid or template**.

15. Evaluate & agree on the business strategy & goals
Tool Name: Evaluate   *Step Name:* [Activity 1.3.2]   *Output File Name:* RankBusinessStrategyGoals.mw
Step Specific Information: Input topic file - [OgzdBusinessStrategyGoals.mw]; Evaluation Method:[Rank from 1 to N (Use each value only once)]; Display Variability: [Yes]
Facilitator Notes: Prompt stakeholders to prioritize or rank the business goals.

16. Determine possible business solution alternatives for achieving the strategy & goals
Tool Name: Generate   *Step Name:* [Activity 1.4.0]   *Outline File Name:* GenBusinessSolnAlternatives.mw
Topic List: What can the organization do in order achieve its business strategy & goals?

17. Clarify & organize the generated business solution alternatives
Tool Name: Organize   *Step Name:* [Activity 1.4.1]   *Output File Name:* OgzdBusinessSolnAlternatives.mw
Step Specific Information: Input file - [GenBusinessSolutionAlternatives.mw]; Step will run in Outliner Mode.
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 **Ishikawa diagram template for capturing constraints** of a given business solution alternative.

Figure 3: Facilitation Script for adapting SSM in Architecture Creation (Contd.)

niques are defined in the preceding section); (c) short data capture statements or functions; and (d) a holistic data capture pyramid template, which has been formulated based on literature in [Lan05, OPW$^+$08] to give an overview of all aspects to be addressed during enterprise architecture creation. The CEADA script in figures 2, 3, 10, and 11 shows when and how to apply these techniques during group sessions with client stakeholders. It has been formulated based on the procedure for designing collaborative processes (see section 1), and it has been documented using Meetingworks^{TM} GSS. The detailed procedure of how the activities in CEADA were derived was discussed in our earlier work (see [NBP11]), the script herein extends CEADA by offering execution details of its activities.

In figure 2 the facilitation notes of activity 1.0 introduce the holistic data capture pyramid template (see figure 4), which provides a shared holistic view and shared understanding of data that is to be gathered during architecture creation and all the information templates that are to be used. In addition, the facilitation notes in figure 2 (activities 1.1.1.1 and 1.1.3), figure 3 (activity 1.4.1), and figure 11 (activity 4.2) show how the Ishikawa dia-
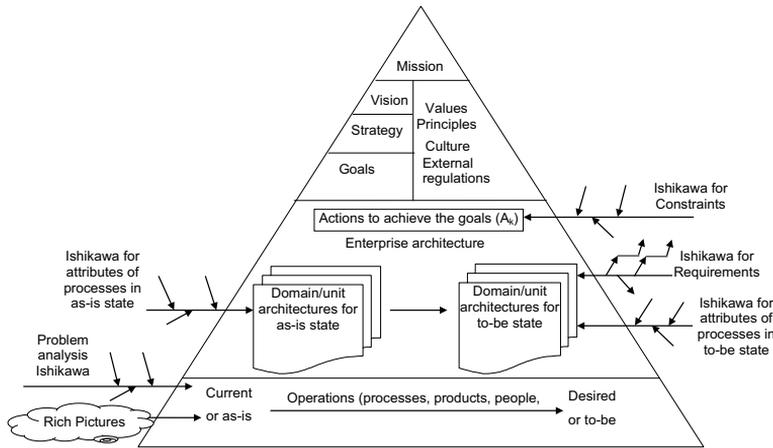
Figure 4: Holistic Data Capture Pyramid Template (Based on [Lan05, OPW⁺08])
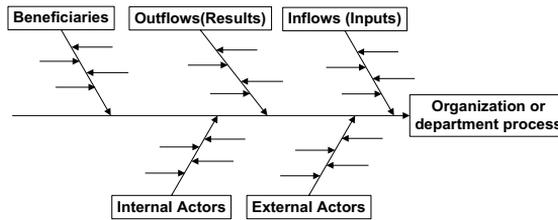

Figure 5: Adapted Ishikawa Diagram Template for Capturing Process Attributes

gram technique has been adapted in mainly four ways. These include: Ishikawa diagram template for capturing attributes of processes executed in an organization (see figure 5); Ishikawa diagram template for analyzing the problematic aspects in an organization (see figure 6 for the problem analysis template that was used at WDLG); and Ishikawa diagram templates for defining constraints and requirements that the architecture pertaining to a given (business) solution alternative must fulfill (see figure 8). The facilitation notes in the script also indicate that once these templates are populated with data, they can be plugged into the holistic data capture pyramid template in figure 4. Furthermore, in figure 2 (activity 1.1.1.1), facilitator notes also introduce the use of a Rich Picture in capturing baseline operations of departments in an organization. From figure 7, there are six key symbols that can be used to formulate a Rich Picture. As shown in figure 7, these symbols were used to formulate a Rich Picture for the as-is situation at WDLG. It shows that WDLG involves various complexities of people (represented with a face-like symbol and accompanying text) e.g. departments, committees, community. The level of detail in a Rich Picture depends on the problem solver [Che98]. Thus, to avoid an overcrowded Rich Picture and to enable shared understanding about the major problem(s) faced, the subsections in each of the 11 departments have not been represented. The dotted lines represent two-way communication, and the storage symbol on a dotted line indicates a decentralized way of data storage. The un-dotted lines represent responsibilities of a given group of people, the stars represent the services offered, and the cloud call-out represents problems faced.
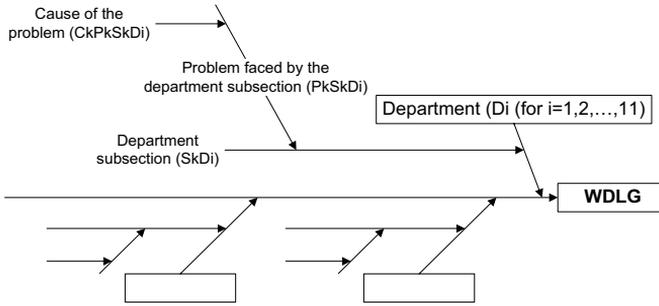
43

Figure 6: Adapted Ishikawa Diagram Template for Problem Analysis in WDLG

As the script indicates in figure 2 (activity 1.1.1.1), these symbols can be used to draw department-specific Rich Pictures, which can later be merged into an organization-wide Rich Picture.

3.2 Creating Target Enterprise Architecture Models

The script in figure 3 (activity 1.4.1) and figure 11 (activity 4.2) describe when and how to use the adapted Ishikawa template for gathering data on constraints and requirements that the architecture must address (see figure 8). In addition, in figure 10 (activity 1.6.1) the script describes when and how to articulate the purpose of the architecture creation initiative using the architecture purpose template shown in figure 9. Furthermore, the script in figure 11 (activity 4.1) shows when and how to use SSM's Root Definitions and CAT-WOE analysis to gather information on requirements and solution scenarios that must be represented in the target architecture models. For example, one of the Root Definitions for WDLG can be denoted as (R), where: R = {*What to do* – enable centralized data storage and IT-supported data processing and sharing in WDLG}; {*How to do it* – by purchasing database servers and client computers, and setting up and maintaining a Local Area Network}; {*Why do it* – in order to have consistent data records, realtime data retrieval, and improved service delivery in WDLG}. Consequently, the CATWOE analysis of R is as follows: **C**ustomers {WDLG staff, Wakiso district community}; **A**ctors {staff in the IT section of the planning department of WDLG, ICT and Internet service providers}; **T**ransformation process {input – isolated databases and manual department-specific processes, output – centralized database and IT-supported departmental but coherent processes}; **W**orld views {centralized database system yields consistent data records and enhances data sharing}; **O**wners {Technical Planning Committee, Ministry of Local Government}; and **E**nvironmental or external issues {financial resources from the Ministry}. Furthermore, the script in figure 11 (activity 4.2.2) shows that requirements can be thoroughly elaborated using the Requirements Elaboration Template (see figure 12). This template shows how the above CATWOE aspects of SSM can be used to assess the requirements that the architecture must address. Figure 12 shows that activity models can be used to represent the transformation processes that must be implemented or executed
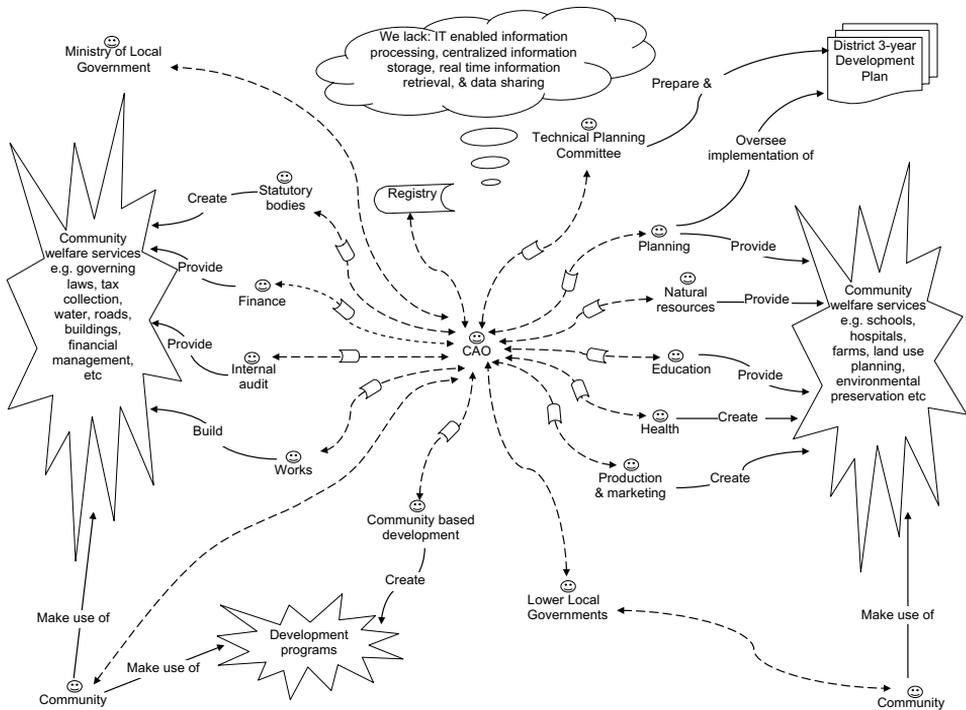
Figure 7: Rich Picture For WDLG as-is Situation

so as to achieve a given requirement. Figure 12 is an adaptation of the format of activity models provided by [HWP99].

4 Performance Evaluation of the CEADA Script

The CEADA extension script presented in section 3 was evaluated in the Department of Radiotherapy at Mulago Hospital in Uganda. This department 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. Out of the 20 staff members in the department, about 14 participated in the CEADA evaluation. The aim of CEADA in this case was to guide the collaborative creation of an enterprise architecture that would improve the execution of operational processes in the radiotherapy department.

The execution of the CEADA script was done using interviews and a collaborative session. Output from interviews was first analyzed and it was then used to formulate the preliminary models that were discussed in the collaborative session. Due to the busy schedule of the department (given its various patients), only one collaborative session was conducted, in which all activities were executed. Thereafter, members who attended the session were
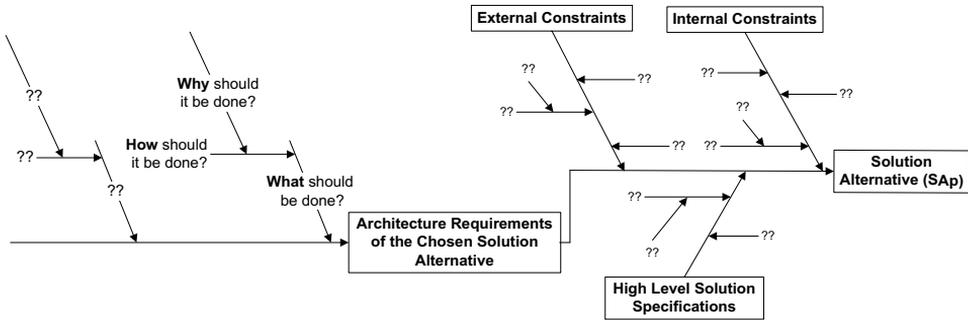
45

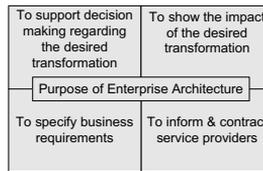Figure 8: Adapted Ishikawa Diagram Template for Constraints and Requirements

Figure 9: Diagram Template for Purpose of the Architecture Initiative (Based on [OPW$^+$08])

given questionnaires so as to capture their evaluation of the performance of the CEADA script against a number of quality criteria. Table 1 presents the evaluation results. Column 2 of table 1 shows the evaluation criteria that were used. These criteria are discussed in detail in [NBP11]. The scores used to measure CEADA's performance were based on a 5-point Likert scale, as shown in the last row of table 1. The mean score of CEADA's performance under each criterion (or sub criterion) is shown in table 1. The standard deviation of the scores (as shown in table 1) illustrates the degree of variability among stakeholders regarding CEADA's scores under each criterion. The mean scores in table 1 indicate that CEADA's performance was good regarding the support for creating a shared understanding and shared vision among stakeholders. In addition, the low standard deviations of scores (shown in the last column of table 1), implies that there was generally a high level

Table 1: Performance Evaluation Results of the CEADA Script

#	Evaluation Criteria for Measuring Performance of the CEADA Script	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	4.36	0.50
a	Support for enabling stakeholders to understand why some of their concerns/views would not apply in some contexts	4.15	0.55
b	Support for enabling stakeholders to understand the concerns of other stakeholders about the current and future operations in the organization	4.36	0.84
c	Support for enabling stakeholders to understand the results of the architecture process	4.25	0.45
2	Support for enabling stakeholders to freely express their views about the current operations in the organisation	4.43	0.94
3	Support for attaining stakeholders' satisfaction with the activities done in the collaborative session(s)	4.50	0.52
4	Support for attaining stakeholders' satisfaction with the outcome(s) of the collaborative session(s)	4.23	0.60
a	Support for enabling constructive critiquing of ideas generated in the session(s)	1.50	0.52
b	Support for enabling stakeholders to understand the objectives of the session(s)	4.29	0.61
Note: The evaluation scale used in the questionnaire that evaluated CEADA sessions is a 5 point Likert scale with responses ranging from strongly disagree (point 1) to strongly agree (point 5)			

18. Choose appropriate business solution alternative
Tool Name: MultiCriteria   *Step Name:* [Activity 1.4.2]   *Output File Name:* ChosenSolnAlternative.mw
Step Specific Information: List of Alternatives - [OgzdBusinessSolnAlternatives.mw]; Input Criteria List Items - [Suitability with respect to: (1) satisfying organization principles i.e. internal constraints; (2) achieving business strategy; (3) achieving business goals; and (4) satisfying external regulations or constraints]
Facilitator Notes: Prompt stakeholders to comment on their scores of the business solution alternatives.

19. Define external constraints that should be considered during enterprise architecture effort
Tool Name: Generate   *Step Name:* [Activity 1.5.0]   *Outline File Name:* GenExternalConstraints.mw
Topic List: (1) What are the policies or laws from regulatory authorities (& what do they imply) that relate to the defined solution aspects? (2) What are the policies or laws from the organization's consortiums, donors or sponsors, unions etc, that relate to the defined solution aspects?
Facilitator notes: Explain answering format: {name of body} - {external principle} - {implied external constraint}

20. Clarify & organize the identified external constraints
Tool Name: Organize   *Step Name:* [Activity 1.5.1]   *Output File Name:* OgzdExternalConstraints.mw
Step Specific Information: Input file - [GenExternalConstraints.mw]; Step will run in Outliner Mode.
Facilitator notes: Plug results into the right section in the **holistic data capture pyramid or template**.

21. Define the purpose of the enterprise architecture effort
Tool Name: Generate   *Step Name:* [Activity 1.6.0]   *Outline File Name:* GenPurposeEAEffort.mw
Topic List: (1) What is the main issue that the enterprise architecture effort must address in order to achieve the defined solution aspects? (2) In realizing the desired solution aspects, how do you want to use the resultant enterprise architecture?

22. Clarify & organize aspects regarding the purpose of the architecture effort
Tool Name: Organize   *Step Name:* [Activity 1.6.1]   *Output File Name:* OgzdAspectsPurposeEAEffort.mw
Step Specific Information: Input file - [GenPurposeArchitectureEffort.mw]; Step will run in Outliner Mode.
Facilitator notes: Guide participants to classify their ideas about the purpose of the architecture into 4 major categories (which 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.

23. Agree on the general purpose of the enterprise architecture effort
Tool Name: Evaluate   *Step Name:* [Activity 1.6.2]   *Output File Name:* AgreedPurposeArchEffort.mw
Step Specific Information: Input topic file - [OgzdAspectsPurposeEAEffort.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability - [Yes]

24. Define high level solution specifications & scope of the enterprise architecture effort
Tool Name: Generate   *Step Name:* [Activity 1.7.0]   *Outline File Name:* GenSolnSpecsScope.mw
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

25. Clarify & assess the defined high level solution specifications or architecture scope dimensions
Tool Name: Organize   *Step Name:* [Activity 1.7.1]   *Output File Name:* OgzdSolnSpecsScope.mw
Step Specific Information: Input file: GenSolnSpecsScope.mw; Step will run in Outliner Mode.
Facilitator notes: assess aspects with respect to problem scope & the purpose of architecture

26. Agree on high level solution specifications & scope of the architecture effort
Tool Name: Evaluate   *Step Name:* [Activity 1.7.2]   *Output File Name:* AgreedSolnSpecsScope.mw
Step Specific Information: Input topic file - [OgzdSolnSpecsScope.mw]; Evaluation Method - [Select (Mark all that apply)]; Display Variability: [Yes]. Plug results into the **holistic data capture pyramid or template**.

27. Determine all solution owners & their roles in the architecture effort
Tool Name: Generate   *Step Name:* [Activity 1.8.0]   *Outline File Name:* GenSolutionOwners.mw
Topic List: List all stakeholders who will be affected by, or benefit from, or participate in the implementation of, the desired solution; & mention what the role of that stakeholder is in the enterprise architecture development effort.
Facilitator Notes: Answering format: {problem/solution owner} - {Role in the architecture development effort}

Figure 10: Facilitation Script for adapting SSM in Architecture Creation (Contd.)

of consensus (among stakeholders) on the performance of CEADA under each criterion.

Moreover, comparing CEADA's performance results at the department of Radiotherapy with its performance results in field study one (see [NBP11]), the performance of CEADA regarding the support for creating a shared understanding and shared vision among stakeholders has improved. For example, in field study one, the average score of CEADA's performance under "creating a shared understanding and shared vision among stakeholders" was 3.80. This average score has increased to 4.28 after the adaptation of SSM and Ishikawa diagram techniques into CEADA. Certainly, the difference in CEADA's performance may also be caused by other factors such as the variation in the complexity and scope of the organization's problem and solution aspects, or in the type or personalities of stakeholders dealt with. However, stakeholders' evaluation highlighted that the Rich Picture model gives a general view of operations in an organization but lacks detailed information about how the operational processes are executed and their attributes. It was also acknowledged that the use of the Ishikawa model templates and the activity models (that are represented in form of a requirements elaboration template) helped to freely represent

28. Clarify & organize list of solution owners
Tool Name: Organize   *Step Name:* [Activity 1.8.1]   *Output File Name:* OgzdSolutionOwners.mw
Step Specific Information: Input file - [GenSolutionOwners.mw]; Step will run in Outliner Mode.
29. Determine all decision makers in the architecture process & their roles
Tool Name: Generate   *Step Name:* [Activity 1.9.0]   *Outline File Name:* DecisionMakersRoles.mw
Topic List: Who are the key decision makers in the organization?
Facilitation notes: Answering format: {position in the organization} - {decision making responsibility}
End of session 1 & preparations for session 2
30. Communicate purpose of session 2
Tool Name: Manual   *Step Name:* [3.0]   *Facilitator Notes:* Give a recap of results from session 1
31. Define concerns regarding problem & solution aspects from session 1
Tool Name: Generate   *Step Name:* [3.1]   *Outline File Name:* GenConcernsProbSoln.mw
Topic List: (1) What concerns do you have regarding the problem & solution aspects?; (2) What has not been captured in the problem aspects? (3) What has not been captured in the solution aspects? (4) Which problem & solution owners have not been included?
32. Clarify & organize concerns about problem & solution aspects
Tool Name: Organize *Step Name:* [Activity 3.2 and 3.3]   *Output File Name:* OgzedConcernsProbSoln.mw
Step Specific Information: Input file - [GenConcernsProbSoln.mw]; Step will run in Outliner Mode.
Facilitator Notes: Discuss the concerns & refer to the Ishikawa diagram template for problem analysis.
33. Validate & agree on the concerns about problem & solution aspects
Tool Name: Evaluate   *Step Name:* [Activity 3.4]   *Output File Name:* ValidConcernsProbSoln.mw
Step Specific Information: Input topic file - [OgzedConcernsProbSoln.mw]; *Evaluation Method* - [Select (Mark all that apply)]; *Display Variability* - [Yes]
34. Define business requirements that the enterprise architecture must fulfill
Tool Name: Generate   *Step Name:* [Activity 4.1]   *Outline File Name:* GenReqtsForEA.mw
Topic List: To move from the current to the desired state, define WHAT should be done; HOW it should be done; & WHY it should 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}
35. Clarify & organize requirements for the enterprise architecture
Tool Name: Organize   *Step Name:* [Activity 4.2]   *Output File Name:* OgzdReqtsForEA.mw
Step Specific Information: Input file: GenReqtsForEA.mw; Step will run in Outliner Mode.
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 prompts in the **Ishikawa diagram template for capturing requirements for the architecture**. 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}. Plug results into the **holistic data capture pyramid or template**.
36. Elaborate requirements for the architecture using CATWOE analysis and Activity Models of SSM
Tool Name: Generate   *Step Name:* [Activity 4.2.1]   *Outline File Name:* ElaboratedReqsForEA.mw
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: guide the stakeholders in doing a CATWOE analysis of each agreed on root definition
37. Clarify & organize CATWOE aspects that describe the requirements & solution scenarios
Tool Name: Organize   *Step Name:* [Activity 4.2.2]   *Output File Name:* OgzdElaboratedReqtsForEA.mw
Step Specific Information: Input file - [ElaboratedReqsForEA.mw]; Step will run in Outliner Mode.
Facilitator Notes: Guide stakeholders to use the **Requirements Elaboration Template** to clarify, organize, & verify aspects that describe the requirements & solution scenarios that the enterprise architecture must address.
38. Validate & agree on the requirements for the enterprise architecture
Tool Name: Evaluate   *Step Name:* [Activity 4.3.0]   *Output File Name:* ValidatedReqtsForEA.mw
Step Specific Information: Input topic file - [OgzdElaboratedReqtsForEA.mw]; Evaluation Method - [Rank from 1 to N (Use each value only once)]; Display Variability: [Yes]
Facilitator Notes: Encourage participants to comment on the ranks they assign to requirements.

Figure 11: Facilitation Script for adapting SSM in Architecture Creation (Contd.)

and structure various aspects associated with the execution of the processes. Therefore, although CEADA's improved performance may not only be attributed to the adaptation of these new techniques, the new techniques played a key role in supporting the organize and clarify patterns of reasoning.

5 Conclusions

Creating an enterprise architecture in a collaborative setting (with active participation of clients) helps to create ownership and commitment among stakeholders. Thus, CEADA is being developed using Collaboration Engineering so as to provide enterprise architects with an explicit way of actively involving stakeholders during architecture creation. From the first field study evaluation of CEADA, some weaknesses were identified in its design
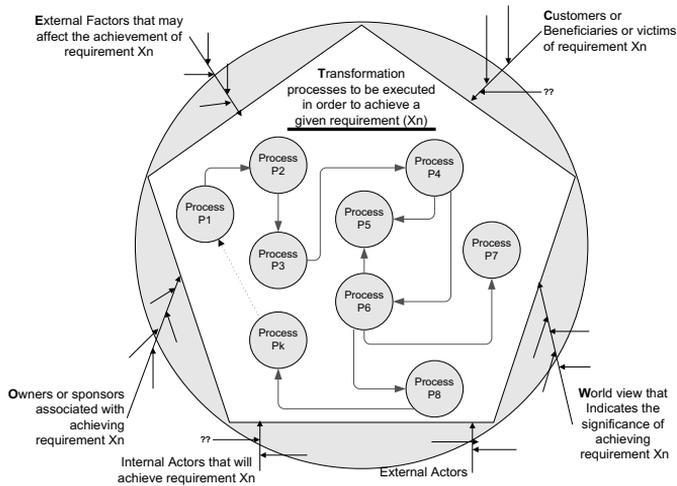
Figure 12: Requirements Elaboration Template

that called for adaptation of SSM techniques so as to address complexities that occur in a collaborative enterprise architecture development environment. Therefore, herein CEADA has been extended using a script that adds on our earlier work by providing facilitation support for using SSM and Ishikawa diagram techniques to execute activities that require the use of clarify and organize patterns of reasoning.

With the CEADA script, hands-on techniques have been adapted for each activity that requires clarifying, organizing, and discussing aspects from brainstorming tasks; and guidelines are given on how enterprise architects can use SSM and Ishikawa diagram techniques to gather data (in group sessions with clients) that can be used to create baseline and target architecture models. Although the Rich Picture has been adapted as a technique for gathering baseline information, it can also be used to gather information on the target situation. Also, embedded in the script is a questionnaire that can be used during interviews with stakeholders, or as template for gathering information from organization documentations. Thus, this research kick-starts the support for enterprise architecture data gathering and stakeholder involvement with SSM, in order to create a shared understanding and shared vision of the problem and solution aspects among organizational stakeholders. However, in line with the Design Science approach, the repeatability and predictability of the script is yet to be determined through further evaluation of CEADA. Further evaluation and refinement of the CEADA script will result in a very useful method that can be used along with the existing enterprise architecture frameworks.

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