

Requirements for Collaborative Decision Making in Enterprise Architecture

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Abstract. Challenges that are hardly technical, have been reported to occur during enterprise architecture development. To address those caused by ineffective collaboration between architects and organisation stakeholders, we are developing a method referred to as Collaborative Evaluation of Enterprise Architecture Design Alternatives (CEADA). Our method aims at enabling effective execution of collaborative tasks during enterprise architecture creation. In earlier work, initial requirements for CEADA were defined and collaboration engineering was used to design a collaboration process for CEADA. Following design science research guidelines, the initial models (describing the requirements and the design of the collaboration process) were analytically evaluated using structured walkthroughs with enterprise architects. The models were then refined and analytically re-evaluated using structured walkthroughs with skilled facilitators and enterprise architects. This paper presents findings from the analytical re-evaluation of the refined model (describing only the requirements), and reports how it was further refined.

Keywords: *Enterprise Architecture Creation, Collaboration*

1 Introduction

Organisations are often challenged by rapid and complex changes that occur in their business environment [14,20], yet they should be capable of adapting swiftly to such changes [14]. Adapting to some organisational changes may imply a major redesign of an organisation's structure, business processes, IT applications, and technical infrastructure [10]. (Enterprise) architecture then comes in handy to manage the complexity [10,14,21,25], and inflexibility associated with an organisation's business processes, information systems, and technical infrastructure [19]. Based on the definitions of (enterprise) architecture given by IEEE [6], ArchiMate [10], and The Open Group Architecture Framework (TOGAF) [24], we define enterprise architecture as a normative means to direct enterprise transformations. Normative means can take the shape of principles, views, or high level architecture models, whose role is to be a normative instrument during the intended transformation. Although enterprise architecture development generally involves creating, applying, and maintaining the architecture to realise its planned purpose [14], this research focuses on creating enterprise architecture.

Enterprise architecting often involves challenges that are hardly technical but are associated with political, project management, and organisational issues and weaknesses [7]. Although politics is a potential risk, in modern business environments, that can fix an organisation into a rigid posture [17], addressing political issues is beyond the scope of this research. We instead focus on how some challenges associated with project management and organisational weaknesses, can be overcome during enterprise architecture creation. From [7], examples of such challenges include: choosing a suitable framework and model; limited modeling tools to allow alignment of business operations and processes; making enterprise architecture models understandable by stakeholders; inability of architecture modeling languages to represent dynamics of a system and enable end-to-end performance analysis of an architecture; and the unrecognised role of an enterprise architect among executives of organisations accustomed to reactive and proactive decision making. Moreover, the problematic nature of collaboration between architects and stakeholders during the architecture effort, leads to delivery of complex and abstract enterprise architecture models that are hardly usable in practice [19]. The stakeholder world and technical design world are quite disjointed, hence calling for the need for an architect to foster connections that will yield output that appropriately fulfills stakeholders' interests [11]. Therefore, fulfilling all stakeholders' interests implies addressing some aspects in the methodology for designing architectures [10].

Although literature (e.g. [9,10,14,21,24]) reveals efforts towards improving the architecting methodology, managing collaborative activities in enterprise architecture creation remains superficially addressed. From the call (by [1,2]) for *openness* in the architecture process, it can be deduced that guidelines for enterprise architecting need to be strengthened with collaborative and interactive tasks. In [13], with the aim of addressing this need, we introduced a method to support collaborative decision making in architecture creation, i.e. Collaborative Evaluation of Enterprise Architecture Design Alternatives (CEADA). The initial requirements for CEADA were defined, and collaboration engineering was used to design a collaboration process to address those requirements. Following the design science research guidelines in [5], the initial models (describing the requirements and the design of the collaboration process to address them) were analytically evaluated using structured walkthroughs with enterprise architects. Output from the analytical evaluation was used to refine the initial models. It was vital to further expose the refined models to skilled facilitators (since CEADA addresses collaboration aspects) and to enterprise architects (for further evaluation). Hence the reason for an analytical re-evaluation (using structured walkthroughs) with skilled facilitators and enterprise architects. This paper presents findings from the analytical re-evaluation of the refined models, and reports how the requirements for CEADA were further refined.

The remainder of this paper is structured as follows. Section 2 reports existing work on improving enterprise architecting. Section 3 briefly describes requirements for CEADA, while section 4 presents their analytical re-evaluation and section 5 their further refinement. Section 6 concludes the paper.

2 Existing Work on Improving Enterprise Architecting

This section reports efforts towards improving the architecting methodology.

In [21] an analysis of several enterprise architecture approaches is given, as well as insights into selecting and creating an appropriate architecture approach for an organisation. Since several architecture frameworks specify architecture products and are silent about the way of creating them, TOGAF defines a detailed method (Architecture Development Method - ADM) for architecture development and for defining an organisation-specific architecture approach [24]. TOGAF recommends several techniques for executing ADM tasks, however, details of executing some collaborative tasks are not given. In [10], ArchiMate is defined to enable visualisation and analysis of architectures, since there was no detailed architecture modeling language for expressing business processes and their IT support in an easily understandable way. Moreover, ArchiMate complements TOGAF by offering concepts that enable creation of consistent integrated architecture models, that aptly communicate TOGAF architecture views, and enable communication and decision making across all organisation domains [9].

In [19], in order to enable architects to understand what stakeholders expect from them, the following are reported as essential attributes for the architecture function: (1) explicitly demarcated stakeholders' roles within the architecture function, at different hierarchical and functional organisation level; (2) willingness of architects to think along with stakeholders and understand their goals and problems so as to provide the best solutions; (3) architects to possess individual skills that enhance effective communication with stakeholders; (4) architects to have a long-term view and a realistic opinion about the organisation and realisation of its business and IT strategy. These attributes call for creation and deployment of (or adaptation of existing) techniques that enhance effective collaboration (among actors) into enterprise architecting.

Deployment of collaborative measures in enterprise architecting is seen in the definition of architecture principles. For example in [12,15,16], approaches are presented for enabling formulation of architecture principles in a collaborative setting. Principles guide enterprise architecting, they justify decisions made on architecture components, they should be linked to stakeholders and their concerns [15], and they represent general requirements (functional and constructional) for a class of systems [25]. Other efforts in improving the way principles are defined include the following. In [3], it is demonstrated how the basic logical principles of Object Role Modeling and Object Role Calculus can be used to systematically formulate architecture principles and improve their quality. In [16], an Enterprise Engineering framework is defined to support: definition of principles in a specific and measurable way, so that they can effectively constrain design space; effective and efficient assessment of the impact of principle(s); and detection of possible contradictions in principles, so that they can be adequately prioritised/clarified. In [24], criteria of good architecture principles are defined.

Enterprise architecture products generally include “*visualizations, graphics, models, and/or narrative that depicts the enterprise environment and design*” [21]; they are not limited to principles [14]. These products describe the enter-

prise architecture decisions taken, and offer an organisation-wide approach for communicating and enforcing such decisions [19]. During the design of these products, the architect needs to communicate with all key stakeholders, balance their needs and constraints so as to acquire a feasible and acceptable enterprise architecture design [10]. In our view, this requires that during enterprise architecture creation, design alternatives for these products be collaboratively generated, evaluated, such that feasible and acceptable ones are selected. Since enterprise architecture literature hardly reveals an explicit way of achieving this, we are devising CEADA for that cause.

3 Requirements for CEADA Method

In design science artifacts for solving organisational problems are created based on pre-existing theories, frameworks, instruments, constructs, models, methods, and instantiations [5]. Using this paradigm, the initial requirements for a method (i.e. CEADA) to support collaborative decision making in enterprise architecture creation were defined (as reported in [13]). This was done by using the causality analysis theory and adapting the generic decision making process defined by Simon in [22] to enterprise architecture. The initial model (describing the requirements) was analytically evaluated using structured walkthroughs with enterprise architects, and the feedback was used to refine the requirements. This section briefly describes the refined requirements for CEADA, as illustrated in figure 1 using Business Process Modeling Notation (BPMN). These requirements were analytically re-evaluated as discussed in section 4.

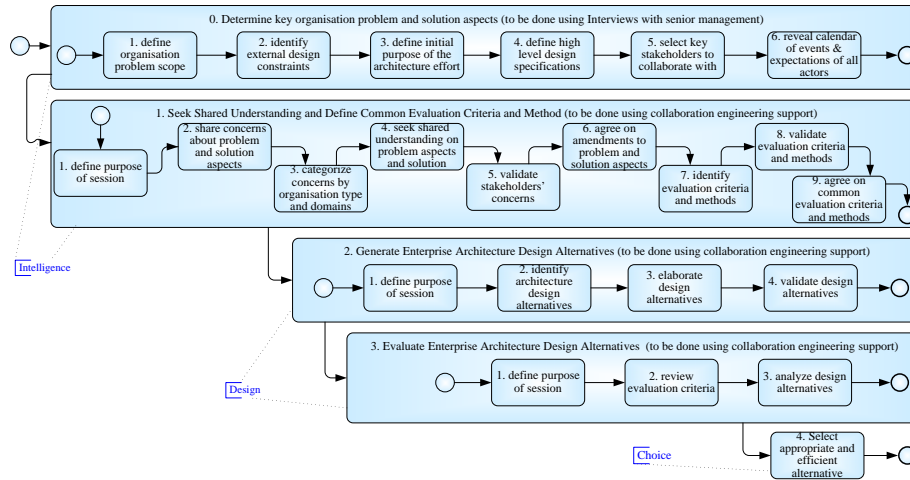


Fig. 1. Decomposition of Requirements for CEADA

The generic decision making process involves three phases, i.e.: Intelligence, investigating an environment for intervention opportunities; Design, devising possible courses of action (decision alternatives) to solve the problem or improve

environment); and Choice, choosing a particular course of action (decision alternative) from those available [22]. In figure 1, steps 0 and 1 depict intelligence, steps 2 and 3 depict design, and step 4 depicts choice.

At step 0 CEADA should enable enterprise architects to collaborate with senior management so as to determine the: organisation’s problem scope, external constraints from regulatory authorities, purpose of architecture effort, high level design specifications, and key stakeholders to participate in the subsequent collaboration required in architecture creation. Given that each stakeholder pursues specific objectives (depending on his/her role in the architecture function, organisation level at which (s)he operates, and the aspect area (s)he focuses on), there are extensive and potentially conflicting stakeholders’ expectations that are hard to satisfactorily address [19]. This calls for the need to seek a shared conceptualisation and understanding of the organisation’s problem and solution aspects between architects and stakeholders (and also among stakeholders). Besides, this shared understanding is the basis for enterprise evolution [14,23]; and it facilitates negotiation [26], which is vital during evaluation and selection of architecture design alternatives. Therefore, at step 1 CEADA should enable creation of a shared conceptualisation and understanding of output from step 0. It should also enable architects and stakeholders to identify, evaluate, and agree on quality criteria for evaluating design alternatives.

At step 2 CEADA should enable identification, elaboration, and validation of architecture design alternatives. At step 3 the method should enable collaborative evaluation of feasible architecture design alternatives, while at step 4 it should enable collaborative selection of appropriate and efficient architecture design alternatives. The purpose of steps 0, 1, and 2 is to gradually building consensus among stakeholders (on the solution aspects) so that they can effectively evaluate design alternatives and select appropriate and efficient ones.

4 Analytical Re-Evaluation of Requirements for CEADA

In design science evolving artifacts are evaluated using methods that are observational, analytical, experimental, descriptive, or testing-oriented [5]. This section reports how the requirements described in section 3 were analytically re-evaluated using bi-lateral structured walkthroughs with skilled facilitators and enterprise architects. Walkthroughs are one of the methods used for analytical evaluation [18]. A walkthrough is a step by step review and discussion, with practitioner(s), of activities that make up a process to reveal errors that are likely to hinder the effectiveness and efficiency of the process in realising its intended plan [8].

The aim of using walkthroughs was to have enterprise architects and skilled facilitators identify and eliminate faults and ambiguities in the requirements for CEADA. Each walkthrough session (with a duration of at most two hours) involved two actors, i.e. the researcher and either an enterprise architect or skilled facilitator. The agenda was: (1) the researcher explained the aim of the research and the role of the architect or facilitator in the walkthrough (i.e. to comment

on the relevance of CEADA in practice, review its requirements, identify faults and ambiguities in them, and give insights on how to eliminate them); and (2) a step by step discussion of CEADA requirements. In each session the researcher took notes which were later studied and used to refine CEADA requirements (as shown in section 5). Output from the three walkthrough sessions is outlined in tables 1 and 2, and described in sections 4.1, 4.2, and 4.3.

Table 1. Summary of Analytical Re-Evaluation of Requirements

#	CEADA Activities	Enterprise Architect	Facilitator	Architect and Facilitator
0.1	Define organisation problem scope	<ul style="list-style-type: none"> - Identifying problem scope and external constraints are vital activities as they are key inputs to visioning and strategy development in a business transformation initiative - Factors like business requirements, business strategy and objectives are vital inputs when defining the problem scope. At this level, detailed information on these factors may not be available but there should be pointers to them, in order to define a clear problem scope - fixed external legal constraints guide the formulation of solution aspects 	<ul style="list-style-type: none"> - Interviews are not a suitable way to achieve these tasks; instead group support system can be used - Pre-existing data files and models (developed using other applications) can be used along with the group support system to enable informed and successful discussions of these aspects - Pre-existing data files and models that were developed (using other applications) before/during step 0 can be used when briefing and executing activities in other sessions 	<ul style="list-style-type: none"> - These activities are important because they yield the first set of design principles - They relate to <i>sponsor meetings</i> in the ASE concept - In practice, ASE is used to address collaboration aspects when developing IAF artifacts - There is need to ensure that management acknowledges the relevance of the subsequent collaborative work and its cost and time implications.
0.2	Identify external design constraints			
0.3	Define purpose of the architecture effort	<ul style="list-style-type: none"> - defining purpose of the architecture effort is based on a clear problem scope 	- relevant	
0.4	Define high level design specifications	<ul style="list-style-type: none"> - should be global or high level specifications of the solution, and should not be confused with low level implementation (design) specifications - explicitly define the type of design alternatives that CEADA is addressing - architect takes part in defining low level principles 		
0.5	Select key stakeholders to participate in subsequent collaboration efforts	- relevant		
0.6	Reveal calendar of events for architecture effort & expectations of architect team & key stakeholders		- relevant	

4.1 Walkthrough with Enterprise Architect

At step 0, defining problem scope and external design constraints are significant because they are key inputs to strategy development in a business transformation. However, figure 1 does not indicate the key inputs for defining a clear problem scope, i.e. business requirements, strategy, and objectives. A clear problem scope is useful for determining the purpose of the architecture effort. Also, considering fixed external constraints at step 0 is vital, as such constraints guide the formulation of solution aspects. Defining high level design specifications should instead be global or high level specifications of the solution, and should not be confused with low level implementation (design) specifications. Requirements (or activities) in step 0 and others in step 1 of the model, are useful for strategy elaboration in a business transformation process. Output from step 0 can be useful for defining criteria for evaluating design alternatives, however selecting a method for evaluating design alternatives is not the role of stakeholders.

Additionally, there is need to clarify the type of evaluation criteria that should be defined at step 1. This is because evaluation criteria can be in four categories,

Table 2. Summary of Analytical Re-Evaluation of Requirements - Continued

#	CEADA Activities	Enterprise Architect	Facilitator	Architect and Facilitator
1.1	Define purpose of session, kind of information required, organisation problem scope, & initial purpose of architecture effort	- relevant	- relevant	- relevant - this can be a plenary activity (e.g. plenary presentation that begins the Scan phase of ASE)
1.2	Stakeholders share concerns about problem and solution aspects obtained from session 0	- relevant	- Classify concerns into: concerns associated with problem scope; and concerns associated with solution specifications and negotiable constraints	- this activity can be executed in parallel sessions (in Scan phase of ASE) using where "take-a-panel" technique - participants can be divided according to their organisation domains
1.3	Categorize concerns by type and organisation domains	- relevant	- relevant	- this activity can be executed in parallel sessions using where "share-a-panel" technique of ASE - each participant in each group explains their concerns to group members to understand a strict time constraint should be assigned to each participant
1.4	Discuss concerns while seeking shared conceptualisation & understanding of problem and solution aspects		- relevant - models developed in preparatory session can also be used	- these must be plenary activities - discussion of concerns can be done after presentations of categorized concerns from the parallel sessions of take-a-panel and share-a-panel
1.5	Validate stakeholders' concerns			
1.6	Agree on amendments to problem and solution aspects			
1.7	Identify criteria & methods for evaluating design alternatives	- Output from session 0 can be used to define criteria for evaluating design alternatives	- relevant - models developed in preparatory session can also be used	- these can be executed as parallel sessions using "take-a-panel", and participants divided based on their organisation domains
1.8	Validate evaluation criteria and methods	- Selection of methods for evaluating design alternatives is not the role of stakeholders.		- plenary activity
1.9	Agree on evaluation criteria & method for design alternatives	- define the type of evaluation criteria (i.e. business criteria, architectural criteria, governance criteria, & operational criteria)		
2.1	Define purpose and output of session	- relevant	- relevant - models developed in previous sessions can be used	- plenary activity
2.2	Identify design alternatives	- There is need to explicitly define the type of design alternatives that CEADA is addressing, since the architecture process involves several levels where formulation of alternatives (and their evaluation) occurs		- These relate to focus phase in ASE in which scenarios are sought, stretched, evaluated, validated, and integrated into a first draft of the solution that architects thereafter use to create a high level architecture description
2.3	Elaborate design alternatives			
2.4	Validate design alternatives			
3.1	Define purpose and output of session	- Business stakeholders should not be involved in the evaluation of enterprise architecture design alternatives (since these are too technical), but should be involved in identifying and evaluating business solution alternatives; and defining requirements for the enterprise architecture		
3.2	Review evaluation criteria			
3.3	Analyse valid design alternatives			
4	Select appropriate and efficient design alternative(s)			

i.e. business criteria, governance criteria, operational criteria, and architectural criteria. Different stakeholders are crucial in defining these criteria, e.g. senior management stakeholders for defining business criteria but not for the other criteria categories, IT manager and members of operational department are crucial for defining governance and operational criteria, while architectural criteria are defined by architects. Criteria categories can then be merged and their interrelationships defined, in order to enable stakeholders to evaluate and select alternatives in an informed way.

In steps 2, 3, and 4 of the requirements, it should be made explicit which type of (design) alternatives CEADA is aims to address. If for example, an organisation's strategy is to expand its operations to country X, then at least two types of design alternatives can be identified. (1) Business solution alternatives (high level alternatives), which are alternative ways in which the organisation can execute its strategy, e.g. by: taking over an already existing company in country X,

merging with an already existing company in country X, or completely starting a new branch country X. (2) Implementation (low) level design alternatives, which are design alternatives for each of the three solution alternatives (identified in (1)) for executing the business strategy in country X. This implies that if one solution alternative has been chosen, then its implementation (low level) design alternatives are identified and evaluated. Therefore, the model should clearly indicate whether CEADA aims to address business solution alternatives or implementation level design alternatives. It should also be noted that each of these types of alternatives requires a different approach of formulation and evaluation. For example low level design alternatives are too technical for stakeholders to be involved in their formulation and evaluation, instead stakeholders should be involved in identifying and evaluating business solution alternatives, and defining requirements for the enterprise architecture.

4.2 Walkthrough with Facilitator

Interviews are not a suitable way for achieving the goal of requirements at step 0, as proposed. Instead of interviews, collaboration engineering or group decision support can as well be used in step 0 to obtain all required information from senior management, especially if more than three stakeholders are involved. Applying collaboration engineering or group decision support should not be restricted to only steps 1, 2, 3, and 4, as proposed. Moreover, pre-existing data files and models (developed using other applications) can be used along with group decision support software at step 0. Besides, models that portray the dynamics of the organisation problem and the intended solution can be constructed at step 0, with the facilitation support from collaboration engineering. Pre-existing data files and models that were developed (using other applications) before or during step 0 (or any other step), can be used when executing other requirements in the method. Such a way of working will enable informed discussions when defining problem scope, external constraints, purpose of architecture effort, and design specifications. At step 1, sharing and categorisation of concerns can be improved by classifying concerns into: concerns associated with problem scope; and concerns associated with design specifications or negotiable constraints.

4.3 Walkthrough with Enterprise Architect and Facilitator

In practice a generic approach known as Accelerated Solutions Environment (ASE), documented in [4], is used in large group interventions at the start of a business (transformation) initiative, to create commitment, agreement, and approval by aligning critical stakeholders. It has also been used to undertake collaborative activities when developing artifacts using the Integrated Architecture Framework (IAF). ASE addresses problems that are complex (in scope, market, politics) and involve a number of key stakeholders (e.g. 30-110) who have divergent interests and views. It is more than traditional facilitated workshops, and involves intensive collaborative work for a duration of three days (without group support systems). Output obtained from a three-day ASE event is used

by architects to create a comprehensive high level solution (e.g. high level architecture description), which is later translated into a low level detailed solution. Prior to the three-day event, several sponsor meetings are held with company executives and the architect team. The sponsor meetings aim at developing content on: the objectives of the three-day event, input information for the success of the event, expected output from the event; and selecting type of stakeholders to be invited to the event, and the standards to be used.

The three-day event is managed by a team of skilled facilitators, who design their facilitation intervention strategies based on desired end results of the event. The event generally follows a *Scan-Focus-Act* cycle. Scan phase involves seeking a common language and understanding of aspects. This involves: a plenary presentation for all invited participants (stakeholders); followed by parallel sessions known as knowledge bursts (of 15-20 minutes), in which participants work in small groups that focus on problem solving and learning new skills; followed by parallel small group presentations of aspects addressed and learned from the knowledge bursts; and completed with a plenary brainstorming session (led by a facilitator) on all aspects learned from this scan phase. Focus phase is assignment driven and aims at finding solutions. Participant groups handle domain specific aspects by answering questions and developing content for a given domain. Different scenarios are sought, stretched, evaluated, and validated to get the desired products and to gain stakeholders' commitment. Act phase involves building group alignment and implementation plans for defined aspects.

ASE concepts can be used to detail CEADA requirements (or devise a process for their execution), and the two approaches would complement each other and yield improved collaboration in the architecture function. For example, requirements at step 0 are important because they yield the first set of design principles for an initiative, and in ASE design principles are obtained through sponsor meetings. Some requirements at step 1 (e.g. sharing concerns on problem and solution aspects, defining criteria) are executed using "take-a-panel" technique in ASE, while others are executed using "share-a-panel" technique. Take-a-panel involves dividing participants into small groups to concentrate on problem solving and learn new skills (in short knowledge burst sessions) whereas share-a-panel involves turns in which each participant explains his or her own concepts to members in his or her group. Requirements at steps 2, 3, and 4 are executed in ASE using focus phase, in which scenarios are sought, stretched, evaluated, validated, and integrated into a first draft of the solution.

5 Further Refinement of Requirements for CEADA

In design science, feedback from evaluating an evolving artifact is used to refine it so as to increase its utility [5]. Feedback from the analytical re-evaluation (in section 4) was used to further refine CEADA requirements as shown in figure 2.

At step 1 appended requirements are: 1 (define purpose of session); 2 (define basic information on business requirements, strategy, and objectives); and 7 (seek consensus on whether scope of the problem and its intended solution

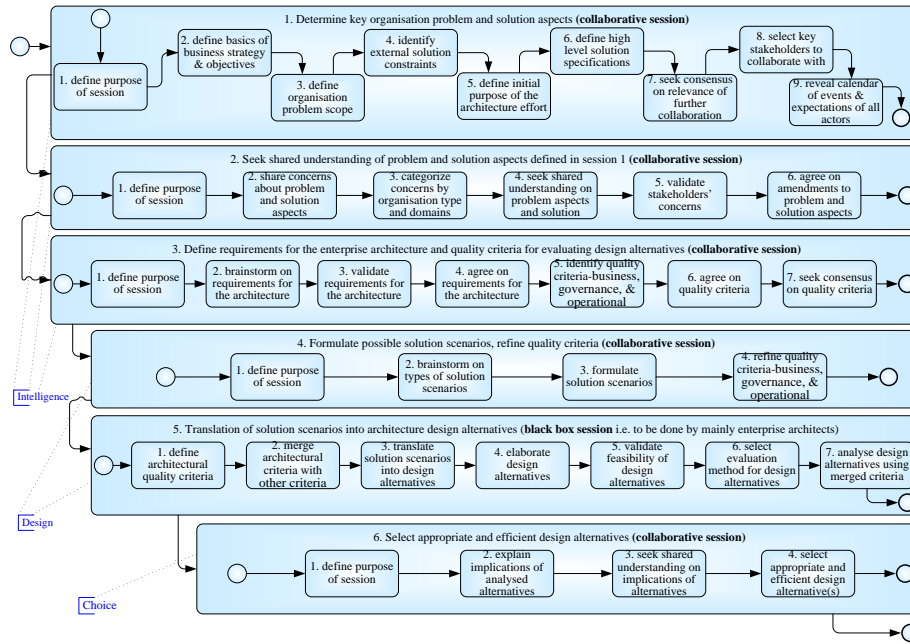


Fig. 2. Further Refinement of Decomposition of Requirements

require a collaborative effort). This is because from table 1 it was indicated that requirements at step 1 ought to be executed in a collaborative session (with senior management and enterprise architects) rather than using interviews. It was also indicated that basic information on business requirements, strategy, and objectives, is essential for defining a clear problem scope and its solution. Moreover, it was indicated that there is need to ensure that senior management acknowledges the relevance of a collaborative effort (in enterprise architecting, so as to achieve the intended solution), since this has cost and time implications.

At step 2, requirements regarding defining evaluation criteria were moved to step 3 because input information for defining evaluation criteria would be obtained during execution of step 3. Step 3 was inserted to ensure that CEADA will enable the definition of requirements for the enterprise architecture, and quality criteria for evaluating architecture design alternatives. This is because from table 2, it was indicated that CEADA should enable stakeholders to define requirements for the enterprise architecture; and that quality criteria should be categorised into 4, where stakeholders should define the business, governance, and operational criteria.

Step 4 was inserted to ensure that CEADA will enable stakeholders to formulate possible solution scenarios and refine quality criteria. This is because it was indicated that stakeholders should participate in identifying business solution alternatives rather than formulating and evaluating the technical architecture de-

sign alternatives. This is also why step 5 has been defined as a black box session, to be conducted by mainly enterprise architects, since it involves translating the identified (or formulated) solution scenarios into proper enterprise architecture design alternatives. Step 5 requirements include: defining architectural quality criteria and merging them with the business, governance, and operational criteria defined at step 4; translating solution scenarios into design alternatives; elaborating and validating design alternatives; identifying a method to analyse design alternatives; and analysing design alternatives. Step 6, a collaborative session, has been decomposed into defining purpose of session; enterprise architects explaining the implications of analysed architecture design alternatives to business stakeholders; seeking shared understanding of these implications among key stakeholders; and guiding stakeholders to select the appropriate and efficient alternatives.

6 Conclusions and Future Work

This paper presented the analytical re-evaluation and further refinement of the requirements for realising collaborative decision making during enterprise architecture creation. Currently, we are undertaking questionnaire surveys (with enterprise architects) aimed at further validating these requirements and capturing more practical insights into them. The analytical re-evaluation also offered suggestions on how these requirements can be executed. For example, we have used ASE techniques (learnt from the walkthroughs) to improve the design of the collaboration process that has been formulated (using collaboration engineering) to address CEADA requirements. Preparations are ongoing, for an experimental evaluation of this collaboration process using a fictitious case. After several experimental iterations have been done on the collaboration process, it will be evaluated using a real organisation case.

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