Viewpoint Based Nonfunctional Requirements Elicitation Framework for Service Oriented Enterprise Systems

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Abstract

The changes from traditional software development process to a more sophisticated Service Oriented Software Development (SOSD) process initiated a new way of thinking on requirements elicitation process. Over the years, the existence of several unstandardized requirement elicitation practices was observed to lead into inefficient SOSD practices resulting in unsatisfactory software products and increased overall costs. This paper attempts to investigate the critical challenges in the methods that are widely practiced in the local industry for Service Oriented Enterprise Systems Requirements elicitation (SORE) process. In addition, the paper aims to define a Viewpoint based framework for Service Oriented Non-Functional Requirements Elicitation (SONFRE) process of Service Oriented Enterprise System (SOES) by integrating a Viewpoint based Requirement elicitation approach with some of the currently used requirements elicitation techniques into a well-specified process method. The proposed Viewpoint based framework was evaluated with case studies conducted on e-government system and by industry experts. Based on the evaluation, the proposed framework is usable and can be applied by anyone with little business analysis experience on SORE. In addition, it allows establishing stakeholders agreed SONFR and also helps in identifying SONFR conflicts very clearly.

Keywords: Service Oriented Enterprise System; Service Oriented Non-Functional Requirement; Service Oriented Non-Functional Requirement Elicitation; Viewpoint Oriented Requirement Elicitation; Requirement Elicitation Techniques

1. Introduction

Software systems are evolving through the years and through these changes the traditional way of software provision has been replaced with a more sophisticated Service Oriented Software systems provisions. Service Oriented Paradigm emerged as a response to bridge the gap between business process models and software architectures in order to give on demand solutions to business needs [1]. Service oriented engineering originated from Object Oriented Software engineering, component based software engineering, and distributed computing concepts that resulted in Service Oriented Architecture development approach and requirements engineering process. The use of this Service Orientation concept in an enterprise brought up another more confined concept called Service Oriented Enterprise System (SOES). SOES is a Service Oriented system that emerged because of the integration of Service Oriented paradigm and existing enterprise system [2].

This change of paradigm required a new way of eliciting customer requirements to fulfill customers' needs. Service Oriented Requirements Elicitation (SORE) involves elicitation of enterprise requirements in Service Oriented context. This includes analysis and incorporation of different stakeholders in the process, identifying the viewpoint these stakeholders have and identifying different focuses of SOES. Over the years, techniques have been introduced to deal with these problems with the aim of reducing the time and cost of software

development. However, these techniques are of little use if well defined frameworks are not provided to assist software engineers in software requirements capturing.

The difficulty of Service Oriented Non-Functional Requirements Elicitation (SONFRE) comes from its vague and intangible nature of Service Oriented Non-Functional Requirements (SONFR) [3] and the existence of different views and viewpoints of different stakeholders in SOES. Based on these core problems, two research questions were raised at the beginning of this research. The first question is how challenging is SONFRE than Service Oriented Functional Requirements Elicitation (SOFRE) in practice and what methods are being widely practiced in SORE? The second question is how the viewpoint based requirements elicitation approach and other requirements elicitation techniques that are widely practiced in traditional requirements engineering can be applied in SOES Viewpoints and Views context in order to elicit SONFR from SOES stakeholders?

The motivation for this research is the existing SONFRE challenges that include poor and unstandardized SONFRE practice in SOSD process, less attention given to SONFRE process, expensive iterative requirement discovery process and maintenance cost in the process of service provision [4]. Because of these challenges, there is a need for generic SORE framework that can be applied effectively and easily implemented locally.

The general objective of this research is to analyze the current SONFRE trends and design a framework which improves upon the existing requirement elicitation methodologies. The key objectives of this research include understanding the challenges of the SONFRE process, exploring the existing SONFRE techniques and their challenges, developing a framework for SONFRE process and evaluating the newly proposed framework.

2. Related Work

The work in [5] contributed a view reconciliation methodology for SORE having concrete terms of Viewpoint, Perspective and View. The Viewpoint includes Metaphysical, Cost-based, Value-based, Pragmatic, and Provider's and Designer's Viewpoint. The Perspectives include Presentation, Transportation, Infrastructure, and Web service, Application, Data and Domain. Presentation perspective describes Enterprise Business Systems (EBS) quality from the point of view of the presentation of information produced by an EBS for service requestors. Transportation perspectives describe EBS quality from the network point of view. Infrastructure perspective describes EBS quality from the implementation platform point of view. Web service perspective describes EBS quality from the service point of view. Application perspective describes the nonfunctional properties of a component as a software product or EBS technical quality. Data perspective describes the nonfunctional properties of data stored in the enterprise's databases, XML documents and other content. Domain perspective describes the domain-dependent EBS qualities which are specific to a particular business domain.

The fact that quality is a broader concept that consists of Non-Functional Requirement as a sub category makes the perspectives of this framework reference perspective for View point based SONFRE process.

The work in [1] emphasizes Quality Requirements negotiation as part of SOES Requirements Engineering to resolve conflicts among stakeholders' quality requirements. It utilizes the concept of Viewpoint and View that is constructed from the integration of SOES Perspectives suggested in [5] and SONFR in a view reconciliation methodology. The idea of View construction from the identified SOES perspectives and SONFR is considered to be vital in Viewpoint based requirements elicitation process as specifying

Views guides and narrows the focus of the elicitation process.

The work in [3] undergoes six main steps including identifying enterprise based Service Oriented Architectures (SOA) stakeholders, SONFR and viewpoint framing them, identifying SONFR conflicts and overlaps, modeling SONFR conflicts and overlaps using Goal Requirements Modelling (GRL) and Use Case Map (UCM) Notations, developing alternative solutions (alternative SONFR and elaborating proposed solutions) SONFR and perform proposed SONFR judgment and trade-offs.

In this work, only the requirements capturing process that focuses on Service Oriented Enterprise Architecture (SOEA) Stakeholders and Roles identification, Viewpoints extraction based on Enterprise Architecture (EA) frameworks and standards, identifying SONFR Conflicts and Overlaps and performing proposed SONFR judgment and trade-off were reviewed and discussed.

Accordingly, Stakeholders and Roles including Business/IT Steering Group, SOEA Steering Board, EA Governance Board, SOEA Centre of Excellence, Business Domain Representatives, SOEA Governance Board, Solution Development Team, Service Development Team, IT Operations and SOEA Consumers were identified from SOA Governance Reference Model (SGRM) and TOGAF 9.1, 2011 governance models. Viewpoints of Enterprise Strategy, Enterprise Business Processes, Consumer, Business Process and Service were extracted. Enterprise strategy Viewpoint focuses on overall enterprise mission of SOES. Enterprise business process Viewpoint focuses on displaying business process of the enterprise without aligning to software systems. Business Process Viewpoint focuses on business processes and supporting service organization for SOES. Consumer Viewpoint focuses on application or human-oriented access of business services in SOES. Service Viewpoint focuses on realization of services for the business and IT capabilities of SOES.

The idea of stakeholder identification and extracting Viewpoints to frame stakeholder requirements is considered to be vital in Viewpoint based Requirements Elicitation.

Taking the above works as a basis and integrating the idea of use of perspectives for View construction and identification of stakeholder and Viewpoint process, a Viewpoint based process framework that customizes the Spiral Process Model for Capturing of Non-Functional Requirements of SOES is suggested in this paper.

3. Research Methodology and Findings

3.1 Research Methodology

This research was conducted in three phases, namely: conceptual analysis, empirical research and constructive design. In the conceptual study phase, previous research works were thoroughly reviewed to get good understanding of SOES, Viewpoint based requirements elicitation process and to identify the gap in recent researches on Viewpoint based SONFRE process for SOES. In the empirical study phase, a quantitative based questionnaire and qualitative based interview were designed and applied to study the challenges and practices of SORE in the Ethiopian software industry. In the study, 29 participants were involved in questionnaire based study and 5 participants in the interview.

3.2 Findings from the Questionnaire

a. On challenges of SORE Process

Based on the results, challenges of selecting a proper service requirements elicitation technique and inability to meet customer expectations were the top challenges taking 52.2% of the responses each. 21.7% of the responses indicated inability to achieve the benchmark quality requirements set for the service system and 19.6% of the responses indicated inability to properly identify service consumers. Based on the figures, it was concluded that all SORE challenges exist in the industry with similar and considerable amount.

b. On Experts' Level of Experience on Predefined Techniques of SOFRE and SONFRE

Based on the results, most of the experts have experience on predefined techniques of SOFRE than SONFRE. The result indicates that there is a need of research on SONFRE techniques than SOFRE techniques.

c. On Frequency of SONFRE Predefined Techniques Usage by Experts

Less than half of the participants often use predefined SONFRE techniques and more than half of the respondents rarely use or don't use predefined SONFRE techniques.

d. On Experts' Satisfaction Level on Existing Techniques of SOFRE and SONFRE

These questions contain four scale choices; Excellent, Above satisfactory, Satisfactory and Not good. Accordingly, the satisfaction on SOFRE techniques got the highest response rate of above satisfactory and satisfaction on SONFRE techniques got the highest response rate of satisfactory.

3.3 Findings from Interviewees

Based on the continent analysis method used for interview data analysis, the non-existence of initial SONFRE process in SORE, non-existence of standardized methods or framework for SONFRE, use of traditional methods for SONFRE and the less attention given for environmental constraints in SONFRE process were observed.

3.4 Conclusions on the Empirical Research Findings

Generally, the above empirical results concluded that most written challenges of SORE do exist in the real world. In the industry experience, SONFRE is more challenging than SOFRE, SONFRE often gets far lesser attention than SOFRE, and constraints which affect SONFR do not get much attention in SONFRE process. As noted in the literature, there is lack of standard framework for practicing SONFRE in the industry and traditional requirements elicitation methods are still widely used in the industry for SOES Requirements Elicitation Process.

4. The Proposed Framework

The Viewpoint based SONFR elicitation framework for SOES, as shown in Figure 1, is a four-stage process framework which includes stakeholder identification, SONFR and their constraint identification, Viewpoint and Perspectives identification and Stakeholder Specific SONFR Capture and arrangement stages.

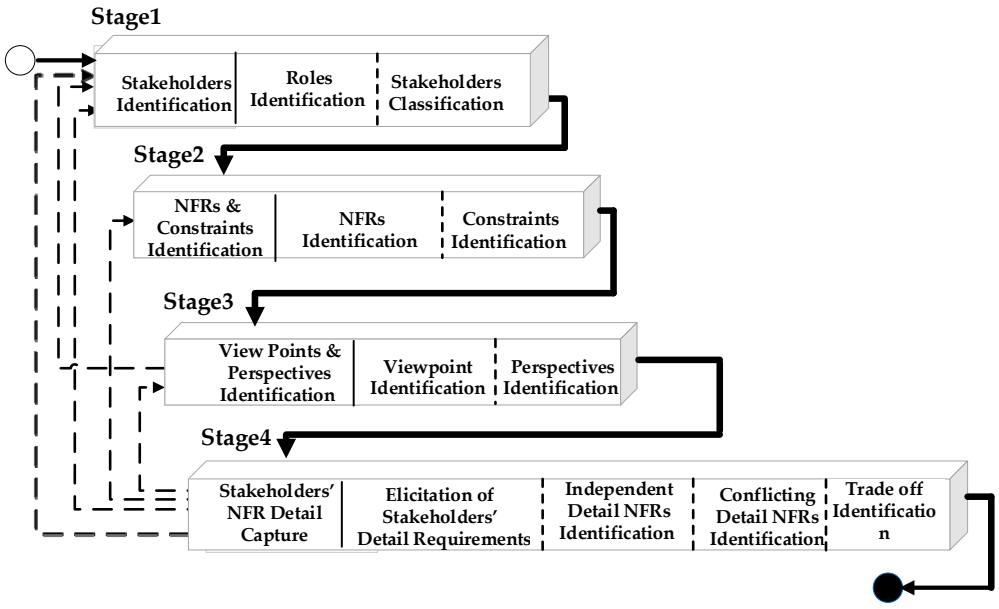

Figure 1: Viewpoint Based Nonfunctional Requirements Elicitation Framework for Service Oriented Enterprise Systems

4.1 SOES Stakeholder Identification Stage

At this stage, Stakeholder groups in SOES are identified with their corresponding Roles as shown in Figure 2.

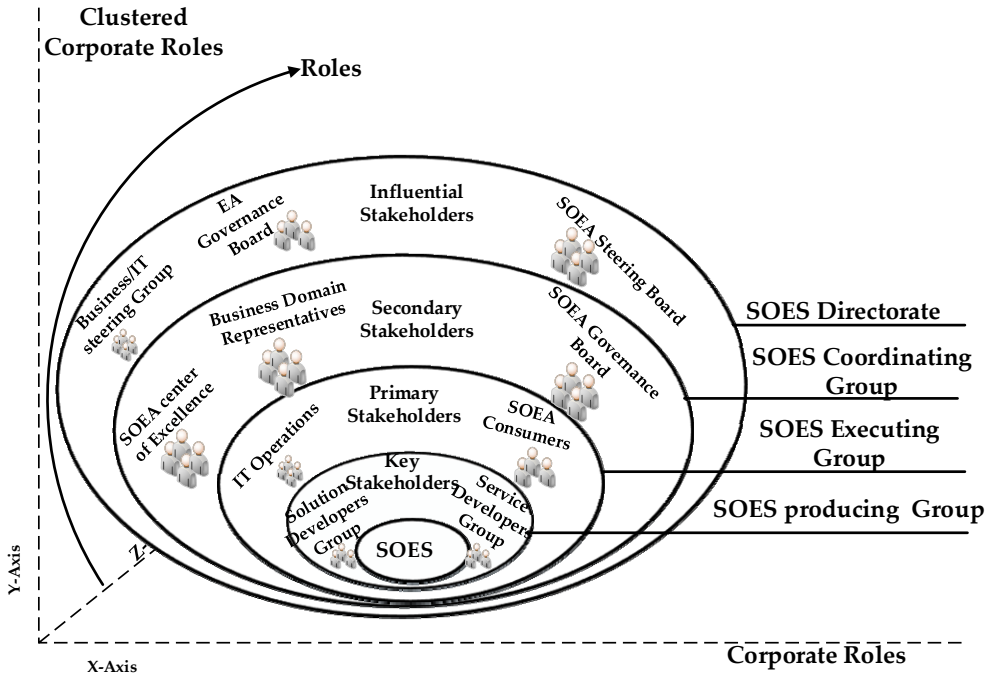

Figure 2: Three-Dimensional Identification of Roles and Stakeholder Types in Clustered Corporate Roles

The first sub-stage of this stage of the framework is SOES Role identification which involves identification of Clustered Corporate, Corporate and individual Roles. Examples of these Roles which were observed on e-government system of Ethiopia are shown in Figure 2. Clustered Corporate Role identification is an observation of skeletal Role arrangement of SOES which is formed from assembly of Corporate Roles. Corporate Role identification is an observation of intermediate Role arrangement of SOES which forms Clustered Corporate Roles. Role identification is an observation of internal Role arrangement of SOES which forms individual Roles of Corporate Roles.

The second sub-stage of this stage of the framework is stakeholder classification which is based on TOGAF 9.1, 2011 stakeholder classification power grid, Keep Satisfied, Keep Informed, Key Player and Give Minimal Effort, being interpreted into stakeholder types. Accordingly, the suggested Stakeholders Classification Schema consists of Influential Stakeholders (Keep Satisfied) that influence the SOES development, Secondary Stakeholders (Minimal Effort) that are affected positively or negatively by the SOES development, Primary Stakeholders (Keep Informed) that can contribute knowledge to the SOES development and Key Stakeholders (Key players) that are key players in the SOES development. Examples of stakeholder types in Clustered Corporate Role are shown in Figure 2.

While applying this stage in the process of elicitation, Corporate Role and Role structure can be referenced from reference models of ISO/IEC/IEEE 42010:2011, SOA Governance Reference Model (SGRM) and TOGAF 9.1, 2011.

4.2 SOES NFRs and Available Constraints Identification stage

At this stage, SONFRs which are significant to that specific Enterprise system and the constraining conditions are identified based on the Enterprise mission.

4.3 SOES Viewpoints and Perspectives Identification Stage

At this stage, Viewpoints and Perspectives of SOES are identified with the corresponding stakeholders and SONFR concerns for requirements elicitation process.

In this paper, Viewpoints are defined with three criteria. These are Identified SOES Roles alignment approach for that SOES, Business IT alignment principles of SOA and Standards and Frameworks of EA followed by that SOES. An initiation of the Viewpoints suggestion in this sub-stage included Viewpoints suggested by Svanidzaitė [3]. These include Enterprise strategy Viewpoint which focuses on overall enterprise mission of the SOES, Enterprise business process Viewpoint which focuses on displaying business process of the enterprise without aligning to software systems, Business Process Viewpoint which focuses on business processes and supporting service organization for the SOES, Consumer Viewpoint which focuses on application or human-oriented access of the business services in the SOES, Service Viewpoint which focuses on realization of services for the business and IT capabilities of the SOES, and Operation Viewpoint which focuses on the overall facilitation of the SOES from the implementation or operation point-of-view.

In this paper, Perspectives represents a particular aspect or focus of SOEA. The initiative for the Perspectives identification in this paper were taken from the available literatures on SOES perspectives [5] and interviews conducted in this study. The suggested perspectives include Presentation, Application, Domain, Information, Integration, Technology and Composite Perspectives. Presentation Perspective is a point of view of presenting and acquiring of every information (data) that forms the overall service system. Application Perspective is a point of view of a component as a new or legacy software product. Domain perspective is a point of view of business area or domain of the enterprise. Information perspective is the point of view of SOES information and data that will be available and processed in the SOES. Integration perspective is a point of view of orchestration of different services in SOES. Technology is a point of view of available or requested implementation technology including the tangible and intangible infrastructures systems, e.g., network and implementation platform that will be applicable in SOES. Composite Perspective is a point of view of internal factors like policy, mission, business target of the SOES system and external factors like political, cultural and ethical norms that could affect the system.

4.4 SOES Stakeholder Specific NFR Capturing Stage

This final stage focuses on capturing specific requirements from the identified stakeholders and arranging these requirements for the next requirements engineering stage of SOES.

The first sub-stage of this stage involves elicitation of SOES stakeholder specific detail requirements. Detailed requirements of stakeholders within each Viewpoints are elicited from different Views using appropriate requirements elicitation techniques.

The second sub-stage of this stage is SOES Stakeholder Specific Detail Requirements arrangements within the same Viewpoint which involves identification of Independent, Overlapping and Conflicting SONFR details and registration.

The third sub-stage of this stage is SOES Stakeholder Specific Detail Requirements arrangements among different Viewpoints which involves identification of Independent, Overlapping and Conflicting SONFR details and registration.

The fourth sub-stage of this stage is SONFRs Trade-off identification from captured stakeholders' Requirements. This involves identification and registration of stakeholders' SONFRs Trade-off among stakeholders of the same and different viewpoints.

5. Discussion and Evaluation

The proposed framework was evaluated with two case studies on e-government systems which were

chosen based on contextual difference and evaluations from three practicing experts in the area.

The first case study was done on Email management system of government-to-employee based e-government system. In this case, only two Roles, Clustered Corporate and Corporate Roles, were identified since the system is based on standards and conflicts and diverging requirements within internal Roles is unlikely. For testing purpose, only three Viewpoints, namely: Enterprise Strategy, Service, and Consumer Viewpoint were identified. Group discussion based Elicitation technique was chosen for capturing SONFR from stakeholders.

The second case study was done on e-transport system which is government-to-citizen based e-government system. In this case, Clustered Corporate, Corporate and individual Roles were identified since conflicts and diverging requirements within internal Roles is likely. Six Viewpoints including Enterprise Strategy, organizational business process, Service, business process, consumer and IT operation were identified. Group discussion, Observation and Interview requirements elicitation techniques were chosen for capturing requirements from stakeholders.

Based on these two cases, the necessity of the Role identification stage in the process of Role incorporation in a Viewpoint and how Viewpoints are defined and prioritized based on the criteria set are illustrated and tested.

For evaluating this framework, three industry experts were chosen from local and international experienced groups and a questionnaire was given. The questionnaire was prepared with six questions containing three 5-level Likert scale based multiple choices and three open-ended type. Based on the multiple-choice answers, the experts agree on the practical usability, benefit, customizability and adaptability of the framework in the industry.

This framework has some contributions which helps to improve the existing practice and previously suggested methodologies.

1. It is a more standardized and guiding framework for experts which can be applied with preferred elicitation techniques.
2. It is much easier to be applied by anyone with little business analysis experience on SORE.
3. It allows establishing stakeholders agreed SONFR and also helps in identifying SONFR conflicts very clearly.
4. It is much more convenient to be applied in an indistinct SOES that is immaturely SOEA based system.

6. Conclusion and Future Work

Over the years, several techniques have been introduced to deal with SORE in an enterprise. However, these techniques are of little use if well defined frameworks are not provided to assist software engineers in software requirements capturing. Based on the findings of the conceptual analysis and empirical researches, this paper presented a SONFRE framework for maturely and immaturely SOEA based SOES which involves guiding Role identification strategy for SONFRE process, Utilization of Identified SOES stakeholders' Roles for viewpoints definition and Consideration of SOES perspectives as part of view construction process. The proposed framework was evaluated with case studies conducted on e-government systems which were chosen based on contextual difference and by experts practicing in the industry. Based on the evaluation, the proposed framework is usable and can be applied by anyone with little business analysis experience on SORE. In addition, it allows establishing stakeholders agreed SONFR and also helps in identifying SONFR conflicts very clearly.

The construction of methodologies for Stakeholders' fuzzy Views, Stakeholders' fuzzy detailed SONFRs analysis and management, captured detailed requirements analysis and extending Viewpoint based framework for Functional Requirements Elicitation process could be investigated in future studies. In addition, Role vs

Responsibilities matching Semantic tool and methodology for Conflict resolution and Trade-off analysis of detailed SONFRs could be studied further.

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