Evaluating GORE Process – A Case Study Based Analysis

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(140-FAS/MSSE/F06)

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FINAL APPROVAL

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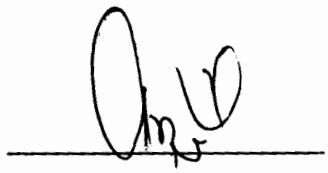

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ABSTRACT

It is important to note the requirements for RE process; as, generally speaking, a process is not only helpful in guiding the development of a product but its model also simplifies the complexities contained within the interdependent set of activities. Process modeling gains more importance in the area of Requirement Engineering (RE), as the socio-technical setting of RE requires proper support and guidance to carry out this, otherwise, time consuming and conflicting phase efficiently and effectively. Goal Oriented Requirement Engineering (GORE) attempts to solve many RE related problems by defining various models for goal-based methods, techniques and frameworks one of which is the GORE Process-GP (which is later named as GREPLICA in this thesis). This research attempts to contribute to the area of GORE Process Modeling by first of all signifying the GP through a series of evaluations based on the Process as well as Goal ontologies and conceptual frameworks. This ratifies the originality of the GP, as every research claims. Based on this evaluation, nomenclature – GREPLICA- is also proposed for the GP that emphasizes the selective important aspects of the GP. Comparison of GP with KAOS is also presented in this research based on the facts pointed out by literature before moving on to an important contribution of this thesis namely validation. Validation of the GP (GREPLICA) is done via implementation on an ERP project which is conducted in an explanatory-cum-exploratory case study fashion. Finally the discussion and analysis validates the results of the case study and proposes certain improvements which make up the future work of the research.

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First of all, all due praise and thanks to Almighty Allah to Whom belongs all the wisdom and knowledge of all the worlds. Every accomplishment, big or small, published or unpublished, praised or upraised, is from Allah whether it is mentioned or not. Then, deepest and humblest thanks and regards to the Prophet Muhammad (Peace Be Upon Him), who is the reason of the creation of this universe and an epitome of all the knowledge descended by Allah on this earth. I owe all my knowledge after Allah to Prophet Muhammad (Peace Be Upon Him) as all the knowledge possessed by mankind in this world is a consequence of the revelations that he transferred to us.

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To my mom.....

(May her soul rest in peace!)

DECLARATION

I hereby declare and affirm that this thesis neither as a whole nor as part thereof has been copied out from any source. It is further declared that I have completed this thesis entirely on the basis of my personal effort, made under the sincere guidance of our supervisor. If any part of this report is proven to be copied out or found to be a reproduction of some other, we shall stand by the consequences. No portion of the work presented in this report has been submitted in support of an application for other degree or qualification of this or any other University or Institute of learning.

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GLOSSARY

FR	Functional Requirements
ERP	Enterprise Resource Planning
GG	Goal Graph
GO	Goal Oriented
GORE	Goal Oriented Requirement Engineering
GP	GORE Process (Generic name of the target process)
GREPLICA	Goal-Based Requirement Engineering Prescriptive Lightweight Comprehensive All-Purpose Process (Proposed nomenclature for GORE Process)
KAOS	Knowledge Acquisition in Automated Specification
NFR	Non-Functional Requirements
PM	Project Manager
RE	Requirement Engineering
REO	Requirement Engineering Objectives
SE	Software Engineering

CHAPTER 1

1. INTRODUCTION

Requirements engineering (RE) is concerned with the identification of the goals to be achieved by the envisioned system, the operationalization of such goals into services and constraints, and the assignment of responsibilities for the resulting requirements to agents such as humans, devices, and software [1]. According to [2], there has been strong evidence that RE needs proper engineering methods and tools, which are domain specific and comprehensive, in supporting major REOs (requirements engineering objectives), and that require very detailed tools a0ssociated with them, to produce high quality requirements, to save time and the effort of rework on requirements, and to reduce resources, such as the size of RE teams. Owing to this very reason, Goal Oriented Requirement Engineering approach and related methods and techniques are attracting interest of software engineering research community as it overcomes the inadequacy of traditional analysis approaches, for traditional system analysis methods in requirement engineering are inadequate when dealing with complex software systems [1].

As an attempt in this direction, this research proposes to validate, evaluate and improve the Goal Oriented Requirement Engineering Process proposed in [8].

1.1. OBJECTIVE

As mentioned above, this research is aimed at paving the way for practical implementation of Goal Oriented Requirement engineering approaches by analyzing the only existing documented process for GORE. The analysis of the process shall include validation, critical review of the results and corresponding improvements.

1.2. PROBLEM STATEMENT

GORE is concerned with the use of goals in various requirement engineering activities including requirement elicitation, analysis, specification, validation, and requirement management. Moreover, it is concerned with the identification of system goals and the transformation of these goals into requirements; it addresses concerns of why a certain

goal is required, how it can be achieved and who is responsible for it in the system and/or the environment. Recent wave of popularity of GORE methods, tools and techniques can be attributed to various claimed advantages of GORE over traditional analysis methods, much of which has been formally documented and listed in [7]. This trend of research has resulted in the formulation of various GORE methodologies, techniques and tools along with their validation, evaluation and application in various industrial projects [7, 8].

However, one area that has received relatively less attention of the RE research community is the formalization of a process for practically implementing GORE approach which can be attributed to the complex nature of RE [65]. The emphasis of much of the work on goals has been on using them to derive formal specifications. However, the practical consequences of adopting a goal refinement approach have not been given the same degree of attention, and these consequences are significant [9, 65]. Due to this reason, the essence of GORE has not been experienced pragmatically by the software engineer practitioners generally and Software Analysts in particular. Infact, [8] provides the only available process with maximum coverage of goal decomposition and requirement engineering activities for GORE approach which can be considered as the first practical step towards the application of GORE approach to maximize and realize the claimed benefits. In order to further the progress in this direction, there is a need of validating and subsequently improving the GORE process proposed by S. Anwer and N. Ikram [8].

To address these issues, the research being undertaken proposes to evaluate and validate the GORE Process for the following reasons:

- ✓ The role of goals in RE is fundamental [14, 15, 54]. Research in the field of GORE is gaining momentum as the traditional RE methods are being considered as inadequate for the complex phase of RE. More details of GORE claimed advantages are explained in the proceeding chapters.
- ✓ The GORE process proposed in [8] is the only comprehensive GORE process that claims the best coverage of RE activities; however, it has not been validated.
- ✓ For practically gaining the benefits of GORE claimed advantages, a comprehensive, practical, validated, and improved process is essential.

1.3. RESEARCH QUESTIONS

The **problem area** of this research is: how to assess the GORE process [8] to analyze its effectiveness in RE phase. This research is aimed at paving the way of practical implementation of GORE approach and will further its benefits for RE community specifically and SE community generally. Hence **the research questions** that will be addressed in this research include:

1. What established REOs are achieved using GORE Process?
    - The main REOs, that shall be analyzed in this research for GP and that have already been defined by researchers of RE [63, 64], include:
        - Completeness
        - Correctness
        - Un-ambiguity
        - Pertinence
        - Consistency and
        - Traceability
2. Does GORE process fulfill the following claimed promises [8] made when applied in practice?
    - Does GORE Process help in the better discovery of goals by using a mix-up of both the bottom-up and top-down approaches?
    - Does GORE Process provide a better coverage of RE activities and GORE concepts?
    - Does GORE Process account for better Requirements Management?
3. Is existing GORE process limited in providing support for GORE approach in special comparison to the **underlying process of** KAOS method??
    - What improvements can be made in this regard?

1.4. RESEARCH BREAKDOWN – MAJOR TASKS

- Proposed plan will involve three steps:

I. Step 1 – Analysis of GORE Process:

- GP lacks a detailed picture of itsLiterature-Based (or theoretical) evaluation of GORE Process to define its conceptual grounds :
    - Evaluation based on the conceptual foundations to attribute the GORE process according to defined ontologies and frameworks.
    - Evaluation through critical comments for [8]
    - Evaluation by Comparison of the GORE Process with underlying process of core existing GORE methodology – KAOS.

II. Step 2 – Basic Validation:

- Validation of the GORE process proposed in [8]:
    - Validation is planned to be conducted in the form of an Industrial Case Study against these dimensions:
        - Requirement Engineering Objectives
        - Self-Claimed Promises.

- *Note: This part of the case study research will be conducted in the explanatory mode as explained by Runeson et.al. [61].*

III. Step 3 – Post-Validation Follow-up:

- Critical, yet objective analysis of the GORE process to underline areas of improvement in the GORE Process. The evaluation shall be two-prong; dealing with the theoretical as well as practical aspects of Requirement Engineering. Based on the evaluation, a comprehensive solution for the improvement shall be proposed.
    - Practical Evaluation will be done on the basis of:
        - Exploratory Results of Step-1.

- ***Note:*** *This part of the case study research will employ the exploratory mode of the case study research as explained by Runeson et.al. [61].*

1.5. RESEARCH METHOD

The research method applied will be qualitative as the validation shall be conducted via a case study [24, 61] for the validation and subsequent improvement of the GORE process.

1.5.1. CASE STUDY DESIGN

Although the details of the case study are explained in chapter 5 but the brief description of the research method used is mentioned below:

1.5.1.1. Type

The design of the case study will be exploratory-cum-confirmatory as the objective of the case study is going to depict in the following section.

1.5.1.2. Objective

The primary objective of the case study is to apply the GORE process [8] on an industrial project to validate the claimed advantages. This part of the case study is going to be confirmatory as the GORE process will be confirmed of the advantages it has claimed.

Besides, another secondary objective of the case study is to do gap analysis of the issues tackled by proposed GORE process and real issues faces in a practical and industrial setup. The emergent issues faced during the case study shall server as the foundation for the improvement in the GORE process. Hence, this part of the case study will be exploratory thereby rendering the status of this case study as confirmatory-cum-exploratory.

1.5.1.3. Unit of Analysis

The unit of analysis in the case study is going to be the selected project. The problem statement and the research method clearly mention the focus on the project. It focuses on validation of the claims made by GORE Process Model through execution of all activities on a real project executed in a professional environment

1.5.1.4. The Case

The case shall comprise of a medium sized industrial software development project from a known domain of SE applications whereby the GORE Process shall be applied during the RE phase to validate its claims. Special care shall be taken in order to make sure that the results of the case are unbiased and any/all limitations shall be stated explicitly.

The validation shall be done in a comparative fashion as the case study shall be done to compare the results of traditional RE activity already done based on an ad-hoc RE process employed by the company with that of the proposed GORE process.

Moreover, the results of the case study shall also be analyzed closely to gain a better understanding of the extent of the support that the GORE Process provides for the RE phase of Software Engineering; meanwhile uncovering the open issues not dealt-with in the GORE process. This will provide a deeper understanding of the RE issues which will serve to formulate new improvements in the GORE Process.

1.5.1.5. Methods of Data Collection

The data shall be collected via following two methods in order to avoid biases.

- ✓ Independent or secondary data collection shall be done via Document & Archive Analysis.
- ✓ Dependent and primary data collection shall be done through Interviews and Questionnaires.

1.5.1.6. Results

The results shall be in the form of:

- ✓ Validation or otherwise of the claims of the GORE Process which will highlight the strengths of the GP.
- ✓ A list of frequently occurring unaddressed issues while conducting the case study which will be highlighted and addressed to propose Improvements in the GORE process.

1.6. STUDY PLAN

The plan of study for the thesis is as follows:

Table 1-1 -Research Timeline

S.#	STEP	DURATION
I	Evaluation	2 Month
II	Basic Validation	4 Months
III	Post Validation Follow-up	4 Months

Note:

The write up shall be completed during the course of each step in parallel but final compilation and research paper write up is intended to be completed in the final month.

1.7. THESIS OUTLINE

The remaining document is structured as follows:

CHAPTER 2 — Chapter 2 reviews the relevant literature pertaining to requirement engineering and Goal oriented requirement engineering with special emphasis on Requirement Engineering activities and challenges. Goal Oriented Requirement Engineering and its motivations are also discussed to underline the significance of this research area. This literature review helps to provide further evidence for the research motivations behind RE generally and GORE specifically, which also are discussed in the beginning of the current chapter.

CHAPTER 3 — Chapter 3 discusses process models in general besides specific goal-based approaches that have been defined in literature and their support for RE process with respect to their RE coverage. The RE coverage evaluation of the GORE approaches is aimed at providing the extent of support of the existing GORE based approaches for the entire RE process activities. It thus reports the state of the art in the RE process models based on Goals and verifies the claim made by the GORE process of being the only GORE process that covers all the RE major activities.

CHAPTER 4 The fourth chapter characterizes the GORE process with special reference to the conceptual framework of process and process modeling discussed in chapter 3. It also attempts to satisfy the criticism on the GORE process by evaluating the existing most popular GORE approach - KAOS – with respect to its underlying process and compare it against the GORE process.

CHAPTER 5 The fifth chapter attempts to validate the process via an industrial case study. The chapter discusses the case study design details including the rationale behind the case selection, methods of data collection and finally the results. The improvements drawn from the case study will also be discussed in this chapter resulting in an improved process.

CHAPTER 6 Finally, Chapter 6 shall shed light on the main contributions of the research work, achievements and the future work.

CHAPTER 2

2. GORE - GOAL ORIENTED REQUIREMENT ENGINEERING

2.1. REQUIREMENT ENGINEERING

Requirement Engineering marks the early and one of the most important phases of software projects which has a marked effect on the quality of resulting software. The success of software system depends on how well it fits the needs of its users and its environment. Software requirements comprise these needs, and **requirements engineering** (RE) is the process by which the requirements are determined [10]. The requirement engineering is defined as *"the systematic process of developing requirements through an iterative co-operative process of analyzing the problem, documenting the resulting observations in a variety of representation formats and checking the accuracy of the understanding gained"* [11].

Software Requirements if improved quality-wise can result in significant improvement in the quality of not only requirements engineering phase but of the whole software being constructed. In other words, RE if not carried in an efficient way has a profound affect on other phases of software development i.e. design, implementation, testing and maintenance [10] [11]. However, this task is not easy and is accepted to be very complex [9] as was stated by F.P.Brooks [12] in his seminal paper "No Silver Bullets": *"The hardest single part of building a software system is deciding what to build. ... No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later"*. Hence, there is a strong consensus in the software research community about the importance and challenges related to requirement engineering which render this field a very important status in software/system engineering [2, 3, 9].

There are myriad of factors contributing to this difficulty including socio-economic, physical, technical, operational, evolutionary [1] (and many other) which can result in serious RE problems including lack of user involvement, requirements incompleteness, changing requirements, unrealistic expectations, and unclear objectives [2] . .Hence, requirements need to be rectified for all these possible problems irrespective of the dimension that they may

pertain to, so that the resulting software can be according to the user needs and can thus be regarded as successful.

2.1.1. REQUIREMENT ENGINEERING PROCESS / ACTIVITIES

RE process is considered as complex yet important and central to the success of software being developed [65, 77]. A good RE process guides the requirement engineers in performing various RE activities and produces good quality requirements so that the rework and frequency of defects in the resultant software could be reduced [77]. However if RE processes fail to achieve their goal, they must be improved. There have been numerous reports on how improvement in RE process has helped organizations gain palpable and tangible benefits at various stages of software development life cycle [3, 65, 66, 67, 68, 69, 70, 71].

Although RE process is considered as highly intertwined with other organizational processes [65], however there exists a very well defined set of activities that constitute the RE process [11, 72, 73, 74, 77]. Hence, it is important to list down the requirement engineering activities that make up the substance of the RE phase.

2.1.1.1. Requirements Elicitation

Elicitation refers to gathering the requirements of the system from different stakeholders. Requirements elicitation comprises activities that enable the understanding of the information, which is collected from the stakeholders, including goals, objectives, and motives for building a proposed software system [22]. In requirement elicitation, information is acquired about the user needs and environment Boundaries, identification of stakeholders; goals and tasks performed are also discovered in this phase [10].

2.1.1.2. Requirements Analysis and Negotiation

After elicitation of requirements, requirements are subjected to analysis in order to remove errors in requirements and check inconsistent, incomplete and conflicting requirements [10]. However, often requirements elicitation and analysis activities are carried simultaneously and hence are inter-leaved such as Haruhiko et al. [22] consider elicitation as part of the analysis activity. After analysis of requirements, requirements, which have been highlighted as problematical, are discussed with the stakeholders for negotiation [10].

2.1.1.3. Requirements Specification

Requirements specification is a structured document, which sets out the system services in detail. It includes all necessary information about what the system must do and all the constraints on its operation. This document may serve as a contract between the system buyer and software developer [10, 18].

2.1.1.4. Requirements Validation

Requirements validation ensures that models and documentation accurately express the stakeholders' needs. Validation usually requires stakeholders to be directly involved in reviewing the requirements artefacts [10]

2.1.1.5. Requirements Management

Requirements management is an umbrella activity that comprises a number of tasks related to the management of requirements, including the evolution of requirements over time and across product families. Requirements management also includes analysis that determines the maturity and stability of elicited requirements, so that the requirements most likely to change can be isolated [10, 19].

2.1.1.6. Requirements Traceability

Requirements traceability, like requirements management is also an umbrella activity. Requirements tracing is the ability to follow the life of a requirement in a forward and backward direction [20, 21]. Traces from requirements to their rationale, requirements decisions, and alternatives that were initially considered become increasingly relevant in the context of a highly distributed project as these traces provide benefits for requirements understanding in such projects that are hard to obtain otherwise, especially if informal communication in the team is costly or just does not occur [20].

Figure 2-1 shows the requirement-engineering phase and the interdependencies between various requirement engineering activities [11]. The figure clearly depicts that various requirement engineering activities are highly intertwined and it's difficult to isolate them; for instance elicitation and validation are highly interconnected in practical setting [78] which serves as a very good argument for the need of a validated RE process.

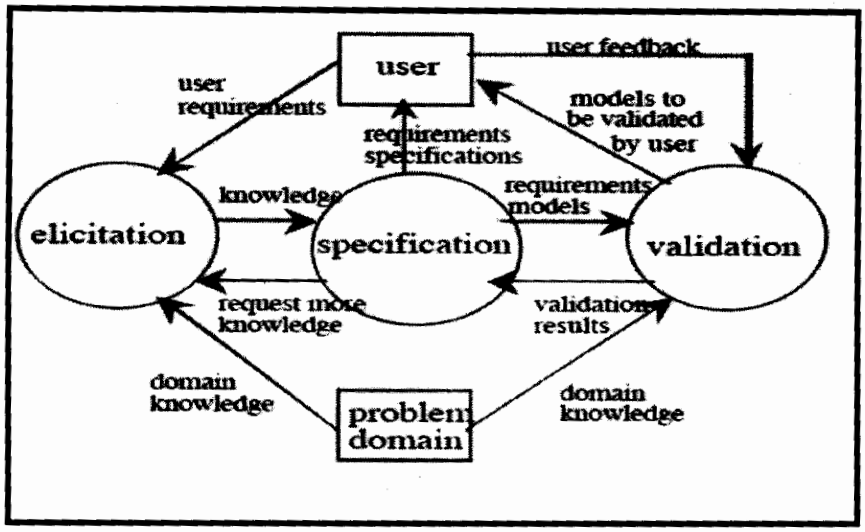


Figure 2-1 - Requirements Engineering Phase [11]

2.2. INTRODUCTION TO GOAL ORIENTED REQUIREMENT ENGINEERING

One improvement in the context of RE challenges discussed above has been the advent of field of GORE- Goal Oriented Requirement Engineering - due to awareness of the leading role of goals in requirement engineering, where a goal is defined as the objective to be achieved by the system under consideration [13].Goals have been regarded as natural and hence a very well-suited way of doing requirement engineering and an acceptance of this fact also shows up in various Requirements documentation standards of highest degree such as IEEE-Std-830/1993 in which a section in the very beginning is dedicated to listing objectives of the system [13]. Goal Oriented Requirement Engineering is concerned with the use of goals in all the activities of Requirement Engineering including Requirements Elicitation, Analysis, Specification, Validation and Management in order to improve the requirements problems faced in the traditional RE approaches and hence is reported to improve the overall software quality [1]. As the ontology, concepts, and terminology of GORE has already been discussed in varying amount of details in [5, 13, 14, 16], hence the discussion here shall be confined to the GORE motivations and GORE-related approaches including all the documented and published methodologies, techniques, tools, and processes shall be discussed in chapter three.

2.3. MOTIVATIONS FOR GOAL ORIENTED REQUIREMENT ENGINEERING

Goal oriented requirement engineering and its benefits have been discussed in literature already and goals have been regarded as a natural way of doing RE, such as A. V. Lamsveerde discusses in [13] that doing requirements engineering with the help of goals has reported to improve the completeness, pertinence, rationale, traceability, readability, stability and derivation of requirements including improved conflict management and better level of abstraction that helps in choosing between alternatives during the requirements elaboration process. The details of these benefits are listed in the following lines [13, 16, 23].

The first and foremost point that gives GORE a very important advantage is the concept of goals itself in the context of RE. Goals are considered a natural and logical way of doing RE as has also been stated earlier. Goals are the relatively less volatile and more concrete statements that position a requirement in the system and naturally provide a rationale for justifying and organizing system requirements.

Another important characteristic that is considered a touchstone for good Requirement Engineering is the completeness of the requirements; and goals happen to provide the sufficient level of completeness by mapping goals and requirements and see if any of the goals are missed by the operational requirements.

The above mapping can also account for the irrelevant requirements by providing a trace from each requirement to one of the high level goals and thus provide support for another major Requirement Engineering Objective "Pertinence".

Identifying goals in the form of a tree that links goals with low-level concrete requirements also helps in providing rationale for each requirement and results in better traceability which can help further in the entire software development life cycle.

The hierarchy between software requirements and their high level goals and this process of refinement of goals-to-requirements is also a well suited way of structuring documents. Hence, it increases the readability of the document to a large extent.

Concentrating on goals and then refining the goals into possible requirements to fulfill these goals happen to provide a very good mechanism of exploring the alternatives and choosing the best instead of blindly following stakeholders concrete choices.

Another benefit that can be attributed to the Goals-Requirements hierarchy is the much needed separation of the stable, high-level goals statements from the volatile, low-level requirements which helps in planning for managing changes to the requirements.

Consistency is another important objective that Requirement Engineering seeks to achieve; and goals provide very important information in this regard in the form of goal graph, an important output of every GORE method. Goal graphs help in detecting and resolving conflicts that arise due to conflicting viewpoints of multiple stakeholders.

Assignment of requirements to agents is another benefit that is served seamlessly by GORE approaches as the concept of agents provide a very good base for assigning the responsibilities of individual requirements to the most suitable agents [23]. Hence, the satisfaction of constraints becomes easy as the most appropriate agents are assigned the responsibility of different goals.

Last but not the least, a very important edge that GORE approaches enjoy over traditional methods is the fact that they provide a very good mechanism for the derivation of requirements from goals in the form of how and why questions. This makes them, along with the scenarios, an ideal choice for the requirements elaboration process.

All of the above reasons contribute to the growing trend of Goal oriented requirement engineering and goal-based techniques, methods, tools and techniques in the software research community. A literature based survey of goal-based approaches is given in the next chapter.

CHAPTER 3

3. PROCESS SUPPORT FOR GORE – A LITERATURE BASED ANALYSIS

3.1. INTRODUCTION TO SOFTWARE PROCESS MODELS

Processes and their representation in the form of software process models play a pivotal role in the software development activity and organizations due to their role in the redesigning of work and allocating responsibilities between humans and computers. However, apart from being important, software process modelling is also considered as a challenge in the context of software development due to the inherent nature of complexity and creativity involved in software analysis and design [26].

Before further explaining the dynamics of process and process modelling, it is important to note some important definitions that form the foundational basis of software process modelling. Humphrey et.al. [27] define a process as *a set of partially ordered steps intended to reach a goal* whereas a process model is defined as an abstract description of an actual or proposed process that represents those selected process elements which are acted upon by a human or a machine and which are deemed important for the objective of the model [26]. Hence, all the infinite real world details, complexities and unnecessary information that do not affect the relevant behaviour of the process are eliminated from the model to support the real purpose of any model which is to reduce the complexity and facilitate the understanding of the interacting phenomena.

3.2. OBJECTIVES OF SOFTWARE PROCESS MODELS

Main objectives of software process modelling are defined in [26, 28]. However, before going into the details it is important to note an interesting point regarding software process modelling objective, benefits and uses. These benefits and uses can only be realized if the process is elaborated to a necessarily sufficient detail which means that there is a precondition associated with every process model which if fulfilled can ensure its proper usage irrespective of the type of process model. The precondition states that the details

related to a process model should be moderately explained which requires on one hand the elimination of the unnecessary elements to reduce the complexity and on the other hand the mention of descriptions of all the necessary details so that the model can guide the execution and does not remain an abstract model. Infact this lack of fidelity between actual and documented processes form the most common mistakes of the organizational process models.

The objectives and the consequential benefits achieved as a result of pursuit of these goals as described by Curtis et.al. are mentioned below [26, 28]:

A. The process model should be elaborate enough to support the common understanding and basis for communication of the group involved. It allows the people involved in the process to execute the intended process in the desired manner. Besides, it provides sufficient information to train the people for that process.

B. Software process models enable the software process improvement activity as it provides a good base for defining and analyzing processes. Software process improvement is achieved via managed evolution of the process through comparisons with alternate processes and by first analyzing the impacts of potential changes to the software process prior to putting them into actual practice.

C. A Process model helps in management of the process as it helps in the comparison of the actual project behaviours with the defined process. Thus, it helps in the measurement of the process via monitoring and controlling activities for a specific project.

D. A process model provides a foundational basis for providing automated process guidance which requires automated tools for manipulating process descriptions. It can help in providing necessary guidance and reference material to facilitate human performance of the intended process.

E. A Process model helps in the provision of automated execution support which requires automated process parts and an automated environment within which, the behaviour of the process can be controlled. It supports the cooperative work by the teams and ensures process integrity by enforcing rules on the execution of the process.

3.3. BASIC ELEMENTS OF SOFTWARE PROCESS MODELS

Before evaluating any of the models, it is necessary to understand the necessary elements of a process. Any component of a process is defined as a process element [27]. Whenever a software process is defined, it normally specifies the actors executing the activities, their roles and the artefacts produced during the course of execution of the activities. Although different elements of process have been identified in literature but the main four are discussed below [27, 28]:

A. An Actor or Agent that executes a process element and performs certain activities. An actor might not necessarily be a human actor, it can be a system actor or a system tool which are the computer hardware or computer software components.

B. The second important component or element is the Activity that produces palpable changes in state of the product by accepting certain inputs to produce certain desired outputs and results known as products. The activities can be compound or elementary and are associated to other activities, roles and artefacts.

C. Artefact or product is another important element of a process and is the sub-product or raw material that is produced, maintained and developed within the process activities by the collaborative action of one or more actors. The artefacts can have multiple versions and can evolve over time such as software requirements specifications and when grouped are termed as software product to be delivered to the user.

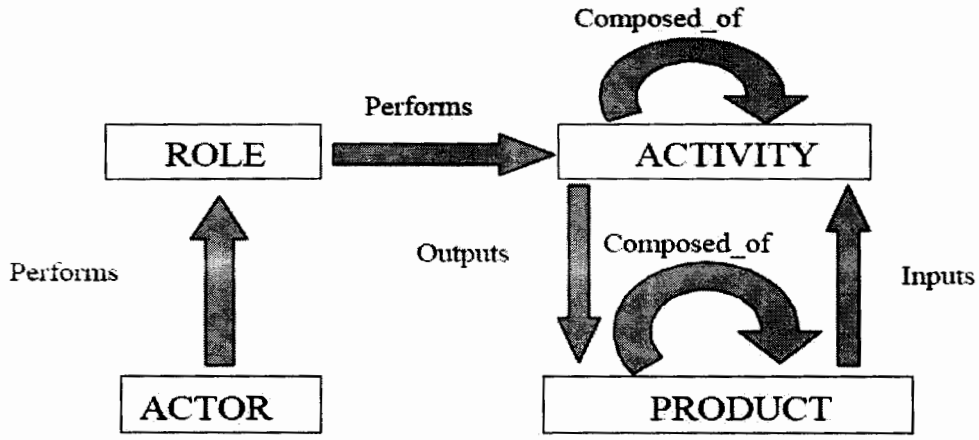


Figure 3-1 - Basic Components of a Process Model [28]

D. Another important basic element is the role that an actor performs and which is defined by a certain level of rights, skills and responsibilities.

Figure 3-1 [28] shows the interrelationship between these basic elements such as Activity/Activity relationship, actor/role/activity relationship etc.

3.4. STATE OF ART OF PROCESS MODELLING IN GORE

As has been discussed in previous chapter, the concept of goals has been conceived in the context of requirement engineering since long ago and goals have been considered as a natural way of doing RE; hence a number of approaches have been formalized and introduced that make use of goals in the context of system analysis. All these efforts will be termed as Goal-Based or Goal-Oriented approaches in this document. Table 3-1 presents a literature-based survey of these goal-based approaches and also attempts to classify them on the base of their depth, level of detail, and composition. The ontological terms used in the classification are described below in order to clarify the taxonomy:

- **Framework**

A framework builds a set of terminologies, concepts, and abstractions that are used while defining a process model such as UML defines terms like *role, resource, assignment* and *task* which are then used in models like UML class diagrams [75].

- **Technique**

A Technique is a series of steps, like in a basic algorithm, that are followed and executed in order to construct or assess software [76]. For instance, code reading technique is used to assess the code. In other words, it is a procedure to perform a development activity. An activity not only embodies the representational aspect but also the procedural aspect [80]

- **Method**

The term method is a broader term than technique as it uses the concept of technique(s) and associated guidelines in order to explain the application of technique [76]. It is an organized approach that tells when, how and where to apply and evaluate a certain specific technique, besides extending the management support. Hence, it is a specific way of thinking with associated rules, directions that drive the development activities along with the work products [80].

- **Tool**

A tool is a program or application that is used to create, debug, maintain, or otherwise support other programs and applications [79, 80]. However, the scope of the tool can be variable as some tools provide support for a couple of notations and others provide assistance to the whole development life cycle.

This confirms that the need of a comprehensive process for GORE is inevitable as none of the approach listed in the table qualify as a comprehensive approach with equal importance to each/all of the requirement engineering activities and concerns, as each approach focuses on a specific RE context [5, 49].

Table 3-1 - A Literature based Survey of Goal Based Approaches

SR. NO.	NAME	PROPOSED BY/YEAR	CLASSIFICATION	EXPLANATION	REFERENCES
1.	The goal-driven change method (GDC)	Evangelia Kavakli	Framework	GDC uses goal-modeling techniques to analyze the change and to identify the alternative plans to realize the change .It is the process of managing the transition from initial organizational situation to a desired situation.	[15, 29]
2.	ISAC (Information Systems Work and Analysis of Changes)	M. Lundeberg (1982)	Method	The ISAC method uses goal analysis to identify business problems to be solved.	[33]
3.	The *i** strategic rationale modelling	Eric Yu's, Li and Liu (2001)	Framework	i* is more oriented towards goal satisficing.	[30]
4.	NFR Framework	Mylopoulos Chung and Nixon (1992)	Framework	In NFR framework, non-functional requirements are represented in terms of interrelated goals.	[32]
5.	The GBRAM (goal-based requirements analysis method)	Antón, A. I (1996)	Method	The GBRM uses goals to elaborate the system requirements. It also provides guideline to extract goals from different sources in one ordered goal set.	[16, 31]
6.	The goal-scenario coupling method	Camille Ben Achou, Colette Rolland, Carine Souveyet	Method	The goal-scenario coupling approach helps in identification of future solutions in order to satisfy the organization's need for change. It uses scenarios in order to elicit future organizational goals.	[34]

SR. NO.	NAME	PROPOSED BY/YEAR	CLASSIFICATION	EXPLANATION	REFERENCES
7.	KAOS (Knowledge Acquisition in automated Specification)	Dardenne, Lamsweerde and Fickas (1993)	Framework	KAOS framework is based on temporal logic and AI refinement techniques where all terms such as goal and state are consistently and rigorously defined. The main emphasis of KAOS is on the formal proof that the requirements match the goals that were defined for the envisioned system. In KAOS, high level goals are refined until constraints, operations and objects that are assignable to individual agents are obtained. In order to specify critical parts of the system KAOS uses a formal language, besides using informal modeling. KAOS is more oriented towards goal satisfaction.	[28]
8.	Qualitative Reasoning about Alternative Options	Axel van Lamsweerde	Technique	In this paper, soft goals for evaluating alternative options arising throughout the RE process are used. To evaluate such options qualitative reasoning scheme is used.	[35]
9.	Tropos	John Mylopoulos, Jaelson Castro and Manuel Kolp.	Framework	Tropos is a requirement-driven approach and it is based on the concepts used during early requirements analysis (from i* modeling framework).	[36]
10.	AGORA (Attributed Goal-Oriented Requirements Analysis Method)	Haruhiko Kaiya, Hisayuki Horai, Motoshi Saeki	Method	A requirement Analysis Method based on goals.	[27]
11.	GOMS (Goal Operators method and Selection rules)	Card, Moran and Newell (1983)	Method	GOMS method is used to analyze the knowledge in terms of goals, operators, methods and selection rules.	[44]
12.	F3	Bubenko (1994)	Framework	This framework suggests the use of goals to uncover the weaknesses and problems.	[45, 50]
13	GQM	Victor R. Basili (1993)	Technique	In this approach goals are used for identification of matrices. Moreover, the system specification is validated against the stakeholders' goals.	[37]
14	Goal Oriented Idea Generation Method for Requirement Elicitaiton	K. Oshiro, K. Watahiki, M. Saeki (2003)	Method	[GOIGMRE]This method is used for the stakeholders to identify sub goals during, and to, facilitate requirements elicitation phase	[25]

SR. NO.	NAME	PROPOSED BY/YEAR	CLASSIFICATION	EXPLANATION	REFERENCES
15.	GSN(Goal Structuring Notation)	Wilson, Kelly, and McDermid (1995)	Technique	The GSN is a notation (accompanied by a method) that graphically presents how goals are decomposed into sub-goals, and eventually supported by evidence. As part of this decomposition GSN captures the strategies based on which the goals were decomposed, the rationale for the approach and the context in which the goals are stated (details about GSN can be found in [2]).	[38] [39]
16.	SIBYL	Jintae Lee (1997)	Tool	SIBYL is a knowledge-based system, representing and managing the qualitative aspects of decision making processes: such as the alternatives, the goals to be satisfied, and the arguments evaluating the alternatives with respect to these goals. Moreover SIBYL uses a semi-formal representation	[40]
17.	The goal scenario coupling framework	Rolland, Souveyet and Ben Achour (1998)	Framework	The goal scenario coupling framework is the tight coupling between goals and scenarios. The goal coupling is in forward and reverse direction; in the forward direction this coupling promotes goal operationalisation whereas in the reverse direction it promotes goal discovery .	[46]
18.	REMAP (representation and maintenance of process knowledge)	Ramesh and Dhar (1992)	Method	REMAP relates process knowledge to the objects that are created during the requirements engineering process.	[47]
19.	Goal- Based Workflow	Ellis and Wainer (1994)	Method	In the goal-based workflow approach proposed in (Ellis and Wainer 1994) an organisation is seen as a tuple [G, A, R] where G is a set of goals, A is a set of actors, and R is a set of resources. Actors act collaboratively using resources in order to attain their goals. In goal-based workflow the focus is on people and goals rather than on procedures and activities.	[48]

SR. NO.	NAME	PROPOSED BY/YEAR	CLASSIFICATION	EXPLANATION	REFERENCES
20.	The reasoning loop model	Louridas and Loucopoulos (2000)	Method	In particular it employees the notion of goal to denote designer's intentions (e.g., objectives to be reached, demands to be satisfied, problems to be solved). Achieving these goals is based on the generation of hypotheses as to the design actions to be taken which in turn produce or affect the design artefacts	[81]
21.	EKD (Enterprise Knowledge Management)	Kavakli and Loucopoulos (1999)	Method	EKD method proposes a set of models in order to describe enterprise knowledge. The purpose of describing enterprise knowledge is to handle situations like; i) Business process transformation or improvement. ii) Information system re-engineering. iii) Information system requirements elicitation etc. The models which are referred to as the product component of the EKD method are object, goal, actor/role, role/activity and rule models.	[42] [43]
22.	GAM (Goal Argumentation Method)	Ivan J. Jureta, Stéphane Faulkner, Pierre-Yves Schobbens.	Method	GAM method provides guidance for; i) justification of modeling choices during the construction of goal model instances. ii) detection of deficient argumentation within goal model instances. iii) It provides the techniques for the engineer to ensure that requirements appearing both in arguments and in model instance elements are clear.	[41]

3.5. ANALYSIS OF GOAL-BASED APPROACHES WITH RESPECT TO COVERAGE OF RE ACTIVITIES [49]

Software processes and process models are meant to reduce complexity and guide the execution of steps [26, 27, 28] involved in the process where a *process step* is defined as an atomic action of a process that has been decomposed to a reasonable extent to support the objectives of the process model and cannot be decomposed further. This notion gives rise to

the idea of granularity and the issue of lack of fidelity between the actual behaviour of the software development and the stated behaviour of the process because most of the time the process models represent high-level plans and the granularity of the process steps is too large. Hence, resultantly, the objective of guidance of the execution of the process is often not achieved [27].

Similar kind of abstraction exists in the process models of the current Goal-based approaches given in table-1, as the decomposition of the RE process into process steps (RE activities) is limited [49]. In other words, based on the comprehensive evaluation performed [49] by Kavakli et.al, it can be easily concluded that the existing Goal-based approaches still need to be improved with respect to coverage of Requirement Engineering activities as all of them, though proven successful, satisfy only specific RE contexts and not the entire RE domain.

Table 3-2 – Goal Based Approaches in relation to RE Activities

TARGET RE ACTIVITY	MAIN GOAL ANALYSIS CONTRIBUTION	GOAL-ORIENTED APPROACH
Requirements Elicitation & Analysis	1- Understanding the current Organizational situation, 2- Understanding the need for change	GOMS, Goal-based workflow, i*, GOIGMRE, EKD, ISAC, F^3, AGORA, GDC, TROPOS
Requirements Negotiation	3- Providing the Deliberate context of the RE Process	SIBYL, REMAP, The reasoning loop model
Requirements Specification	4- Relating business goals to functional and non-functional requirements	KAOS, GBRAM, the NFR Framework, the Goal-Scenario coupling framework
Requirements Validation	5- Validating system specifications against stakeholders' goals	GSN, GQM

All of the above discussion further highlights the need for a comprehensive process that covers the entire requirement engineering activities and deals with the problem of abstraction by decomposing the process steps to a sufficient extent.

CHAPTER 4

4. CHARACTERIZATION OF THE GORE PROCESS

4.1. RATIONALE BEHIND THE CHARACTERIZATION

Quality of the software product is determined by the quality of its development process [51]. S.T. Acuna et.al. argue that Software development cannot be improved by the introduction of certain effective tools or environments only; rather it requires the entire development to be seen as a process that considers the complex interrelation of a number of organizational, cultural and technology-related factors [51]. Every process-based research is motivated by this philosophy and GP [8] is no exception. However, inspite having the same philosophy, each process serves specific situations and is motivated by certain special factors from organizational, cultural and technological domains that make it unique. The following sections will explore the uniqueness of the GP and highlight the characteristics of the process based on different conceptual frameworks and perspectives. This characterization will also help position the GP in the domain of process research and systematically identify the areas where it needs improvement, if any.

4.2. MEANS OF CHARACTERIZATION

The GORE process (GP) presented in [8] by Naveed Ikram et.al. supports Goal oriented RE and is the only defined GORE process with the best coverage of RE activities, roles and artifacts. The evaluation given in the table 2 verifies that the current GO approaches (except for the GP) are limited in providing the support for all RE activities as they focus on a particular RE context. Hence, a part of the claim made by the GORE process is verified that, of all the GO Approaches, it provides the best coverage in terms of RE activities and analyzing the GP based on the Process and Process modelling concepts (explained in the previous sections) would help further verify this claim. Hence, following sections present a characterization of the GORE process with respect to:

- ✓ Basic Process Modelling conceptual framework given in [26, 51]
- ✓ Special Goal-based framework [49]
- ✓ In special comparison to one of the most popular GORE approaches - KAOS.

4.3. EVALUATION OF GP BASED ON THE PROCESS MODELING CONCEPTUAL FRAMEWORK

First part of characterization of the GORE process is done in the following section to position the GORE process with respect to the process framework concepts and ontology. (Adapted from [51]).

Table 4-1 - Characterization of the GP Based on Process Modelling Framework

CRITERIA	*Information Perspectives*				*Approach*		*RE Activities Covered*						*Process Elements Supported*				*Process Environments*		
	Functional	Behavioural	Organizational	Informative	Prescriptive	Descriptive	Req. Elicitation	Req. Analysis	Req. Specification	Req. Validation	Req. Management	Req. Traceability	Actor / Agent	Role	Activities	Artifacts	Organizational	Cultural	Scientific / Technological
GORE Process	✓	✓	✓	✓	✓	X	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Firstly, the attribution is done on the basis of conceptual ontology and basic process elements. Then GP will be evaluated from the viewpoint of the information it can address, and lastly the diverse process environments it covers will be presented.

The GP given in [8] is a ***Manual prescriptive*** model as it prescribes the recommended process for goal based RE instead of describing the existing process adopted from any organization as is the case in the descriptive modelling. It is aimed at defining the required means of executing a GP and guides how a goal-based requirement engineering process should be conducted.

From the perspective of information, GP satisfies all the 4 types namely informative, behavioural, organizational and functional. For satisfying the functional perspective, it outlines all the basic elements of a process such as roles, actors, activities and artifacts. Major

activities covered in this process correspond to all the goal-oriented activities such as goal decomposition, goal analysis, goal modelling and goal operationalization each of which in return correspond to relevant requirement engineering activity/activities. The actors include the wide category of stakeholders that can include all the relevant people from business and project domain as well as the primary actor of business analyst (requirement engineer) that may comprise representatives from the analysis and design teams depending upon the configuration of the analysts' teams as per the organizational rules. Finally, the artifacts include both the input and output work products, such as the document containing the highest level goals behave as an input to the process where as Goal graphs and goal taxonomies are the output artifacts from the process.

Another important criterion to assess is the process environments. Process environments comprise the factors from three inter-related environments namely organizational, cultural and scientific/technological. The Goal-oriented nature of the GP model explains the support for all the 3 process environments.

GP adequately handles the commonly occurring fidelity issue [27, 51] of the process modelling. This can be attributed to the full coverage of the RE activities as well as goal derivation activities which make sure that all the process steps are sufficiently decomposed to provide the details to a reasonable level so as to guide the execution of the process steps properly.

4.4. CHARACTERIZATION OF THE GP BASED ON THE GOAL DRIVEN FRAMEWORK

This characterization is inspired by the analysis performed in [49] by Kavakli et.al. of all the current Goal-based models. This section attempts to characterize the GP based on the same evaluation framework as defined in [49].

Figure 4-1 adapted from [49] depicts the main framework dimensions which address all the main aspects of goals. The selection of this framework is also inspired by its comprehensive coverage of the main goal-oriented concepts and aspects. The following section provides a summary of the evaluation of GP model based upon the dimensions of the proposed framework.

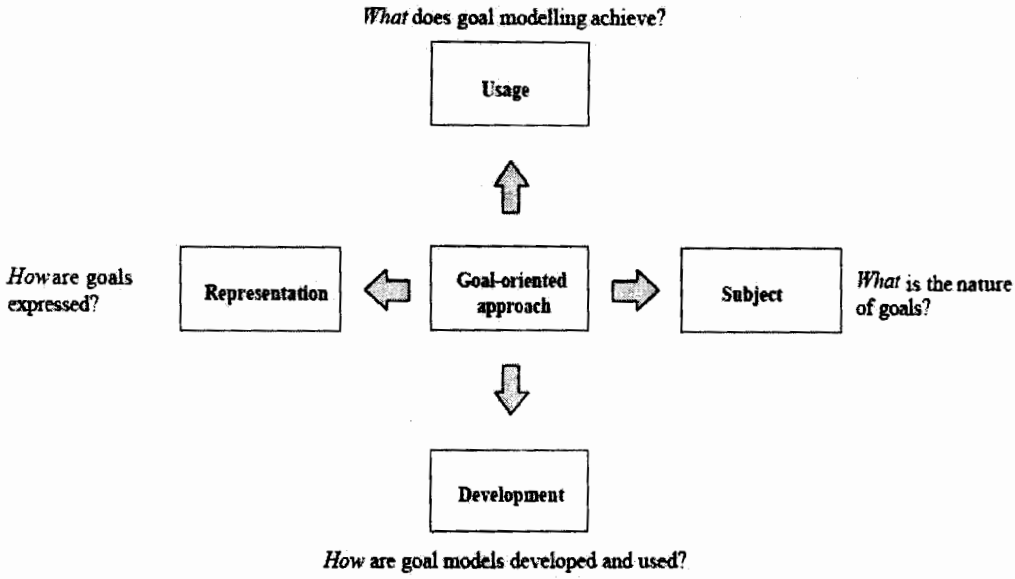


Figure 4-1 -Framework for Evaluating Goal-Based Approaches

As mentioned above the framework depends on four perspectives of goal-based models: usage, subject, representation and development. Following lines discuss the characterization done in table-4-2. A tick mark represents that the property is supported and a cross represents otherwise.

Table 4-2 - Characterization based on Goal Based Criteria

CRITERIA	*Usage*					*Subject*			*Development*		*Representation*		
	understand current org. situation	understand the need for change	provide the deliberation context within which RE occurs	relate business goals to system components	evaluate system specs against stakeholders' goals	Enterprise Goals	Process Goals	Evaluation Goals	Way-of-Working	Tool Support	Formal	Semi-Formal	Informal
GORE Process	X	X	✓	✓	✓	✓	✓	✓	♦	X	X	X	✓

4.4.1. USAGE DIMENSION

GP supports 3 out of 5 of the usage criteria. Although, the process does provide change management support generally but the specialized support for managing enterprise level goals is not provided in GP, hence the *understand the need for change* property is not checked for GP. Similarly, in the context of *understand current organizational situation* the GP does understand the importance of the business goals at the enterprise level but does not emphasize any kind of derivation in this context. As far as the attribute of *provide the deliberation context within which RE occurs* is concerned, GP fully supports the context of RE process that derives the entire goal-based development and supports problem solving such as conflict resolution through appropriate activities. Regarding *Relating business goals to the functional and non-functional system components*, GP supports 2 out of 3 categories. Out of *goal elaboration*, *scenario definition* and *non-functional requirements definition,* first two get sufficient level of support as the necessary activities for derivation of goals and scenario coverage are provided. Although, there is no explicit support for NFR which is the third category, but there is no restriction on the GP and it can be used for derivation of FRs as well as NFRs. *Validating system specifications against user goals* is another process quality that is supported by GP as an explicit plan of validation of user goals against scenarios is specified in GP.

4.4.2. SUBJECT DIMENSION

About the subject dimension, the criterion is based on the subject matter of the goal based approaches which is the goal graphs. This criterion takes into account 3 distinct but orthogonally related types of goals namely enterprise, process and evaluation goals. The GP support both the process and validation goals but not the enterprise goals as it provides the deliberation context for RE process as well as validation support.

4.4.3. REPRESENTATION DIMENSION

Representation deals with the notation used to express goal graphs. The possible subclasses of this criterion include formal, informal and semi-formal. GP satisfies the informal goal graphs types as there is no restriction defined in the process. However, it can be argued that

due to flexibility provided in the process, any of the 3 types of goal graphs can be developed however for the sake of clarity, this flexibility is being used to support informal notation.

4.4.4. DEVELOPMENT DIMENSION

Lastly, the fourth development view concerns the way that goal models are derived, and evolve. This view considers the dynamic aspects of goal driven approaches, i.e., the proposed way-of-working and the tool support provided for enacting this way-of-working.

The defined options for proposed way-of-working include:

- ✓ ♦ = suggest a number of steps and associated strategies
- ✓ Blank which implies that no steps have been identified

Whereas the defined options for tool support include:

- ✓ M = support for model construction, F = formal reasoning support, G = process guidance

TH 6889

GP does not provide the tools support hence the tool support cell for GP is left blank whereas proposed way-of-working is defined to the full extent as all the possible steps are explained in full length.

4.5. CHARACTERIZATION OF THE GP BASED ON COMPARISON WITH KAOS

It can be checkable from the current state of the art that KAOS (Knowledge Acquisition in Automated Specification) and the i* framework are the two main goal-oriented modeling techniques [52, 53]. The GP attempts to outline a hi-fidelity process with a full description of the possible goal decomposition and RE activities. However, it is important to verify the process integrity and for this purpose this last section will outline the differences of KAOS [13,23] and GP as KAOS makes the best model of the contemporary GORE approaches. Apart from the prominent success of KAOS, another reason of selecting KAOS for comparison with GP can be attributed to the critical comments on the GP [8] which highlighted the similarity of GP with KAOS. The comparison is not done on the basis of personal judgments to avoid biases and is based on the evaluation of KASO done in [54].

Table 4-3 - Comparison of GP and KAOS

CRITERIA	KAOS	GP
Completeness (Internal & External)	Uncertainty about the correctness of decomposition process.	Scenario driven Approach accounts for internal as well as external validity
Validity of Goals	Operationalization of the leaf goals not enough to ensure the validity	A scenario based artifact is maintained for the validity in later stages.
Reusability	No support for reusability or reusing old libraries	GP ensures the reusability of old goal libraries by the initial consultation of high-level goals.
Iteration	No support for revising a big model once a deficiency is discovered	The steps of GP clearly support the iterative development of goal models as each step refines the final artifact of goal model step by step.
Information gathering	No restriction guidance regarding information gathering techniques.	The lightweight and generic nature of the GP explains this aspect.
Formalism	Supports only the advanced user	It is a light-weight hi-fidelity guidance process presented in a process model that guides the execution of the process to the necessary details. Hence, works well for the beginners also.

4.6. NOMENCLATURE OF GP BASED ON CHARACTERIZATION

Based on the characteristics of the process identified in the preceding sections of this chapter, the GP is being named for ease of referencing as follows:

GREPLICA

Goal-Based **R**equirement **E**ngineering **P**rescriptive **Li**ghtweight **C**omprehensive **A**ll-Purpose Process

This nomenclature besides providing the privilege of ease of referencing also proves to be a quick fact sheet of the process main characteristics (which have been describes earlier in this chapter) and hence can provide a fruitful insight into the process attributes for the practitioners and researchers alike.

CHAPTER 5

5. VALIDATION OF THE GORE PROCESS

Previously, the GORE approaches have been analyzed and the GORE process [6] has emerged as the only documented, published, and unique process for GORE. This chapter, now, provides a validation for this GORE process through an industrial case study. The following sections describe the design of the case study in details including the selected case, data collection methods, the outcomes of the application of the proposed process and a discussion on the possible improvements. But before going into the details of the case and the results of the study, a review of the case study is presented to explain the details of the research method applied.

5.1. SELECTION OF THE CASE

As mentioned in the preceding lines, the research method applied here is case study as defined and explained in [24]. However, the case study has been designed in such a way so as to suit and prove valuable for the specific case at hand. As the main purpose of this case study is to validate a process, hence the need of comparison is inevitable. In order to fulfill this need, the case study was conducted so as to compare the existing process and GP.

5.1.1. RATIONALE BEHIND SELECTING AN ERP PROJECT

An ERP system can be defined as the parts and portions of the software that can be reused by the projects focusing on ERP Implementation to satisfy the organizations goals and build new systems [56]. While, the selection of an ERP project was unintentional and wasn't based on any intentional efforts, however its selection never proved to be a misfit rather endorsed the case study objectives. Infact, A lateral literature review on the ERP projects revealed that the problem of successful implementation of projects in ERP is also lower than expected like that of other software systems and goals based approaches have been proposed to solve problems related to the ERP systems' implementation as well [56].

Due to the following reasons, the ERP project is considered suitable for the study at hand:

- ✓ Like traditional software systems, the mismatch between the organizational goals and the requirements or system functionalities also exist in ERP projects.

- ✓ RE in ERP implementation projects is the most expensive stage [56, 57, 58] which implies RE process to be an important phase equally for ERP projects as it is to any other software system. Hence, ERP projects can provide a very good opportunity for RE process validation.

5.1.2. INTRODUCTION TO THE PROJECT

The implementation of the process started with the selection of an appropriate case to conduct the case study. The selected case for this validation is a project from the domain of a Government Organization that deals with taxation and related business activities. This client company is going to be referred to as Company-A in the rest of the document for the sake of ease of referencing and confidentiality whereas the development team for this project was from an internationally renowned organization that has expertise in providing ERP solutions to big client organizations. The development organization will be referred by the name of Company B and the development team will be considered as Team B in the rest of the sections of this document. The Project that was selected for this study was an ERP project concerned with the automation of following components of the company A:

A. Financial Accounting (FI)
B. Controlling (CO)
C. Project Systems (PS)
D. Materials Management (MM)

The case study was designed so as to facilitate a comparative study of the proposed process and the existing process on the live real functional sub systems of the above mentioned project. The unit of analysis, hence, is a functional package from the FI module of the project on which the proposed process has been applied. The chosen unit of analysis and its details will be discussed in the later sections. The application of the proposed process on a live project showed various interesting advantages as well as certain potential improvements which will be discussed later on in the chapter.

5.1.3. TEAM COMPOSITION

The team composition (Fig-1) for the ERP project was hybrid. The team B, which comprised of 6 members including project manager (PM), had the main task of implementation of the ERP system. Whereas, an ERP team from the company A, which will be called as team A from now onwards, was responsible for liaison with team B to discuss the implementation and related ERP matters and ensure the proper user involvement and communication of both the teams.

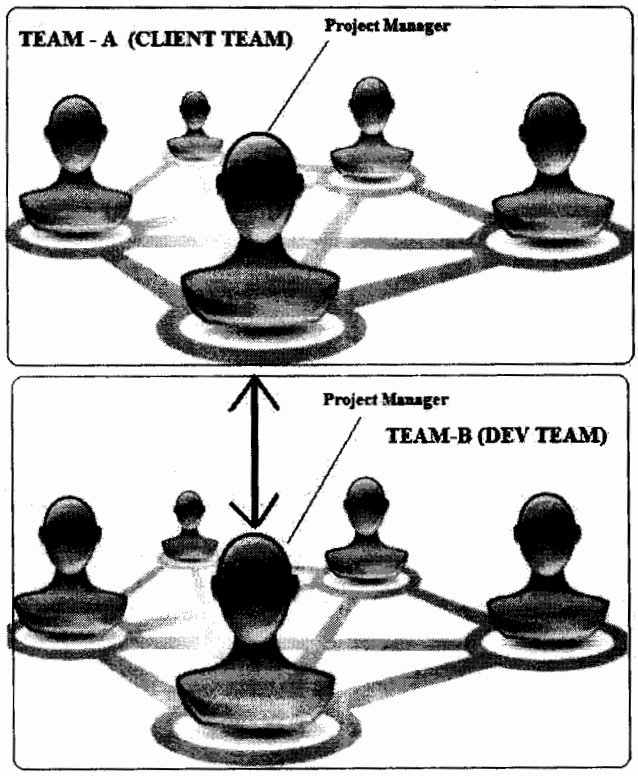


Figure 5-1 - Team Composition

5.1.4. INPUT AND OUTPUT DATA

The case study relied on different methods of data collection which increases the validity and integrity of the data being collected and hence adds to the credibility of the results of the case study. Input data was collected on daily basis so as to avoid any confusion and ambiguity later on in the process.

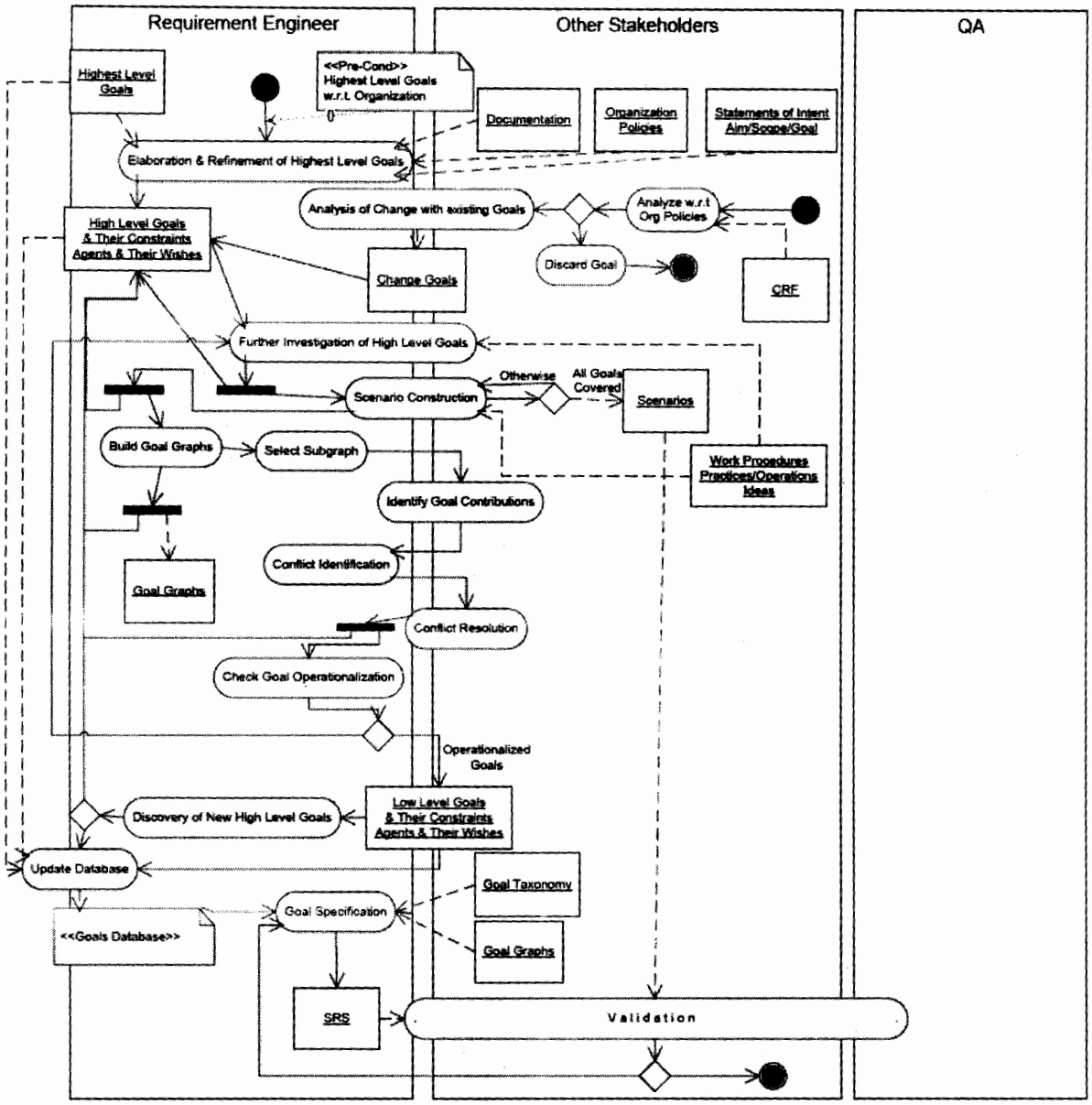


Figure 5-2 - The GORE Process [8]

Moreover, besides relying on two modes of data collection, the sources of data collection were also multiple, as the same information and data was acquired through different methods from both teams, A and B. The main methods for collecting data comprised of:

- ✓ Documents Analysis
- ✓ Interviews
- ✓ Direct Observation

For the ease of understanding the data can be divided in the 3 types. Although, complete and accurate details on the input and output data can be found in the case study design section, the mention here is to outline the data requirements and data production.

Pre-Execution Data:

As the name suggests, the data in this category mainly comprised the project charter, the project plan and other documents containing the company and the project profile. The documents consulted and provided by both the company A and company B included:

- ✓ Project Scope
- ✓ Organizational history
- ✓ Project Charter and Project Plan
- ✓ Documents explaining the Existing RE Process being followed

Besides the document study method, interviews were also conducted from the team members of both the company A & B wherever the need arose to collect the information about the project and company history. The details of the documents and interviews shall be explained in the section pertaining to the implementation of the process.

In-Execution Data

This section comprises the data developed during the implementation of the process as suggested by the GP and immediate feedback. This group of data includes:

- ✓ Different goal-based models and descriptions produced in different steps of the execution of the process.
- ✓ The simultaneous feedback of the process taken during the course of the process execution.
- ✓ Data from different log books maintained during the execution of the process.
- ✓ Experiences during direct observations

Post-Execution Data

The third category of the data namely post-execution data was collected after the execution of the GP. It mainly was composed of feedback taken through interviews from both the teams A and B.

- ✓ Finalized goal models and related documentation
- ✓ Proposed process feedback

5.2. DETAILED CASE STUDY DESIGN

5.2.1. OBJECTIVE OF CASE STUDY

The case study was organized to be a single-case design as the object of the case study, i.e. the process to be implemented - GREPLICA – is comprehensive and covers all RE activities. Hence, it was time consuming to design the case study to be multiple-case.

The case study was organized to be conducted in purely qualitative manner. Following lines outline the purpose of evaluation:

a. Investigate whether GREPLICA is a practical process or not in terms of implementation.

b. Test the results of GREPLICA against REOs.

c. Confirm whether GP meets its self-defined objectives or not.

d. Outline any/all issues to outline the improvement for the process.

The scope of evaluation was limited to the Requirement Engineering phase and the evaluation did not cover the management aspects such as finance and marketing.

5.2.2. EVALUATION CRITERIA

Evaluation of the case study was designed to cover all the major aspects of Process Assessment. For, this purpose a comprehensive 3D framework was formulated which is briefly discussed as follows:

a. First dimension of the framework covered the major REOs (Requirement Engineering Objectives) namely:

   i. Completeness

   ii. Understandability

   iii. Traceability

   iv. Pertinence

b. Second dimension outlined the GP self-defined objectives including Optimized and relatively better:

v. Discovery of Goals

vi. Coverage of RE Activities

vii. Requirements Management Support

c. Third and final dimension shall cover the process dimension including factors as ease of application and flexibility of the process:

viii. Robustness

ix. Flexibility

2. Outlining a Measurement System.
3. Prioritizing the criteria.
4. Selecting Evaluation Methodology.
5. Producing raw data for the analysis.
6. Compiling and reporting the results.

5.2.3. RAW DATA

The raw data shall be in the form of different reports including:

1. Daily Performance Report which will include but will not be limited to:
   a. Work Performed on that day
   b. Major and Minor RE Activity/Activities initiated and/or completed
   c. Step(s) of the process covered/completed.
   d. Artifacts produced.
   e. Roles Involved
   f. Data concerning following points shall be maintained separately.
2. Deficiency Log
3. Journal of Immediate Observations of the Analysts gathered through the interviews intended to be conducted at the end of each day.

5.2.4. FORMAL DATA

Formal data shall comprise of all those documents that will be formulated during the course of the GP and are going to contribute towards the main deliverable of the RE phase: SRS or detailed software specifications. While analyzing the deliverables it should be noticed that GP supports the iterative development of its main deliverable i.e. goal graph.

Following table outlines the main deliverables and associated details.

Table 5-1 - Summary of Formal Data to be Created

STEP of GP(GREPLICA)	DETAILS OF THE ARTIFACT	MODE, NAME & CODE OF THE ARTIFACT	CONTRIBUTIONS TO SRS
GP-1	High Level Goals, constraints, agents and their wishes	Create - Statement of Goals (HLGS)	Objective Section of SRS
GP-2	Refinement of HLGS	Update – Statement of Goals (HLGS)	Objective Section of SRS
GP-3	Explicit Documentation of the Scenarios to cover all the elicited goals	Create – Coverage Scenarios (CS)	Appended with use cases.
GP-4	Goal Models with all the hierarchy definitions	Create - Formal Goal Graph (FGG)	Appended in SRS as a separate section
GP-5,6	Goal Models with details about goal contributions	Update – Formal Goal Graph (FGG)	Appended in SRS as a separate section
GP – 7,8	Goal Models adjusted after conflict resolution	Update – Consistent Formal Goal Graph	Appended in SRS as a separate section

STEP of GP(GREPLICA)	DETAILS OF THE ARTIFACT	MODE, NAME & CODE OF THE ARTIFACT	CONTRIBUTIONS TO SRS
GP – 9 ,10, 11	Goal Models updated for operationalization details	Update- Final / Complete Goal Graph	Appended in SRS as a separate section

Feedback & Reporting

The feedback shall be taken from the Documentation Logs maintained specially for this project and interviews conducted at the end of each day regarding the activities up taken, continued and/or finished during the course of that day. It is to be noted that the process shall mainly be executed by the Analysis Team of the target organization in order to eliminate any bias regarding the skill level. As the case study is improving as well as explanatory (which involved confirmatory studies)-cum-exploratory as mentioned in [61], the reporting shall be extensive; at two levels namely:

- ✓ **Level-1 Reporting** shall assess the extent of process validation based on the 3D criteria defined earlier. A quantitative evaluation for the fulfillment might be defined to make the results more objective. This level shall satisfy the confirmatory part of the case study.
- ✓ **Level-2 Reporting** shall be in the form of problems and in-depth analysis of the issues faced during the implementation of the process. Certain recommendation shall be derived from the results of level-2 and shall form the basis of proposition for improving the effectiveness of the process. This level shall address the exploratory needs of the case study.

5.2.5. LIMITATIONS OF THE CASE STUDY

2.3.1.1. Single-Case Design

As the case study was designed to be a single-case, hence there will be a need of replication of the case study to generalize the results. However, this limitation is compensated by strong validity constructs such as multiple data sources.

2.3.1.2. Limited Scope

The case study was being implemented on a large scale ERP project to note down the effects of GREPLICA on early phases of development only i.e. RE phase. Hence, the case study schedule and scope did not take into account the later phases of development (such as design or coding) or the overall finished product quality nor did it claim to do so at the start of the research. However, careful designs of further cases studies and experiments can account for this limitation in the future research.

5.3. DISCUSSION ON THE EXISTING PROCESS OF COMPANY B

Company B follows the standard SAP implementation methodology known as ASAP (Accelerated SAP) [59, 60] which is a very comprehensive model for ERP implementation projects. The discussion on ASAP is out of scope for this case study as the entire methodology is a large-scale solution for implementation and optimization of ERP systems whereas, the focus in this study is confined to RE only. However an attempt was made to capture the RE-related issues. Hence, on interview (which is attached in the appendix A) and document analysis, many RE problems were identified which are discussed below:

- ✓ The company suffered delays in requirements acquisition and the requirements workshops and meetings were delayed. Infact the entire B2P (business blue print) phase was already over-running the planned schedule.
- ✓ Within ASAP, no special process model was being followed for guiding or managing the requirements activities specifically.
- ✓ The tool support and the methodology were being efficiently used to satisfy the technical aspects where as inter-personal aspects were ignored which was proved by the need to arrange additional RE meetings and workshops with clients.

5.4. IMPLEMENTATION OF GREPLICA/GP MODEL

The case study was conducted in detail and took two months to complete. As the design reveals, it spanned the RE phase of SDLC and was conducted by the Team B under the supervision and guidance of the author in a qualitative manner. Although the author also occasionally became part of the team in order to guide and elicit the feed back ethnographically, but it was very limited. As has already been explained that the project

scope comprised 4 major sub-systems; however the case study was conducted on Accounts Payable module of the FI sub-system. Remaining sections of the document discuss the detailed activities of the process (fig-1) when implemented on the project.

5.4.1. ELABORATION & REFINEMENT OF HIGHEST LEVEL GOALS

This activity gave a very good start for the team B to proceed and mainly depended on the first phase of the ASAP methodology namely Project preparation [59, 60]. Normally, the high level objectives are studied for the sake of documentation but this experience to study and document the goals in order to drive the process was new for the team. Apart from being a technical way of driving the process, this activity increased the general confidence of the team in knowing about the Company A. While studying the documents, it was revealed that the project and hence its goals were inspired from another similar project of the sister-organization of Company A, which was related to financial reporting and auditing. Following goals were extracted from different project and company documents:

- Adopt and implement best business practices
- Modernize Government Audit procedures
- Adoption of Internationally accepted Accounting and Auditing standards
- Improved Financial Accounting and Information systems
- Tighter internal controls
- Build staff capabilities

However, on close inspection of the project goals, the level of abstraction of the goals seemed low and the goal sets were disjoint. Hence, at this point no goal graph was developed and the next step naturally gave a very good follow up activity.

5.4.2. FURTHER INVESTIGATION OF HIGH LEVEL GOALS

This activity was accomplished by consulting both the PMs from Team A and Team B. *How, Why, What* and *How Else* questions were asked during the unstructured interviews from Team A and Team B PMs.

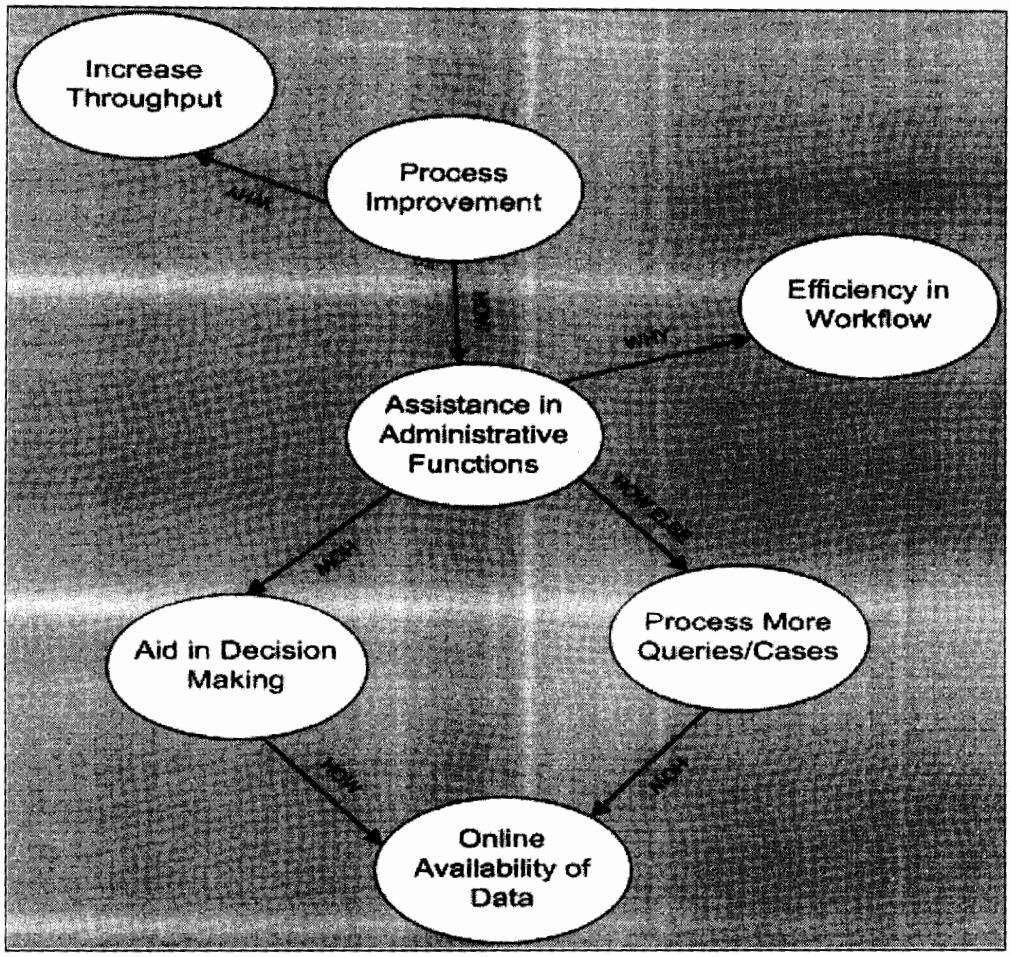


Figure 5-3 - High Level Goal Graph after 1st Iteration

This activity supported both the top-down (what, how) and bottom-up (why) decomposition of goals as well as the goals at the same level (how-else) were also elicited in this step. The disjointness of the goals was also removed as the goal links provided a very rational connection between the goals.

The goal graph constructed as a result of this step is shown in fig 5-3.

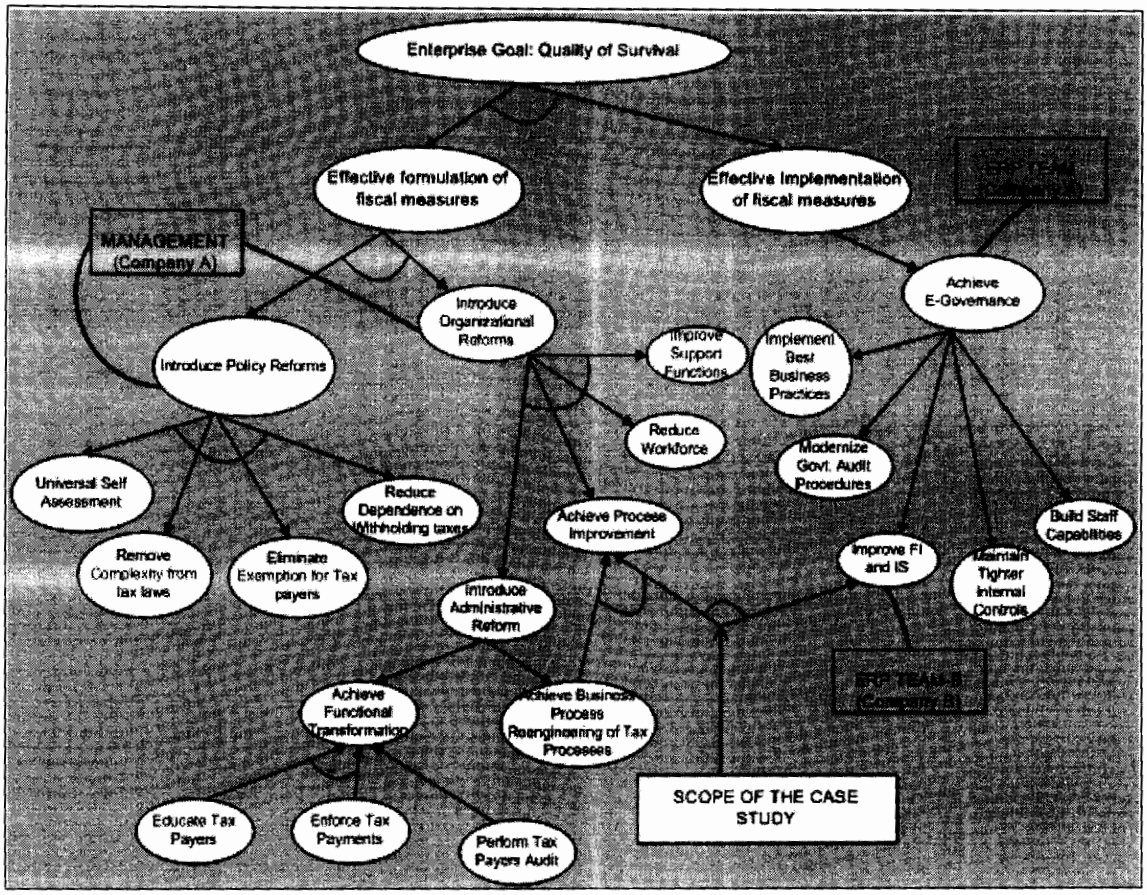


Figure 5-4 - High Level Goal Graph after 2nd Iteration

5.4.3. SCENARIO CONSTRUCTION

In this activity scenarios were constructed in order to provide the benefit of discovery of new high level goals, better validation and operationalization of high level goals. This activity revealed further goals and helped in providing the missing links. Besides, being very fruitful and advantageous in terms of goals and requirements, it was also termed as easy by the company A as all the members of team A were already familiar with the concept of use cases. However, the scenarios that were constructed were in the essential style and a template was developed before actual writing activity.

Scenario # 1

Name: Generate Purchase Requisition

Purpose: To raise a purchase order when a requirement is generated from the user and the item is not in the stock.

Rationale: To facilitate the user departments and improve the process

Precondition: The user is eligible to raise the request

Postcondition: Purchase Order successfully generated

Steps:

1. The procurement department will run the purchase requisitions list.
2. Selection of type of Planning.
3. a. If it is schedule then periodic schedule MRP will run.

   b. If it is urgent then MRP will runs for single item.
4. Display the generated MRP list.
5. Check for any abnormality.
6. a. In case of abnormality amends/correct the respective data.

   b. If there is not abnormality Purchase Requisition will be generated.
7. Purchase Requisition release required forwards it to approving authority for approval.
8. Approving authority will approve the Purchase Requisition and the process will end.
9. Manual Purchase Requisition process will start with the creation of reservation.
10. After receiving the reservation Procurement Department will check the stock availability for that material.
11. If the stock is available then Procurement Department will issue the material against the reservation.
12. If stock is not available then Procurement Department will creation the Purchase requisition.
13. Purchase Requisition will be approved by competent authority.
14. After the approval of Purchase Requisition Procurement Process will start.
15. When the Procurement Process will complete and the material arrived then
16. Procurement Department will issue the material reference to the reservation.

Scenario # 2

Name: Create RFQ (Request for Quotation)

Purpose: To request pricing from the vendor.

Rationale: Upon receiving the vendor responses, quotes/ prices are updated in the quotation record for evaluation and selection.

Precondition: A standardized printout is to be used in COMPANY A for all requests made to supplier.

Postcondition: Upon receiving the vendor responses, quotes/ prices are updated in the quotation record for evaluation and selection.

Steps:

1. Value will be checked in case value not greater than Rs. 100,000 process will end.
2. In case value greater then Rs. 100,000 it will check whether Technical proposal required or not.
3. In case Technical proposal required, Technical proposal will be called. Go to step 5.
4. In case Technical proposal not required financial proposal will be called.
5. Proposal(s) will be received.
6. It will be checked that it is fulfilling the prequalification criteria. In case no process will end.
7. In case of fulfilling the prequalification criteria bidder price will be maintained.
8. Technically bid will be evaluated out of SAP system.
9. Price comparison will be executed.
10. Best quoted vendor quotation will be selected.
11. Quotation will be accepted or rejected.
12. In case quotation accepted approval will be obtained for successful quotation and PO processing will start and quotation will be converted into PO.
13. In case quotation rejected it will be rejected with reason.

14. Rejection letter will be sent to vendor and process will end.This activity provided various advantages, which are listed below using the example of scenario number 1:

The high level goals discovery was made easy by asking questions about the rationale of the scenario. For e.g. scenario 2 helped in discovering a very new important goal for the goal graph which was "Facilitate the Employees" which on further investigation revealed that the Quality of Survival of the Company can be achieved by maintaining relationships with both customers and clients (i.e. tax payers). The goal graph after the scenario construction activity is shown in the fig 5-6 which clearly shows both these newly discovered high level goals

- ✓ The scenarios made the operationalization task very easy. The high level goals were operationalized as new details were added to each scenario such as preconditions and post conditions.
- ✓ Missing links of goals graphs were provided in a systematic manner and facilitated the goal-based thinking.
- ✓ The task was easily accomplished with minimum of effort and provided support for validation activity done later on.
- ✓ The activity of scenario construction seemed ideally placed between the proceeding (goal graph development) and preceding (further investigation of high level goals) activities.

A summary of this activity is presented here in the following table 1:

Table 5-2 - Summary of Scenarios and New Goals Discovered

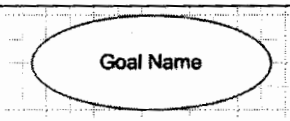
SCENARIO NUMBER	SCENARIO NAME	NEW GOALS DISCOVERED	EXPLANATION
1	Generate Purchase Requisition	1. Facilitate Employees	A why question about this scenario revealed that organizations (especially government Org.) are interested in the Quality of survival and wish to extend support for their employees

SCENARIO NUMBER	SCENARIO NAME	NEW GOALS DISCOVERED	EXPLANATION
2	Create RFQ	1. Maintain Organizational Integrity	Quotations are raised to request the pricing from vendors and it is done according to certain rules which are neither facilitating its employees nor facilitating its clients i.e. tax payers. Hence a why question about this scenario revealed another high level goal which is Maintain Org Integrity.

5.4.4. BUILD GOAL GRAPH

This activity ensured that the goal graph is complete and accurate as it was incrementally developed and recurrently was supported by activity number 2 and 3. The following table shows the goal graph elements used in the goal graph presented in figure 5-6.

Table 5-3 - Goal Graph Elements

SR. #	SYMBOL	NAME	EXPLANATION
1		Soft Goal	Goals that are satisficed and are non-functional in nature
2		Hard Goal	Goals that can be satisfied and are functional in nature
3		AGENT	Software, hardware or human components responsible for the fulfillment of the goal

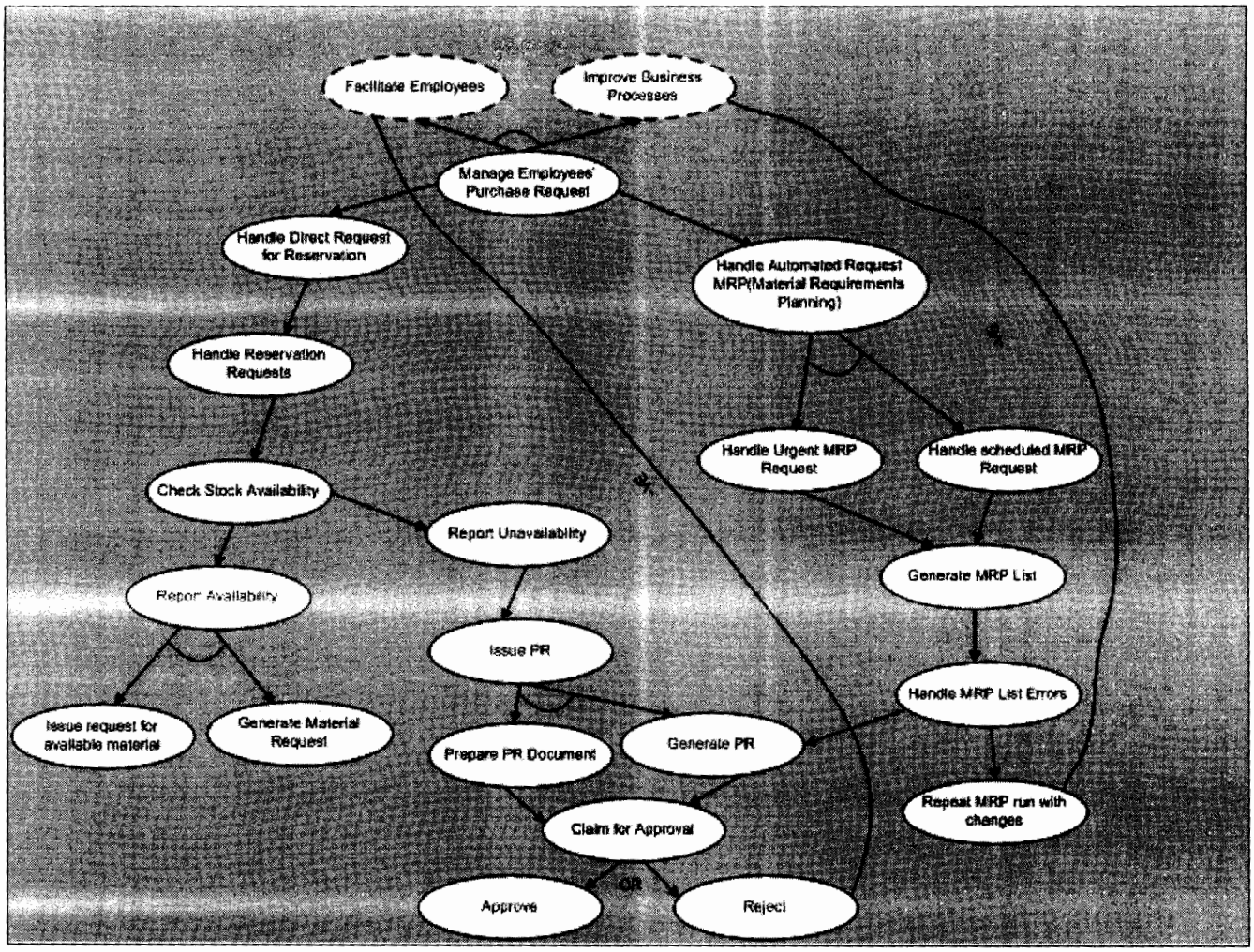


Figure 5-5 - Goal Graph for *Generate PO* Scenario (Materials Management Module)

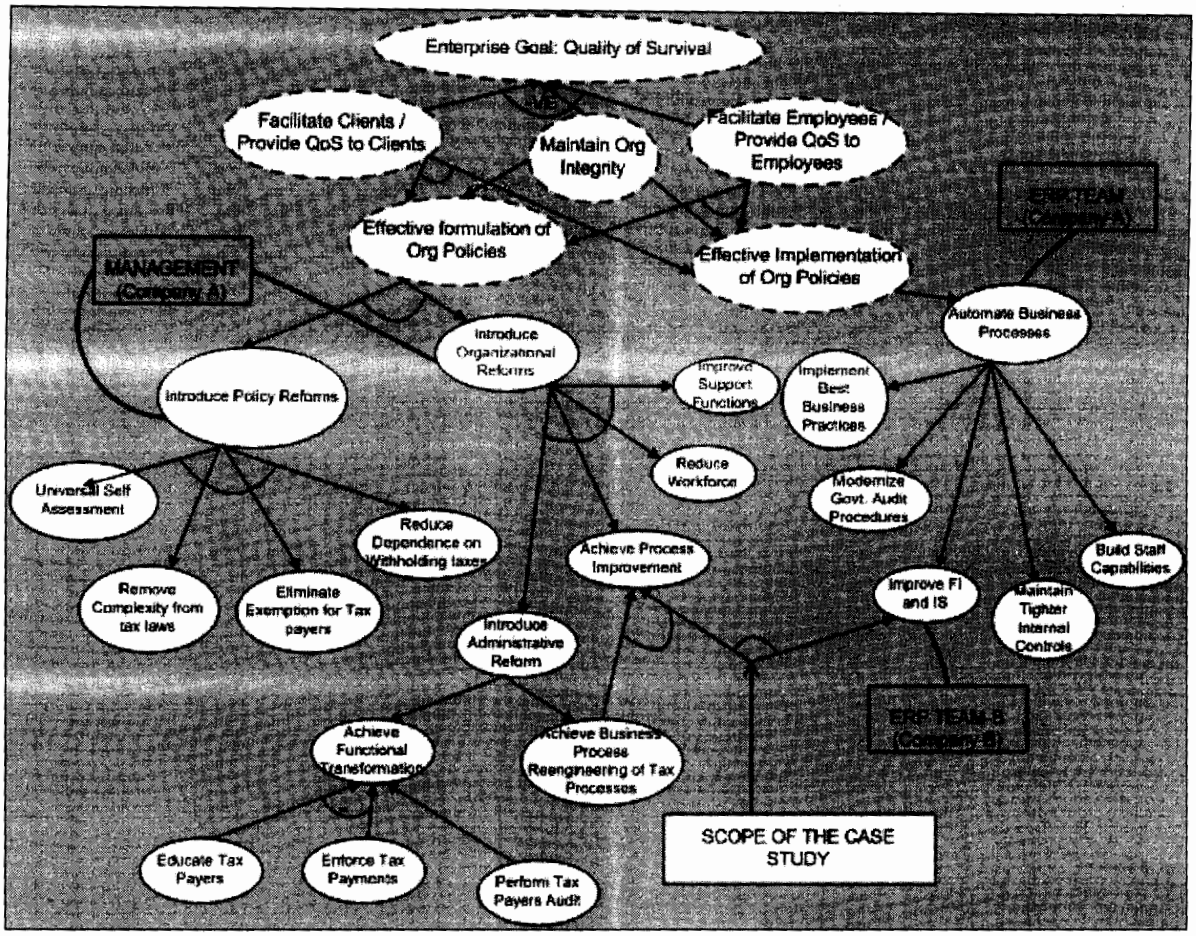


Figure 5-6 -High Level Goal Graph after 3rd Iteration (After Scenario Construction Activity)

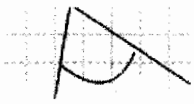
5.4.5. SELECT SUB GRAPH

This activity was conducted on the base of intuition by selecting a sub graph from the main goal graph. The team B with the help of author devised a rule for selecting a sub graph in order to avoid confusion. The sub graph was selected based on bottom up approach and 5 node-deep rule was formulated and applied according to which the sub graph was selected which was at least 5 nodes deep from the root node. For instance, in the goal graph of figure 5, the sub graph with the highest node of "Check stock availability" was selected which resulted in the graph ending at leaf nodes Issue request for available material, Generate Material Request, Approve and Reject. This graph was further used in the next activity discussed in the following lines.

5.4.6. IDENTIFY GOAL CONTRIBUTIONS

To identify goal contributions, a legend was defined that contained the main contributions and brief descriptions to aid the team. The main goal contributions depicted in the fig. 5-6 are explained in the following table:

Table 5-4 - Legend for Goal Contributions

SR. #	SYMBOL	NAME	EXPLANATION
1	-VE	Negative contribution	When two goals are in conflict with each other or hurt the attainment of the parent goal
2		AND Contribution	When both the child goals are necessary for the attainment of the parent goal
3		OR Contribution	When one of the child goals should be fulfilled to fulfill the parent goal

5.4.7. CONFLICT IDENTIFICATION & RESOLUTION

Conflicts identified in this activity were later on resolved based on the negotiation. On one hand, Conflict identification and resolution provided a very good rationale for the requirements meeting scheduling and on the other hand they made a very good agenda for these very meetings.

5.4.8. CHECK GOAL OPERATIONALIZATION

Operationalizations ensured the completeness of the goal graph and were supported a great deal with the scenario construction activity.

5.4.9. UPDATE GOAL DATABASE & GOAL SPECIFICATION

Of all the activities carried out in the process, database update activity was ambiguous as the term database was not defined. This activity was carried out manually by the team as the database specialization was not present in the team. The activity carried out manually made

sure that the goals and their attributes were properly captured. Hence, the table maintained for the storage purpose also served the purpose of specification.

5.4.10. GOAL VALIDATION

This activity is dependent on the scenario construction activity and was conducted in two steps. Initially Team B validated the goals by mapping scenarios to the goals and later on stakeholders were also involved in this validation exercise.

5.4.11. CHANGE MANAGEMENT

The change management process already being followed by the Team B was supported by tools. Hence, this part of the claimed process couldn't not be validated as the team B could not be convinced to switch from their automated change management process to the manual process suggested by GREPLICA.

5.5. DISCUSSION AND ANALYSIS

5.5.1. EVALUATION OF GREPLICA AGAINST REOs

Table 5-5 - Evaluation of GREPLICA with respect to REO

	IMPACT	REASON	MAPPING OF THE REASON to GREPLICA
PERTINENCE	Highly Improved	Iterative and Incremental Development of GG	Goal graphs development and refinement activity removes all duplicate and ensures the presence of relevant goals.
CORRECTNESS	Highly Improved	Lower conflicts rates among goals, Validation of goals by Scenario,	Conflict Resolution Scenario Construction Goal Validation
TRACEABILITY	Slightly Improved	Lack of Database tool support to store traceability links	Lack of tool Support
UNDERSTANDABILITY	Highly Improved	Complexity of the goals models was reduced	Goal decomposition activity reduced the complexity.

5.5.2. EVALUATION OF GREPLICA AGAINST CLAIMED BENEFITS

Table 5-6 - Evaluation of GREPLICA against Self-Claimed Benefits

SELF-CLAIMED BENEFIT	VALIDITY	REASON
Top-Down & Bottom-Up Support	HIGH	Iterative and Incremental Development of GG
Coverage of RE Activities	HIGH	Deficiency logs did not contain any entry about an unaccounted RE activity.
Coverage of GORE Concepts	HIGH	GORE ontology is usefully employed by GORE.
Requirement Change Management Support	LOW	Lack of Tool Support
Support to other Management Activities	LOW	Lack of Tool Support

5.5.3. SUMMARY OF EVALUATION

At the end of case study, following improvements and observations were made:

1. The main advantage of the GREPLICA can be attributed to the scenario construction activity. Apart from being an easy and not-so-formal activity, it also ensures the completeness of the goal graphs and hence the related requirements.

2. Goal database should be supported by at least an Entity Relationship Diagram (ERD) model to guide the developers about the goal attributes. Infact, a database with fully defined entities and attributes is the real need of the process as it tends to bring the much needed support to store the goals and related artifacts.

3. As is mentioned by A.V. Lamsweerde in [62], goal methods should support 4 distinct and desired qualities: Model-driven nature, Constructive, Incremental and Rigorous but lightweight. After the analysis, GREPLICA was analyzed to be supporting all the first 3 characteristics. All 4 are discussed one by one briefly in the following lines:

a. GREPLICA is model based as the figure 5-2 confirms. Models tend to provide a desired reduction in complexity to support the users of the RE method. The dependencies abstracted in the model simplify the possible directions, inputs and outputs of various activities.

b. GORE method should be constructive enough to properly guide the construction of goal graphs of not only small systems but also large complex systems. The comprehensive nature of the GREPLICA in terms of coverage of GO and RE activities and its application on an ERP system provides strong support for its constructiveness.

c. Figures 5-3, 5-4, 5-5 and 5-6 clearly depict that the process supports the iterative and incremental development of goal graphs. As RE is normally termed as knowledge discovery process, hence a good RE method is bound to support this natural requirement of the RE area and GREPLICA provides enough support for this characteristic.

d. The final characteristic is partially fulfilled by GREPLICA as its not a formal model and provides easy to understand semi-formalism that serves the users of this model without exposing them to any complexities of the RE models. This proves that the process is light-weight. However, one area where the process needs to improve is that it can be made more rigorous by developing tools to provide a platform for developing the goal graph and managing all the contributions and taxonomies in and efficient manner. Moreover, as mentioned earlier in the discussion and analysis, a fully implemented database is going to support the GREPLICA and its users a great deal.

CHAPTER 6

c. The need of the characterization arose from the fact that the process inspite of covering major RE and Goal-based activities lacked an insight into its empirical and ontological base pertaining to both process as well as goal-based concepts. The process based evaluation confirmed the claim about the coverage of necessary activities by GREPLICA as it covers all the necessary activities related to goals and requirements; a property termed as hi-fidelity in the context of process ontology. It further attributed GREPLICA from other process perspectives and further clarified its taxonomy and classification. Besides the evaluation according to process ontology, the research also identified the distinctiveness of GREPLICA as compared to other relevant models in the Goal-based arena by evaluating it according to a goal-based framework based on usage, subject, representation and development of goals.

d. This part of characterization added further depth to the process and helped reveal the status of GREPLICA in goal-based research. Moreover, a comparative study has also been presented which states the differences of GREPLICA and KAOS in order to finalize the claim of distinctiveness of GREPLICA. Resultantly, this literature-based evaluation underlined the unique properties of the process and theoretically confirmed the claims made by GREPLICA besides hinting to the areas of potential improvement.

2. The next step to any theoretical concept is the practical validation, which this research has performed by applying the process model to a live industrial case study. The case study was conducted in a confirmatory-cum-exploratory fashion which not only helped validate the claims of the process but also specified the potential improvements. The ERP project was analyzed for its RE phase while applying the GREPLICA after training the development team (referred to as Team B in the thesis). The analysis of the case study gave a very positive feedback and confirmed the advantages of GREPLICA. The feedback from the team revealed that the process is very easy to apply in practical settings and aids the development of requirements due to the favourable knitting of the process steps. For instance, the placement of Scenario Construction activity right after further investigation of high level goals activity and before Build Goal Graph activity provided the right type of follow up and start for both the activities respectively. This proves that the model is easy to implement and is

6. CONCLUSION

This chapter discusses the conclusion and future prospects of this research.

6.1. CONTRIBUTIONS OF THE RESEARCH

Out of the entire software development process, the requirement engineering activity is the most fundamental phase which is characterized by heavy social interaction among stake holders and can define the fate of the software. In order to manage this socio-technical process many models have been proposed which can be divided into two main categories: Traditional approaches and Goal-Oriented Approaches. Although, traditional approaches have been used widely since the early days of software development; however they remain limited in terms of providing support for varying needs of RE field. Hence, Goal oriented paradigm was introduced to cater the needs of variety of software projects and has managed to live up to the expectations of the RE community. However, different models concentrate on different context of RE and goal activities.

Hence, a comprehensive GO process in terms of coverage of both, goal-oriented and requirement engineering activities to guide the practitioners and its validation has been the need of the hour. The contributions of this thesis include:

1. Firstly the characterization of the process GREPLICA to analyze the process with respect to both goal-based and process-based frameworks.
    a. This not only highlighted the process strengths and weaknesses but also helped in positioning the process model under study with respect to process ontology and goal-based evaluation framework.
    b. As a result of this characterization, the nomenclature for the GP has also been suggested (GREPLICA) which emphasizes on the characteristics of the process. This technique assists in finding out the extent to which it can be useful for practitioners in the RE area.

carefully formulated keeping in view the pragmatic RE process requirements. The entire process proceeded seamlessly supported the natural RE process flow. Not only did the validation support the process claims but the exploratory mode of the case study gave valuable feedback to improve the modeling of the process and the daily logs maintained throughout the course of the case study execution helped enormously in this regard. Due to this spontaneous feedback mechanism, the validation and improvement results can be highly regarded.

6.2. RECOMMENDATIONS AND FUTURE WORK

It is important to understand the process requirements for requirements engineering process as the entire software development is dependent largely on the RE phase for its quality. Processes represented as process models guide the development and good validated process models ensure that the concerned artifact produced is of desired quality. Conclusively speaking a good requirement engineering process is central to a good final software product. Although, RE is central to both hardware and software; however, speaking specifically about software, the need of a validated process model increases manifold as the final product is not tangible and hence demands for an extra care in precise understanding of requirements which can be guided well through a process model that is easy enough to follow and adapt and strict enough to keep the requirements on track. It has been practically proved that a generic but comprehensive requirements engineering process can ensure the effective and efficient development and management of requirements. Apart from validation, the research results have also outlined an improvement proposal.

The improved process needs to be further validated which can chalk a very direct and clear direction for future research in this regard. Generally speaking, as the case study results can not be abstracted hence there is a need to do more research to validate the process on different types of software engineering projects especially on small and medium type projects to ensure the claim that the process is generic and can serve a wide variety of software projects. It is hoped with great conviction that the area of requirement engineering processes can benefit greatly from further research on this topic.

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APPENDICES

QUESTIONNAIRE FOR ANALYSIS OF EXISTING REQUIREMENT ENGINEERING PROCESS AND PROBLEMS

PARTICULARS OF THE RESPONDENT:

Name:_____
Qualification:_____
Main Role in Project:_____
Any Supporting Role:_____
Any Special Responsibility related to Requirements Engg. Activity:_____

QUICK FACTS:

Facts	Responses	Any Extra Details
Project Name		
Project Team Members		
Team Members specified for RE Activity		
Experience (Number of Projects up taken)		

Q 1) What process is you currently following for gathering and eliciting requirements from the customers?

_____
_____
_____
_____
_____
_____
_____
_____
_____

Q 2) Are their any specific techniques for the following requirement engineering activities that you follow?

Requirements Elicitation:_____
Requirements Analysis:_____
Requirements Specification_____
Requirements Validation_____
Requirements Management_____
Conflicts Resolution_____
Requirements Prioritization_____

Q 3) What problems you most commonly face during the Requirements Engineering process?

Q 4) Do you have pre-planned techniques for resolution of different problems that occur during Requirements Process?

Q 5) Do you have any fixed formula for specifying time and cost for the RE activity in the entire project timeline?

Q 6) Normally what proportion of time you dedicate for finalizing requirements from the customer?

Q 7) How do you gather different requirements for your projects?

Q 8) Do you plan any special sessions with your customers?

Q 9) Do you take care of the goals of the customer organization while finalizing requirements?

Q 10) How do you make sure that the requirements elicited from your customers are complete and consistent?

Q 11) Do you think a new process for requirements activity is required as far as your projects and organization is concerned?

Q 12) What good would you normally seek from a documented process for Requirement Engineering? Any special benefit?

Q 13) What Requirements activity mostly troubles your project progress?

Q 14) How do you identify your stakeholders (Client Community) and who is responsible for this?

Q 15) What influence do the stakeholders normally have in your projects?

Q 16) How do you validate your specified requirements? Do the stakeholders/customers representatives involved during elicitation and validations are same?

Q 17) What specific document, if any, is produced by your team during the Requirements process?

Q 18) What process/procedure you follow for managing changes in requirements?

Q 19) How do you ensure that the project objectives and requirements are compatible?

Q 20) Any other information that you want to share regarding requirement engineering process that you would like to share?

QUESTIONNAIRE COMPANY A SAP IMPLEMENTATION (TO ELICIT THE HIGH LEVEL GOALS)

Name: _____

Designation: _____

1. What do you think is the purpose to develop the software?

	Strongly Agree	**Agree**	**Weakly Agree**	**Disagree**	**Weakly Disagree**	**Strongly Disagree**
Assistance in Administrative functions						
Aid in decision making/support						
Process more Queries/Requests						
Access up-to-date accurate data						
Transparency in process/workflow						
Automate process/workflow						
Secure access of data						
Reduce cost						

2. Processes from which departments are being automated in this project?

	Fully	**Partially**	**Not at all**	**In Future**
Finance Department				
Accounts Management (Transaction Management)				
Vendor Profile Management				
Supply Chain Management				
Resource Management				
Human Resource Department				
Employee Attendance System				
Employee Profile Management				
Payroll Management				
Information Technology Department				
Public Benefits				
Tax Payer Profile Management				
E- Support				

3. Why have you chosen above mentioned departments?

	YES	NO	MAYBE	Don't Know
Most cost incurring departments				
Most time consuming activities are involved within the process flow				
Hold the most important and confidential data				
Any other?				

4. What kind of system is already in place at Company A (especially those particularly departments)

	YES	NO
Fully manual		
Semi Automated [MS office: MS Excel]		
Web application		
Desktop Application		
Customized or specially built application		
Any other?		

5. Who will be the end users of the SAP implementation?

END USER CLASS	YES	NO
Executives		
Directors		
Managers		
Clerical Staff		
Any other software please specify		

6. What do you think or expect is the impact of the SAP implementation project?

7. What differences do you expect from the replacement of the existing system with the SAP implementation project?

	YES	NO	MAYBE	Don't Know
Employee training/Employee hiring				
Workflow of the process				
Centralized and concentrated data				
Security and confidentiality of data				
Any other software please specify				

8. How would you measure the successful completion of project? e.g. return on investment (ROI)

_____

_____

_____

_____

_____

9. Do you expect any benefits in terms of cost reduction?

	YES	NO	MAYBE	Don't Know
Downsizing				
Minimizing redundant activities				
Errors induced costs are reduced				
Increased work performance				
Any other software please specify				

10. Do you foresee any problems/ ambiguities in this project?

_____

_____

_____

_____

_____

QUESTIONNAIRE FOR ASSESSMENT OF DAILY TASKS

(Used for conducting interviews for the assessment of daily tasks; however, other general questions in response to the listed questions can also be asked .)

1- What were the major activities of RE done today?

   a. Elicitation

   b. Analysis

   c. Specification

   d. Validation

   e. Management

   f. Any other_____

2- Did you manage to complete any of the above mentioned activities?

   a. Yes

   b. No

3- What Artifacts did you develop during the course of the work today?

4- What steps of the process were followed?

5- Were those steps sufficient to account for the practical activities that you conducted? How?

6- What other activities you have to do besides those mentioned in the steps of the process?

7- What roles were involved during the course of the activities today and what did they do?

8- Did the process guide your course of activities well or did you feel bound?

9- What major benefits you realized while using the process of following its steps?

10- Did the dependencies between different steps of the process guide you well or do you want to propose any more of the flows between the steps?

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