REQUIREMENT ELICITATION BASED ON VALUE CHAIN ANALYSIS

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ABSTRACT

Requirement elicitation is an analysis, abstraction, synthesis, extracted process which obtains real and correct software requirements from users' demands, thoughts and expectations. The accuracy and integrity of software requirements is crucial to the success of the software. Although many software engineering techniques have been applied, incomplete, inaccurate or inconsistent requirements still remain for the enterprise information system which includes rich domain knowledge and multiple users playing various roles in complex organizational structure. From the angle of economic management, the paper presents an enterprise informatization requirement analysis model (EISRAM) and the acquisition processes by value chain analysis after the classification of the demand and reasons for the requirement change are discussed. The new idea and expanding method of software requirement elicitation could reduce software failure rate.

Keywords: *Requirement Elicitation, Value chain, Enterprise informatization, Elicitation processes, EISRAM*

1. INTRODUCTION

Requirement Engineering (RE) consists of activities like elicitation, analysis, negotiation, specification and validation, which are independent, iterative and incremental and pass through the entire requirement analysis stage. Requirement elicitation's main target is to comprehend clearly what users or clients need and collect their initial demands. As the base of a software project, Requirement elicitation also has very high impact on subsequent analysis, design and building phases as well. At the requirement analysis stage, software developers usually deal with obtained demands by RE tools, such as Rational's RequisitePro and UML, and depict software requirements with some normative methods, but incompleteness of collected users' demands and changes of the requirement increase development cost, time and impair the quality of the software. Since the 1990s, RE has become the research focus in the field of software engineering. Many scholars and engineers have presented kinds of theories and methods. In practice, Regnell.B and Kristopher proposed an improved use case analysis method to obtain stable software requirements[1]; T. L. McCluskey elaborated requirement capture technologies and models by a kind of formal method[2]; Axel van Lamsweerde attempted a standard, heuristic method to solve the inconsistency of the requirement gaining from various aspects[3]; Daniela E. Damian and Didar Zowghi discussed software requirement challenges and possible solutions for those development organizations who have many affiliates in different locations under the background of globalization[4]; In order to solve the problems of software requirement ambiguity and complexity, ChenDali demonstrated a requirement process model based on TSP (Team Software Process)[5]; With scenario-role-data view and activity diagram, LiuFeng suggested a scenario-based collaborative requirement elicitation approach for EIS(Enterprise Information Systems) [6]; According to users' individualities and context, ShuFengdi considered an use-driven requirements elicitation method to improve the user participation and quality of obtained requirements, which emphasized the domain knowledge reuse effect[7]; Shang Zongmin and Wang Haiyang put forward an acquiring users' personal requirements method on the basic of the process semantic library from the angle of business process[8]. In theory, Alistair Sutcliffe and Neil Maiden defined the requirements engineering general domain semantic model and its composition with domain knowledge theory[9]; Matthias Jarke identified, obtained and formalized domain knowledge, similarity matching and software engineering knowledge classification [10]; Using theories of enterprise ontology and

domain ontology, Jin Zhi discussed requirement capture process[11]; Focusing on business process analysis and using formal description method, Gan Zaobin and Lu Zhengding proposed a condition digraph requirement description model[12]; Liu Wei,Liu Zongtian and Shao Kun divided requirements engineering into early-phase requirements capture and late-phase requirements specification based on extended I* modeling framework1 and UML to realize the transition from early-phase requirements capture to late-phase requirements specification smoothly[13]; Shen Bin explored software requirement refinement and validation in service-oriented environment with the aid of SOFL (Structured Object-oriented Formal Language) and hierarchical Petri net[14]; From the angle of software development management, Macaulay designed a process of delimiting demand boundary and acquiring requirement in the early stages of software development, and put forward a method of requirement elicitation, called USTM (user skills task match) based on cooperation[15]; Prodromos D. Chatzoglou and Linda A. Macaulay pointed out that requirement elicitation is an iterative process, and analyzed the factors of the number of iterations with RCA(Requirement Capture Analysis) spiral model from project management perspective[16]; Mu et al. categorized demands and proposed a concept of non-normative requirements, and considered effective non-normative requirements management help to minimize requirements errors in the acquisition process, and to improve software development process and software quality[17]; Wong Qing and Li Mingshun gave a software requirements measurement method for controlling and managing changes of demand fluctuation analysis after analyzing those causes of demand change and their trends according to statistical process control theory[18]; From the perspective of knowledge management, Li Xiaoming, Sun Linyan and Wang Yingluo analyzed the general process of software requirements elicitation according to dissipative structure theory and pointed out obstacles of requirement capture [19]; Although these acquisition techniques, analysis methods and implemented models greatly improved the accuracy and integrity of ongoing software requirements, previous studies have still ignored some difficulties in capturing enterprise informatization requirements, which have rich domain knowledge

and complex organizational structure, such as multi-section' requirement description, complex problem domain, communication obstacles between users and analysts, incomplete demand, requirement inconsistency and correctness of the acquired requirements. From the angle of economic management, an analytical model of the enterprise information software requirements acquisition in the paper is proposed for supplement of software requirement elicitation with the help of the value chain analysis.

2. THE CLASSIFICATION OF DEMAND AND SOFTWARE REQUIREMENT CHANGE

2.1 The Classification of Demand

From the perspective of time, the demand can be divided into the basic, specification and potential demand, as shown in Figure 1. At stage Ⅰ, only a small part of the customers are aware of a kind of demand which is called potential demand; at stage Ⅱ, the standard demand, which features are all understood unambiguously, is popular for most customers; at stage Ⅲ, the basic demand has been fully understood and could be tailored for a user's particular need. Along with the change of time and the environment, the potential demand will gradually shift to standardize the requirements, and ultimately could become the basic needs
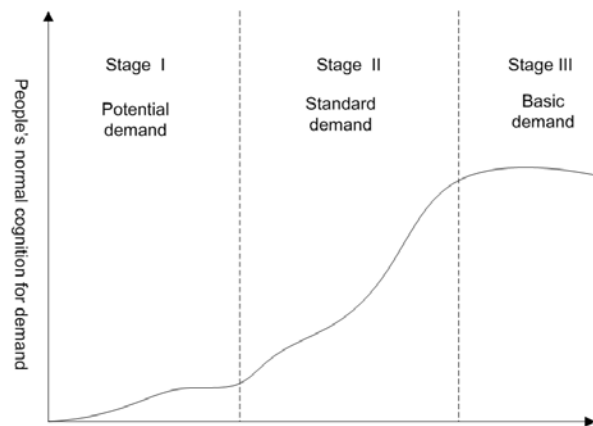

Figure 1 *Three stages of demand change[2]*

From software development perspective, the demand is divided into three types:

a. Business requirement. It reflects the software users' objective for ongoing software system and is

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1 Yu E. Modeling strategic relationships for process reengineering [D]. University of Toronto, Department of Computer Science, 1995.

2 Ding Junwu, Han Yuqi, Zheng Chengde. Research on capturing of customer requirements based on TRIZ, Computer Integrated Manufacturing Systems,2006,12(5):648-653

illustrated with project views and document. Business requirement is acquired by the means of understanding the domain knowledge, and could be expressed as follow, business requirement =the target + the business scope.

b. User requirement. It reveals users' problem areas and what they want to get, and describes those tasks which the ongoing software should accomplish. User requirements are acquired by communicating with users and on spot investigation.

c. Software requirement. It includes functional requirement, non-functional requirement and design constraint (technique parameters, hardware and software environment and expected using environment), and defines those functions that must be realized for users to resolve their problems, complete the desired tasks to meet the business needs. Software requirements are gained by analyzing business and user requirement with the help of the software engineering theory and technology.

Business requirement and user requirement belong to the categories of basic demand and standard demand, they are not only focus on software requirement analysis, but also the premise of building software, and the potential demand is the basis for lengthening software lifecycle. Business requirement determines user's requirements. Analysts identify functional requirement, non-functional requirement and design constraint of enterprise informatization of software based on analyzing business requirements and user demands. Therefore, software requirement can be represented from six aspects: (1) definition of the organization and jobs, (2) business processes, (3) processing rules (algorithms), (4) data items, (5) processing functions; (6) the relationships among the above five.

2.2 Requirement Scope

Successful requirement acquisition strongly depends on the clarity of project scope. Functional requirements' change is the major cause of revising the ongoing developing software. In the process of requirement elicitation, the definition of project scope is inevitably prone to some errors. If the scope were too wide, collected demands would be more than realistic need and the process of acquiring requirement would be prolonged and redundant software functions would be occurred. If the scope were too narrow, some demands beyond the scope, which are important for users, would be ignored and the ongoing software would not

behave exactly what the user thought it would. Reasonable and right software requirements scope may establish well-defined functional requirements and controlling scope errors can control the change of functional requirements.

The relationship of requirement elicitation and the scope likes that of 'chicken' and 'egg', in other words, the scope boundaries are defined by acquiring demands and software requirements are achieved under the guidance of the scope. Namely,

a. The software requirements are obtained by acquiring customer demands, and the range of software requirements is determined and managed on the basis of requirement elicitation.

b. The management of software requirement scope could be laid a groundwork if requirement elicitation and the scope amendment are processed step-by-step or by stages in the project scope according to the priorities of the requirement and the actual situation of the software project.

c. Along with the process of requirement elicitation, the requirements would change, and so the project scope amendment and some project missions' alteration would come up.

Software requirement is always supplemented, refined, and perfected constantly. During the requirement elicitation, software developers set preliminary project scope in accordance with the software project feasibility analysis report, define software requirements scope together with users' fuzzy demands, verify and validate software requirement scope by work task decomposition, and then establish the functional requirements of the whole system. Clear scope is the foundation of the successful project accepted and software system delivered.

C Origin of software requirement change

Requirements management KPA(key process area), which aims at improving demand management and reducing requirements changes or impact of requirement change, is ranked the top in the repeatable level (Repeatable) according to the CMM(Capability Maturity Model for Software), it shows the importance of the KPA in the software development processes. There are many causes which lead to the enterprise information software requirements' change. Changes of business organizations, processes and external environment may change the software functional requirements. Requirement elicitation Steps, implementation and testing methods may generate a new understanding of the previous problem domain. Any recognizable

variance, for example, preconceived software architecture, requirement elicitation cost, software development organization and management practices, etc., can led to the change of the software project requirements. The main changes factors of enterprise information software requirements are as shown in Table 1.

TABLE 1   *REASONS OF ENTERPRISE INFORMATION SOFTWARE REQUIREMENT CHANGE*

Reasons or factors	Main content
subjective reasons	• Customer demands are misconstrued as system functional requirements by developers. • Excessive customers' expectations • Developers and customers have overestimated the each other's professional background knowledge
Technical reasons	• Use of development tools • Changes of development model, process, etc. • Requirement refinement before clearly defining the project scope • No the specified requirement baselines • Without a good software architecture
External influence factors	• Market, policy, laws, etc. • Change of business operating environment
Enterprise management factors	• Organizes structural adjustment, business process reengineering • Business direction adjustment • Changes of project budgets • Project group interior adjustment

3. REQUIREMENT ELICITATION FROM VIEW OF THE VCA

With the fast development of IT technology and the popularity of kinds of networks, enterprise informatization has become a common view among most enterprise managers. However the successful rate of enterprise informatization system is still a troublesome problem. Standard Group investigated more than 8,000 various civil and military software projects in the U.S.A, the software success rates are 27%, 29%, 28% in 1996 and 2000 and 2004 respectively, requirement determination is crucial factor to the success of the software project. From view of software development technology, lack of standardized demand obtain process and analysis technique, no modeling and abstracting software requirement, regarding users' demands directly as software requirement, no long-term considerations of ongoing software non-functions requirements in the stage of project requirement elicitation,, such as

performance, safety, usability, maintainability, expandability and so on, become the main reasons of developed software failure or disparity in enterprise expectations. Proceed from the classification and changes of demand, the paper proposes a model and discusses the process of requirement elicitation from the angle of economic management.

3.1 Enterprise Information Software Requirement Analysis Model(EISRAM)

After analyzing enterprise value activities and the relation among enterprises, suppliers and customers, Michael Porter put forward the concept of value chain, which includes the basic activities (internal logistics, production operation, external logistics, marketing and service) and support activities (procurement, technology, human resources management and enterprise infrastructure) in 1985, as shown in Figure 2.
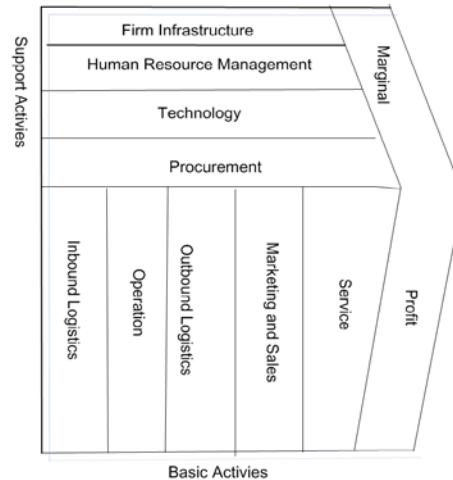

Figure2 *Enterprise value chain Diagram*

The value chain analysis could identify, classify and sort enterprise's business activities using systematic approach from the angle of strategy, and analyze the value chain composition, each value activity status and the relationship among them. Enterprise value chain is not only the set of value activities, such as product design, production, sales, marketing, delivery, service, but also reflects the interdependence among the relevance value activities. Therefore, the difference of enterprise value chain is the main source of enterprise competitive advantage.

Value chain analysis method is generally divided into internal value chain analysis, vertical value analysis and transverse value chain analysis.

The internal value chain analysis

The enterprise internal value chain could be used to analyze each job in the internal activity chain, compare its cost with its added value, find those jobs which are non value-added or don't match their costs with created values, and so improve business process on the basis of the relationship between the change of the value and the jobs. It may distinguish the enterprise's each basic or the support activity, and carries on the cost value analysis to these value activities. Multiple patterns of management, for example outsourcing, are adopted to optimize enterprise internal value chain and to ensure the core competitiveness of the enterprise by eliminating the lower value-added or benefit jobs.

The vertical value analysis

The enterprise vertical value chain could be used to analyze the relationship among the enterprise value production activities and its suppliers, cooperative merchants and distributors, evaluate enterprise status in the entire industry value chain, and help to establish strategic partnership with upstream and downstream firms and form a stable supply and sales channels. The integration of forward and backward the enterprise value chain could enhance enterprise's competitive advantage for a leading position in the industry value chain.

The horizontal value chain analysis

The enterprise horizontal value chain could be used to analyze some value chains of those competitors in the same or similar market. It helps entrepreneurs to understand their competitors how to finish the each job in their value chains and its cost, and compare with themselves, they could establish a benchmark to measure and improve their own management activities. They should gain the initiative in the market over the other competitors by taking countermeasures to enhance their competitiveness to create advantages.

The enterprise internal value chain analysis is the intersection of vertical and horizontal value chain analysis. The outcome of the vertical value chain analysis determines the enterprise product strategy, the return of the horizontal value chain analysis points out the enterprise competition advantage and makes sure the enterprise production mode. Improving the internal value chain is an important enterprise goal, and the optimization of the internal value chain will strengthen the vertical and horizontal value chain of the enterprise.

Enterprise informatization project is not a something that can be completed once for all, but it is constantly in the updating, improving and developing process. With the enterprise continuous development and grow, enterprise demands are changing. Some factors contributing to enterprise informatization software requirements are as follow.（1）the change of capital structure. Such as enterprise merger, will often change greatly enterprise's structure, culture and business process so that the informatization requirement will be rebuilt.（2）the change of business organization. Organizational structure adjustment makes business process change.（3）the change of business. Understanding the industry status, enterprise vision, the position in the industry, the operation model, service object, business target and the industry development trend, systems analysts can lay good foundation of obtaining and analyzing the user's true and correct demand and judging their quality. This paper puts forward an enterprise informatization software requirements acquisition model and the steps from the perspective of VCA as shown in Figure 3.
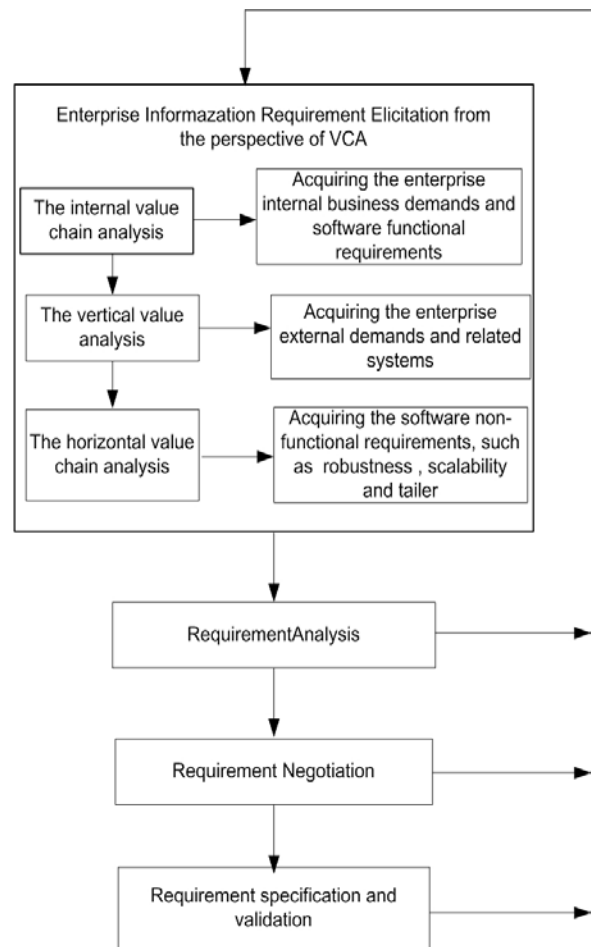
Figure3 *Requirement Elicitation model from the perspective of VCA*

Gaining various internal business demands and software functional requirements by internal value-chain analysis

Internal value chain analysis is the foundation of value chain analysis. Enterprise basic functional activities are responsibility of various business departments. Value activities are linked by the internal relation, which is a kind of sources of competitive advantage and exists in basic activities, different support activities and between basic activities and support activities. As a subsystem, various business departments are responsible for one or several jobs, which create use-value, make some products or services transfer in the enterprise and realize value accumulation and transferring.

Combined with the investigation of organization structure, job setting, and responsibilities defined etc, system analysts could understand what various departments do in the internal value chain, define the system scope and differentiate various subsystems and then establish specific goals and objectives of the enterprise information system.

Collecting the original accounting documents, financial statements and reports from various business units, system analysts could analyze various departments' internal value chain and find the relationship among the logistics, cash flow and information flow, and then each subsystem work flow and processing rules of business departments are analyzed to determine the core business activities of the business department.

With the aid of the core business activities and basic function analysis of each business department, business interface relations between various business functions and enterprise basic functional activities could be determined, and then define the relationship between ongoing enterprise informatization system and existed information system.

Gaining various external business demands and software correlation systems by the vertical and horizontal value chain analysis

The research topics of the vertical value chain analysis include some strategic issues, such as industrial entrance, industrial exit and vertical integration etc. And the counterpart of the horizontal value chain analysis involves price and quantity, technology direction of development, procurement and sales, services and son on.

Providing some appropriate open interfaces further the enterprise management level in future with the aid of evaluation of enterprise external demand and correlation systems by the vertical value chain analysis.

Relevance exists not only in enterprises internal value chain but also among the enterprise value chain, suppliers' value chain, channels' value chains and the buyers'. Suppliers, channels and buyers' value activities and their costs or benefits are affected by the other. The suppliers provide enterprises with some products or services, channels generate values of commodity circulation, products are capital input carrier of purchasers' values, so their various value activities and all kinds of links among those enterprises' value chains could provide opportunities for enhancing the enterprises' competitive advantages.

System analysts analyze and initially design various interfaces of external systems owned by the enterprise and its upstream and downstream firms on the basis of the profit distribution on whole industry value chain by vertical value chain analysis; and reasonably expect the future of the industry trends and the enterprise's development, the enterprise extending to the upstream and downstream of the vertical value chain and evaluate the internal value chain. Some reserved open interfaces could be redesigned or used for future enterprise informatization software.

Evaluating systems applying environment and considering the software system's robustness and scalability by horizontal value chain analysis

The horizontal value chain is the set of all enterprises' value chains within the same industry interactions; there are competitive relationships among these enterprises which have the same or similar functions' products. Facing the current and potential competitors, enterprises should make or adjust their competitive tactics and development directions in good time to reduce costs or differ product for competitive advantages through clarifying the strengths and the weaknesses in business processes, marketing, customer services and external existing and potential opportunities and threats.

One of the main factors of the enterprise informatization requirements' change is the change of enterprise development. System analysts could understand the enterprise's competitive advantages and its technical development and service directions, evaluate the possible impacts of changes of pricing and product, purchase and sales channels

and the business logics on the competition and associated enterprise and responding measures by horizontal value chain analysis; and judge whether customer's business processes comply with the relevant industry standards during discussing business processes, and then put forward suggestions of clipping business processes to guide and help the customer collection and analysis, and predict its the possibility of business processes' changes for laying a foundation on good robustness and scalability of enterprise information system.

3.2 The process of requirement elicitation

   Demand acquisition is the first step of the requirements development and foundation on requirement analysis. Correct, complete demand acquisition is the key to ensure project successful. Understanding the users' business requirements and business modeling combined with industry standards and best practices, and analyzing the potential demand and effective reverse communication by VCA, analysts could overcome those asymmetric obstacles of domain knowledge, enhance the mutual understanding between developers and users, make the business clarity, operability, efficiency and perfection; and then software potential demand, customers' demand change in the software development process and the changes of organization and future business predictability could be predicted. Under the angle of VCA, a process of requirement elicitation is put forward, as shown in Figure 4.
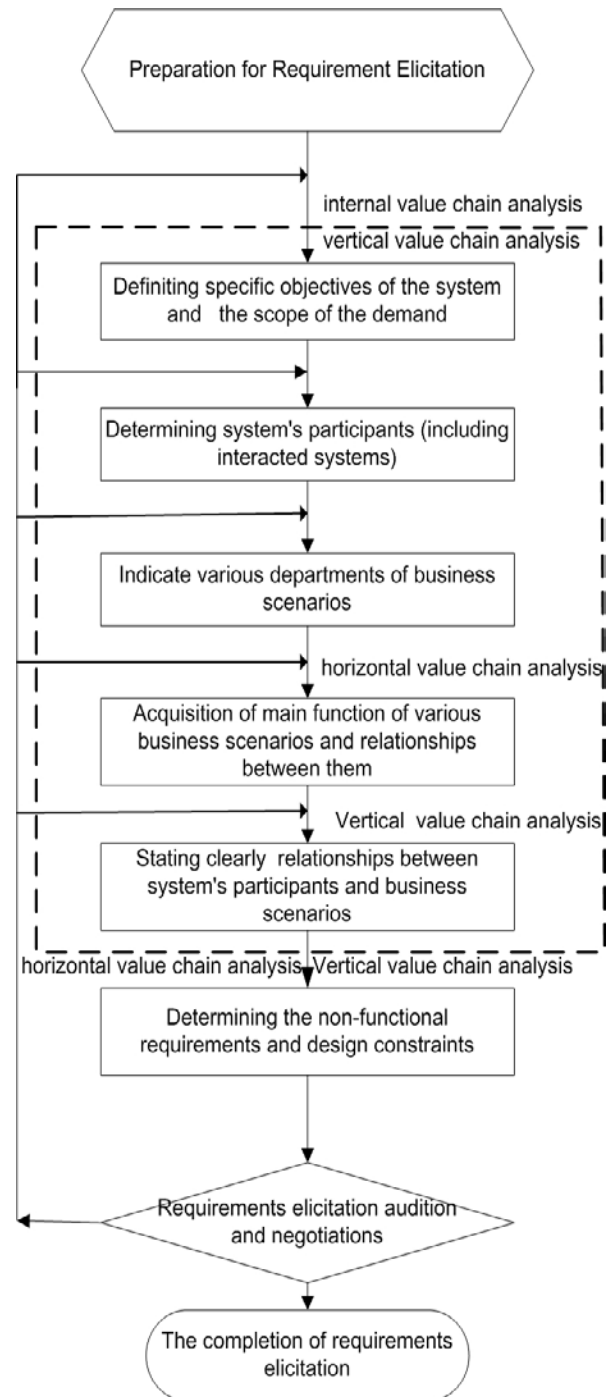

Figure 4 *Processes of requirement elicitation under the angle of VCA*

   Major activities of requirement elicitation are shown as Table 2

TABLE 2   *MAJOR ACTIVITIES OF REQUIREMENT ELICITATION UNDER THE ANGLE OF VCA*

Activities	Explanations
Definite specific objectives of the system and the scope of the demand	• Give a clear definition of the software system objectives by surveying organization structure, offered jobs and responsibilities • Analyze scopes of the domain and the ongoing system and set users' demands priorities for centralized them treatment
Determine system's participants (including interacted systems)	• Find system's participants, clients and relations among them • Identify software and hardware systems associated with the ongoing development software system
Indicate various departments of business scenarios	• Indicate those processed information and their sources provided by the system for users by analyzing each business's process, function and processing rules • Specify exchange informations between subsystems and external associated systems • Describe the system's human computer interfaces
Gain main functions of various business scenarios and relationships among them	• Describe various functions of business scenarios and relationships between them • Confirm the pre- and post-conditions of these functions
State clearly relationships between system's participants and business scenarios	• Select and decompose each function • Briefs communication between system's participants and functions • Describe refined and recognized functions and relationships among them
Determine the non-functional requirements and design constraints	• Determine non-functional performances like availability, maintainability, reliability • Make sure design constraints, such as hardware, software, management, testing, interfaces
Audit and negotiate requirement elicitation	• Control and feedback every activity in requirement elicitation • Confirm and describe in demand rationality in lucid language • Analyze and evaluate correctness and consistency of requirements with clients • If match expectation, stop the process of requirement elicitation, otherwise back loops

4. OTHER ISSUES OF REQUIREMENT ELICITATION FOR ENTERPRISE INFORMATIZATION

Software requirements have characteristics of fuzziness, uncertainty, change and subjectivity. The complexity of software requirements shows in the following aspects: description, perfection, development time, detail. So the following must be paid attention during the processes of requirement elicitation.

1. The accuracy of requirements is affected by the definition of the enterprise informatization project.

Enterprise informationization is essentially a great leap of enterprise existing organization structure, management concept and management mode. The definition of the enterprise informatization project is the premise of software project success.

The project should have a clear aim, namely, the project should have the available functions and some optional features;

Any businesses must be defined, namely, can use terminology and process to describe a business;

Business processes must be match the target, if some business processes had conflicts with enterprise's targets, these goals and processes should be redefined easily;

2、The integrity of requirement depends on the willingness and the executive power of enterprise managers, who provide strong and direct leadership or the extent of their involvement

Enterprise informationization is a systems engineering, which involves the implement of management idea, personnel quality improvement, information integration, etc.

Those various business level managers with different understanding of informationization might propose their department's informatization demand in line with the spirit of collaboration if enterprise top managers could advance and propel the process of informatization constantly and make the all enterprise staffs have clear and united understanding;

Business managers objectively analyze and evaluate those internal elements, industry structure and the relative market position of the enterprise from the perspective of the development strategy, and then plan the integrity, long-term, fundamental issues of enterprise development, specify the possible scope and functions of the information needs.

5. CONCLUSIONS

Most of the enterprise information software project's failure lies not in application of software development technology, but lost of the focus or gravity of the project. If software developers should intervene deeply into enterprise management, operations and accumulate abundant industry knowledge, they could accurately grasp and understand the enterprise demands. Once obtaining the requirement, analysts, developers and customers can explore kinds of solutions. From the perspective of economic management, this paper attempts to focus on enterprise value activities rather than only enterprise's current business demands, a new model and steps of requirement elicitation from the view of VCA are suggested to software developers for reducing enterprise informatization software failure rate

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