A Proposal of a Method to Navigate Interview-driven Software Requirements Elicitation Work

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Abstract: - System development for software is in accordance with requirements specification. Omissions or errors in requirements specification cause omissions or errors in subsequent deliverables. Therefore, requirements elicitation work in order to prepare requirements specification is a very important process. However, it is very difficult to extract customer requirements for software development without omissions or errors, mainly because customers and software engineers (SE) do not share common knowledge resulting in omissions or errors in the requirements elicitation work due to poor mutual communication.
Therefore, in this paper we are proposing a structure to navigate requirements elicitation work through interviews in order for SEs to elicit customer requirements without omissions or errors by using the interview technique. We are also conducting a comparative experiment in regards to the cases that requirements elicitation work is conducted by both utilizing and not utilizing this structure. As a result, we were better able to elicit customer requirements without omissions or errors in the case of the former rather than the latter; therefore we successfully verified that the structure proposed in this paper by utilizing this structure is effective.

*Key-Words: -R*equirements Elicitation *R*equirements Elicitation Work Requirements Specification Navigation Rule Interview IEEE830

1 Introduction

There are various life cycle models for software development, including “waterfall model” and “spiral model.” Whatever life cycle model is used, however, development progresses in accordance with requirements specification that summarizes customer requirements. Therefore, if there are omissions or errors in requirements specification prepared through requirements analysis work, software completed will include omissions or errors, possibly creating software that does not match customer’s intention. As a result, work will have to be redone, causing delay in the development period or increase of budgeted development costs. Software development will then suffer from fatal damages. In this regard, requirements elicitation work to find out customer requirements is considered to be very important. However, it is not an easy work to elicit customer requirements for software, to accurately analyze requirements elicited and to summarize them into a specification. The main reason is that customers and software engineers (SE) do not have common knowledge.
This leads to poor communication with each other, causing omissions or errors in the requirements elicitation work. Consequently, omissions or errors also occur in the requirements specification, resulting in significant damage to software development. This is the reason why development of a system to support these tasks is desired.
In order to solve this problem, a structure to navigate interview-driven software requirements elicitation work is proposed in this paper, so that an SE is able to elicit customer requirements without omissions or errors by using the interview technique for software requirements elicitation work. By conducting a comparative experiment in regards to the cases that requirements elicitation work was conducted by both utilizing this structure and not utilizing this structure, the effectiveness of the proposed structure is indicated. This paper consists of the following chapters. In Chapter 2, the importance of and issues in the requirements

analysis process upon conducting requirements elicitation work are explained. In Chapter 3, the objectives and positioning of this study as well as related studies are described. In Chapter 4, the structure to navigate interview-driven requirements elicitation work is explained and at the same time examples are indicated. Chapter 5 presents the conclusion of this paper.

2 Importance of and issues in the process of requirements elicitation

2.1 Importance of requirements elicitation

In software development, the process of requirements analysis is the first process in any life cycle model. In other words, software development progresses in accordance with a specification that summarizes customer requirements obtained through this process, regardless of life cycle models. Therefore, in the case that a specification prepared with the process of requirements analysis includes omissions or errors of customer requirements, software developed will also include omissions or errors. Thus, the process of requirements analysis occupies an important position in the process of software development.

2.2 Problems in requirements elicitation work

In software development, a system actually developed might not conform to the system required by the customer in many cases. One of the reasons includes difficulties in the requirements analysis work. Difficulties in the requirements analysis work can be divided mainly into two categories: difficulties attributable to the customer and difficulties attributable to the developer.

2.2.1 Difficulties attributable to the customer

First of all, difficulties attributable to the customer include the case that the customer does not understand what he or she wants in the system. Since the customer is often ignorant of software development technologies, requirements for the system presented by the customer are abstract, e.g. "want to have inventory control software developed; want to process as easily and quickly as possible; and want to reduce the labor costs to half by reducing the manpower as much as possible," reasoning for realization is unclear, and the level of requirements is not consistent.

These kinds of customer requirements are part of necessary conditions to realize the system but do not satisfy sufficient conditions. In this regard, the customer who requests software development has an abstract image to the kind of software he or she seeks, and is not able to communicate detailed system requirements to the developer as it stands now.

2.2.2 Difficulties attributable to the developer

Since it is a common practice for the customer to present requirements specification as well as detailed system requirements to the developer to whom system development is delegated, the developer would focus on realization of detailed system requirements presented by the customer. He or she would also focus on a design method and programming technique for consistent design quality and its achievement. However, the system is developed in accordance with customer requirements. If customer requirements are unclear, it is not possible to design and develop a proper system. Therefore, preparation of accurate requirements specification and system requirements became necessary.

Although the work to obtain customer requirements for a system is very difficult, the SE's role is to realize this; and his or her skills including experiences and knowledge become important. In the present situation, however, there is only a handful of experienced and expertised SEs equipped with knowledge within a corporation who are able to conduct these tasks effectively. When there is no expertised SE, beginner SEs with less experience in requirements elicitation work for software development will have to perform the duties.

3 Purpose of this study

3.1 Purpose

As mentioned in Section 2, the current requirements elicitation work has two problems. One is that the customer is not familiar with software development technologies and does not know what kind of information should be given to the SE to develop software. Because of this problem, a situation occurs where the customer does not know how to answer questions from the SE.

The other problem is that the SE does not fully understand the overall picture of customer's business, and is not able to determine what he or she fails to find out from the customer or whether or not there is a discrepancy. As a result, requirements specification will include omissions or errors, and software completed will end up as something that does not conform to customer requirements.

In order to solve these two problems, it is necessary for the SE to ask questions so that understanding of a system required by the customer will converge effectively, thus requirements are elicited without omissions or errors.
The purpose of this paper is to propose a structure to navigate interview-driven software requirements elicitation work, so that the SE is able to elicit customer requirements without omissions or errors by using the interview technique.
Subsequently, the effectiveness of the structure proposed in this paper is indicated by conducting a comparative experiment in regards to the cases that the requirements elicitation work is conducted by both utilizing and not utilizing this structure.

3.2 Positioning of the study

The requirements elicitation techniques [1, 10, 11, 12] include the following:
(1) Material collection method
(2) Survey method (questionnaire method)
(3) Interview method
(4) Method using a brainstorming method
(5) Method using a worksheet
(6) Method using a card
(7) Method using a tree
(8) Method using an analysis diagram of clerical procedures or icons
(9) Method to elicit requirements through conference for requirements elicitation

In this paper, requirements are elicited by using the interview method among various requirements elicitation techniques. This technique is adopted because it is widely used in practice and easy to use.

3.3 Differences between similar studies in the past and this study

(1)Method with the system development procedure for mainframers
The "standard system development procedure" has been developed mainly for mainframers. They include IBM BSP (Business System Planning) [2], Hitachi HIPACE (Hitachi Phased Approach for high productive Computer system Engineering) [2], Fujitsu EPG (End-user oriented Planning Guideline) [2], C-NAP (Customer-needs Analysis) [2], NEC STEP/E (Standard Technology & Engineering for Programming Support) [2], Toshiba TUPPS (Tool, User and Project-Planner System) [2] and UNISYS NUP (Nippon Unisys Problems Sol) [3]. Among them, BPS adopts the interview method, PPDS (Planning Procedure to Develop System) [2], HIPACE's requirements analysis procedure adopts brainwriting and objective tree, STEP/E adopts the KJ method, and NUPS adopts brainstorming mainly, as techniques to "excavate problems." Rules for interviews, etc. are written in a manual in regards to some of the above that adopt the interview method; however none of them support the interview-driven requirements elicitation process on a computer.

(2)Study in regards to interview-driven requirements elicitation support system
Lafourche, etc. proposes a framework to elicit software requirements by mutually-driven conversation using natural language (English), claiming that "the conversation control method exchanged between a user and system has not received much attention in the software requirements support system where the conversation is in natural language (English)." [4] In that case, how the conversation theory can be applied to software requirements elicitation and how the conversation theory can be incorporated in the form to cooperate with the rules for requirements elicitation are described, in addition to the necessity of conversation theory in natural language. However, technologies themselves that support interviews are not mentioned.
Leite, etc. developed FAES [5] the interview-driven requirements support system, based on the idea of a general interview assistant. FAES's knowledge database is developed based on BSP (Business System Planning), CSF (Critical Success Factors) and E/M (End Means Analysis), and is integrated in accordance with a concept model. In FAES, 22 kinds of question sentences are automatically generated in order to generate an instance for the concept model. These question sentences consist of a fixed part and variable part. The variable part is generated by incorporating answers already obtained from other questions, and a chain of questions is established by generating the variable part. In addition, the heuristic is activated at the end of the interview or to a specific question, and a question is presented. When a user answers it, accuracy of the answer, the relationship between an answer and an answer, and the need for further questions are checked with the activated heuristic. Objectives of FAES are to automate interview-driven requirements elicitation and automatically check the accuracy of requirements specification.

(3)Study in regards to interview-driven requirements elicitation
There are various findings as a result of a comparative experiment between a expertised SE and beginner SE in regards to interview-driven requirements elicitation conducted in the Reference

[1]. Differences between an SE with less practical experience (beginner SE) and an SE with a lot of practical experience (expertised SE) are clarified including the content and progress of interview in the requirements elicitation work as well as description in requirements specification.
Topics adopted by SEs can be categorized into nine topics as indicated in Fig. 1.

What	Software functions to be developed	Topics in regards to system functions
Example	What can be done, for example	
Why	Background and reason of development	
Current System	Presence of current system	
Budget	Development budget	Topics in regards development budget and time for completion
Schedule	Development period	
Constraints	Relationship with other systems	Topics to determine the method to realize the system
Polices	Development policy and architecture based on the policy	
Conditions	Various interfaces	

Fig. 1 Categorization of topics

In the interview-driven requirements elicitation, there was no clear transition pattern in the transition method of topics in the case of beginner SE, while there was a clear transition pattern in the case of a expertised SE as indicated in the following:

① Pattern 1 (customer in an alienated relationship)
{What | Example | Why | Current System}
> {Constraints , Policies , Conditions}
> {Budget | Schedule}

② Pattern 2 (normal customer)
{What | Example | Why | Current System}
> {Budget | Schedule}
> {Constraints , Policies, Conditions}

③ Pattern 3 (very close customer)
{Budget | Schedule}
> {What | Example | Why | Current System}
> {Constraints , Policies, Conditions}

In the above, {A , B , C} means that the topics are adopted in the order of A, B and C. Only after topics in the first categories run out, topics in the subsequent category will be discussed. This kind of transition method of topics is called a serial type.
{A | B | C} means that topics in the other categories might be discussed before topics in the first category end. This kind of transition method of topics is called a parallel type.
In regards to {What | Examples | Why | Current System}, topics discussed here all relate to functions required by the customer for the software to be developed, which are rolled out in parallel.
In {Budget | Schedule}, topics discussed here relate to the development budget and period, which are rolled out in parallel.
In {Constraints, Policies, Conditions}, all topics discussed here influence how to develop software, which are rolled out serially.
There are three different transition patterns to be adopted, depending on the difference in intimacy with the customer indicated in the above.
Topics relating to the development budget and period are adopted at the end in the case of the customer in an alienated relationship in Pattern 1. (For example, system development for the customer has never been undertaken in the past, and a new business development is being developed.) For this reason, the need will occur to return to topics relating to software functions and how to develop it, in order to match the development budget and period.
In the case of the customer in Pattern 2 in a gray relationship (who fall under neither Pattern 1 or Pattern 3), it is necessary to adjust how to develop software to match the development budget and period, by adopting topics relating to the development budget and period immediately after finding out functions required in the software to be developed.
In the case of very close customers in Pattern 3 (for example, system development has been undertaken from the customer many times, and the relationship as a business partner has been continuing), topics relating to the development budget and period are adopted first, and software functions and how to develop it are adjusted in order to match them.
The transition pattern of topics toward the customer in a normal relationship (Pattern 2) will be indicated in Fig. 2 in the form of a flow chart.
The Reference [1] does not indicate a method to navigate interview-driven requirements elicitation by stage and category of topics or a goal-oriented requirements analysis method.

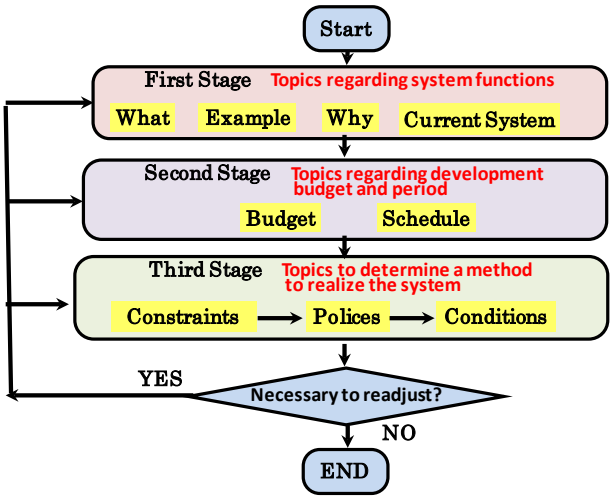

Fig. 2 Transition pattern of topics

4 Interview-driven requirements elicitation method

4.1 Method to navigate interviews

In order for beginner SEs to be able to elicit requirements as expertised SEs do, we recognize the requirements elicitation work conducted by the SE to the customer as an interview work, and consider how to navigate the interview work by beginner SEs.

4.1.1 Two-class model of topics and questions

In order for beginner SEs to be able to elicit requirements as expertised SEs do, support (navigation) is provided so that the interview progresses in accordance with the transition pattern of topics adopted by expertised SEs. However, it is not possible to navigate the interview work simply by making the transition pattern of the topic categories the same as expertised SEs. This is because of the need to navigate the work to ask questions within one category. For this purpose, the two-class model is adopted which consists of a class where the transition pattern of topic categories is the same as expertised SEs and a class where the work to ask questions is navigated within one category, as indicated in Fig. 3.

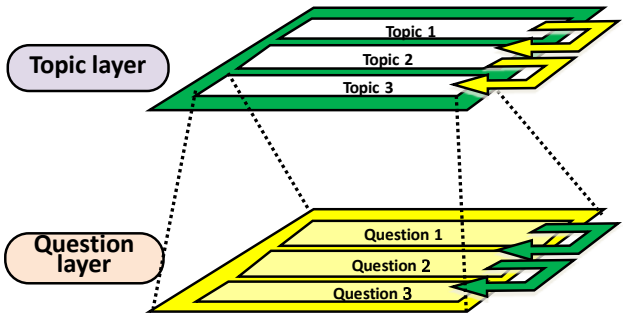

Fig. 3 Two-class model of topics and questions

4.1.2 Method to navigate transition of topic categories in the upper class

The progress management table is used in order to navigate the transition pattern of topic categories to be the same as expertised SEs in the topic layer in the upper class. In interview-driven requirements elicitation, it is possible to manage how much the interview progresses along the scenario, by proceeding with the interview in accordance with the scenario and at the same time by managing the progress by category. Thus, the progress of interview-driven requirements elicitation work is managed by preparing the progress management table corresponding to the scenario with the support tool. The example of progress management is indicated in Table 1.

The column of Progress in this table means the following:
0: The topic has not been discussed yet.
1: The topic is in the course of discussion.
2: Discussion on the topic is complete.
3: It is not necessary to discuss on the topic. In the case of new implementation, for example, it is not necessary to adopt the topic for the current system.

The progress status for each category is determined by the SE (or a leader of SEs if several SEs are in charge) and information is set in the progress management table. It is therefore possible to manage the progress of requirements elicitation work by using the progress management table as indicated in Table 1.

Table 1 Progress management table

Category	Order	Type	Progress
What	1st	Parallel	2
Example	1st		
Why	1st		
Current System	1st		
Budget	2nd	Parallel	1
Schedule	2nd		
Constraints	3rd	Serial	0
Polices	3rd		0
Conditions	3rd		0

4.1.3 Method to navigate interviews for each stage

The way to proceed with topics in an interview by a expertised SE is patterned in the transition pattern of topics which consists of three stages. The method to navigate interviews from the 1st to the 3rd stages is clarified in the following:

4.1.3.1 Method to navigate questions in the 1st stage

Effective elicitation of requirements begins with "What," by interviewing on system functions to be developed. At this time, if the system functions presented by the customer are unknown, questions in regards to "Examples" (specific examples of system functions) are given to ask the customer to present specific examples. Functions presented by the customer can be understood by asking him or her to present specific examples of system functions.

Next, the background to develop the system functions as well as their objectives and reasons are asked and understood with "Why," in order to understand why the system functions presented by the customer are necessary.
Subsequently, questions about the system currently in operation are asked with "Current system," in the case that there is a system currently in operation. This will be very important information that determines what kind of approach should be taken to system functions to be newly developed. Thus, four categories of "What," "Examples," "Why" and "Current system" are used simultaneously.
At this time, the method to navigate questions in the "What" category (questions on functions required for the software to be developed) is clarified. Questions in the "What" category relate to software functions to be developed, and necessary functions vary for each application area. Therefore, it is necessary to design a versatile structure that can be utilized in any application area. If the application area is narrowed down, the function options required there will be narrowed down as well. Accordingly, the application area is narrowed down until all the variations of the function required by the customer can be expressed in the form of options. In this case, each function option can be considered as an answer expected from the customer to the question of what kind of functions are desired. The structure is indicated in Fig. 4. The flow of Fig. 4 is in the following:

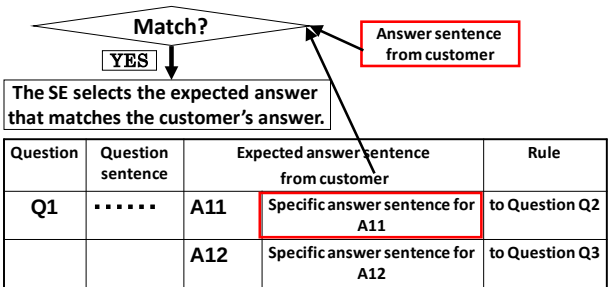

Fig. 4 Structure to automatically determine the next question based on a question and selection of an expected answer to the question

① The system presents a question sentence to the SE who asks the question to the customer by forwarding the question sentence to the customer.
② The customer gives the answer to the SE.
③ The SE selects an answer that seems to match the customer's answer among expected answers presented by the system in terms of the meaning. At this time,
A) If it is impossible to judge whether or not the customer's answer matches any of the expected answers, questions are repeated until the SE can identify an expected answer that matches the customer's answer. Subsequently, the expected answer that matches the customer's answer in its meaning is selected.
B) If there is an expected answer that matches the customer's answer in its meaning, select the answer.
④ The system automatically determines the next question sentence in accordance with the expected answer selected.
⑤ The system presents the next question sentence to the SE.
⑥ Repeat ① to ⑤ until there is no more question to ask.

In this manner, question sentences to be interviewed by the SE to the customer and expected answer sentences by the customer are established. In the case that an expected answer comes back, the next question is established. In this manner, the rule to navigate the interview is established.
The relationship between a question and expected answer can be expressed with the AND/OR tree [6, 13] used in the goal-oriented requirements analysis. The goal-oriented requirements analysis is a method to elicit requirements required for a system by considering them as the objectives to realize the system and rolling them out with the concept of objective - accomplishment method (or the concept of goal - sub-goal). In this case, the AND/OR tree is used to easily come up with a method to accomplish the goal (or objective). In the two adjacent layers of the AND/OR tree, the upper node is the objective (goal) and the lower node is the accomplishment method (sub-goal). A situation where multiple methods needs to be accomplished to realize one objective is expressed with the AND relationship, and the situation where one method needs to be accomplished among multiple methods is expressed with the OR relationship. For example, by gradually rolling out from a large objective such as a management goal to partial objectives that comprise the large objective, specific measures are elicited.
The relationship between the question asked by the SE in order to elicit requirements requested to a system and the corresponding expected answer is expressed using the AND/OR tree in Fig. 5, as a specific example of medical image information system.

Medical images generated by a medical photographic device within a medical facility is digitally stored and managed in the medical image information system. It is also the information system to observe images using a medical monitor on a computer to support diagnostic imaging. By comparing with various images (multiple medical devices and previous examinations) as well as with advanced image processing, highly accurate diagnostic imaging is achieved. This system also realizes improvement of service to patients by disclosing to them treatment information (informed consent), as well as cost reduction by reducing film costs and storage space by going filmless[14].

In Fig. 5, the goal or objective to "systematize the medical image information in order to realize quality improvement and efficiency improvement of medical imaging business as well as improvement of service to patients" is rolled out with the concept of objective - accomplishment method by using the AND/OR tree. The specific example of the navigation rule expressed by utilizing the structure to automatically determine the next question in accordance with the question and selection of the corresponding expected answer indicated in Fig. 4 is indicated in Table 2, which corresponds to the content of the AND/OR tree indicated in Fig. 5.

Since the node of "systematization objective" and the lower node in Fig. 5 are in the AND relationship, it is indicated that all answers including "improvement of medical quality," "business efficiency improvement" and "improvement of service to patient" are selected with the navigation rule in Table 2, then moving onto the next Question Q3.

The node of "quick diagnostic imaging at any time, anywhere" and the lower node in Fig. 5 are in the OR relationship, indicating to move onto the next question (Q6 or Q7) in accordance with the navigation rule in Table 2, by selecting one of the multiple candidate answers in regards to the scope of system requirements including "image reference within a hospital" and "image reference at any affiliated local hospital" in the lower node.

4.1.3.2 Method to navigate questions in the 2nd stage

What is discussed in the 2nd stage is the development budget and period. First of all, the "idea toward the development budget and period" is found out from the customer. Furthermore, questions in regards to "details and basis of the budget," "whether the budget amount is still uncertain or fixed" and "constraint in the development schedule" are asked by the SE sequentially, to put together the interview at this stage.

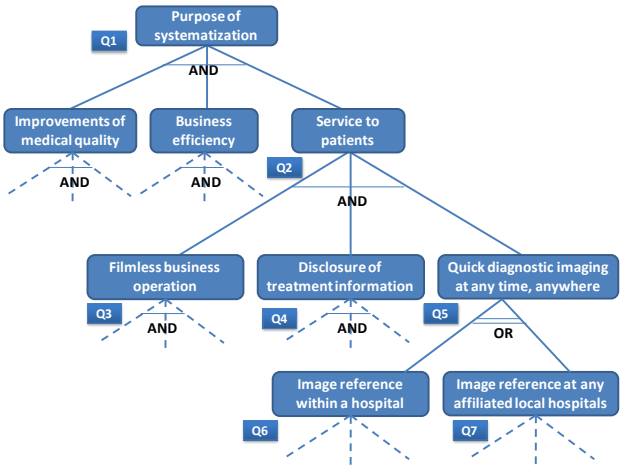

Fig. 5 Example expressing the relationship between the question and the corresponding expected answer using the AND/OR tree

Table 2 Navigation rule for medical image information system

Question		Candidate answer		Rule
Q1	What is the purpose of systematization?	A11	Improvements of medical quality	To Q2
		A12	Business efficiency	
		A13	Service to patients	
Q2	What is the business requirement necessary to realize the objective?	A21	Filmless business operation	To Q3
		A22	Disclosure of treatment information	
		A23	Quick diagnostic imaging at any time, anywhere	
Q3	What is the systematization requirement necessary for filmless business operation?	A31	Operation for 24 hours/365 days	To Q4
		A32	Ensure three principles for electronic record	
		A33	Store treatment information for more than 5 years	
Q4	What is the systematization requirement necessary for disclosure of treatment information?	A41	Display a summary of treatment information for patients	To Q5
		A42	Store treatment information in external media for patients	
Q5	What is the scope of systematization requirements for diagnostic imaging?	A51	Image reference within a hospital	To Q6
		A52	Image reference at any affiliated local hospitals	To Q7
Q6	....			

4.1.3.3 Method to navigate questions in the 3rd stage

What is discussed in the 3rd stage includes topics in regards to system architecture and interface, including how to achieve these functions on what conditions. Topics that belong to "Constraints," "Policies" and "Conditions" are relevant in this case. Topics are explored in the order of these three categories: "Constraints," "Policies" and "Conditions." Once topics in one category are completed, topics in the next category are discussed. The SE asks questions sequentially, to put together the interview at this stage.

4.2 Method to confirm completeness of items to describe in requirements specification

The SE elicits system requirements to be developed from the customer through the interview, and prepares the requirements specification based on information obtained. Therefore, information obtained from the customer through the interview work has to be sufficient to encompass the description of the requirements specification. Criteria are necessary to confirm to what extent information to be described in the requirements specification is covered. We decided to utilize IEEE830 [7] in order to confirm this completeness. This is a document in regards to software requirements specification (SRS) proposed by IEEE (The Institute of Electrical and Electronics Engineers, Inc.) When it is judged that all information necessary to fill all items described in the requirements specification stipulated by IEEE830 are obtained from the information based on the interview to the customer, it is considered as the time to end the interview-driven requirements elicitation work by the SE.

5 Comparative experiment

A comparative experiment was conducted in regards to the cases that utilize and don't utilize the structure to navigate interview-driven requirements elicitation work explained in Chapter 4 in regards to the requirements elicitation work required for the medical image information system through interviews by the SE to the customer.

5.1 Method to prepare a navigation rule for medical image information system

Authors have actually conducted a requirements definition of medical image information system for hospitals in the past, and based on the experience to develop, implement and apply the system based on the requirements specification, the superset of customer requirements for medical image information system was defined.

In addition to navigation in the upper layer of the two-class model defined in Chapter 4 as a method to elicit requirements for the medical image information system by using the interview method, it is not possible to navigate requirements elicitation work unless interviews on areas specific to each application area (for medical image information system in this case) are successfully navigated. This is because each application is considered to have different requirements. Therefore, based on the business knowledge and experiences of a expertised SE who has the experience to develop, implement and apply medical image information systems, what the systematization is for (objectives of systematization) was clearly defined and a rule to navigate interviews for eliciting customer requirements required to realize the objectives was prepared in accordance with goal orientation [6, 13].

Criteria are also necessary to confirm that information to be described in the requirements specification is consistent and without contradiction among requirement factors. It is possible to confirm consistency with the work order method to elicit customer requirements as well as with the interview navigation method by the SE indicated in Figure 4. As indicated in Figure 4, question sentences to be interviewed by the SE to the customer and answer sentences expected from the customer are established. When an expected answer comes back, the subsequent question corresponding to the answer is established (it means that the rule to navigate interviews is established). Since the relationship between a question and expected answer is expressed with the AND/OR tree, it is possible to confirm consistency with the navigation method where the lower requirement satisfies the upper requirement.

With the above method, what the systematization is for (objectives of systematization) was clearly defined, and at the same time the rule to navigate interviews for eliciting customer requirements required to realize the objectives were elicited based on goal orientation. [6,13]. Furthermore, conditions upon presentation of each question item as well as the order of presentation were organized, to prepare the navigation rule for interviews in accordance with the scenario[8,15] for customer requirements in regards to the medical image information system. The example of the navigation rule prepared is indicated in Table 3.

In regards to the navigation rule for questions and answers prepared, information on "what category in the transition pattern of topics the question belongs to" and "what item of IEEE830 the question relates to" is added, and categorized into the content of questions and answers as indicated in Table 4.

In regards to the navigation rule for the medical image information system prepared in this experiment, 343 requirements were elicited.

5.2 Requirements elicitation support system

The requirements elicitation support system is a system to support the requirements elicitation work, which can be directly utilized by SEs and customers. This system presents the SE who conducts the requirements elicitation work candidate questions to

be asked to the customer by utilizing the rule of the order to present questions stored in question sentences. It is also a system to navigate the work procedure. The requirements elicitation support system is also constructed as the application program. The overall picture of the system is indicated in Fig. 6.

The requirements elicitation support system has five characteristics. First of all, the navigation rule is taken out of the KB Server during an interview, and the Interview Server presents the SE the best question sentence and candidate answers navigated from the question in accordance with the navigation rule. Next, the SE selects one that seems to match customer's answer out of candidate answers. The KB Server then automatically determines the following question sentence, and presents the SE the following question sentence and candidate answers navigated from the question. The example of the navigation rule is indicated in Table 3.

Since the navigation rule varies by business system, each is prepared by a expertised SE, and added and registered onto the requirements elicitation support system. The added navigation rules can be changed or revised as necessary.

The second characteristic is automatic storage of interview history (e.g. questions asked by the SE, decision on candidate answers, etc.). The interview history can be referred to for confirmation.

The third characteristic is the ability to manage how the interview is progressing, by managing the progress by phase and category.

Table 3 Example of navigation rule

Question		Candidate answer		Rule
Q1	What is the systematization requirement for diagnostic imaging?	A11	To store images for more than 5 years according to the standard specification form	To Q2
		A12	To display finalized image used for diagnosis under the same condition as the time of diagnosis	
		A13	To display stored image within one second	
...	....			...
Q10	What is the requirement to system functions in diagnostic imaging?	A101	To display image	To Q11
		A102	To measure image	To Q20
		A103	To output image	To Q30
Q11	Is it necessary to adjust brightness and contrast?	A111	Necessary	To Q12
		A112	Not necessary	To Q15
Q12	Is the function to automatically adjust brightness and contrast necessary?	A121	Automatic adjustment by testing area	To Q13
		A122	Automatic adjustment by disease	To Q14
...	....			...

Table 4 Categorization of the content of questions and answers for the medical image information system

Item No	Question and answer	Category	Corresponding part in IEEE830
1	Current problem / problem desired to	Why	1.2 Scope
2	Objective of systematization	What,Why	1.1 Purpose 1.2 Scope
3	Expected effects	Why	1.2 Scope
4	Scope of business departments for systematization	Why	1.2 Scope
5	Constraint on project	Constrains Schedule Budget	2.4 Constraints
6	Scope of business	Why	1.2 Scope
7	Current business	Why	1.2 Scope
8	Requirement for business improvement	What,Why	1.2 Scope
9	Business operation time	Why	1.2 Scope
10	Constraint on business	Constrains Schedule Budget	2.4 Constraints
11	Scope of systematization	Policies	2.1 Product perspective
12	Systematization requirement	Policies	2.1 Product perspective
13	Organization and user of system	Policies	2.3 User characteristics
14	Use of existing system	Current System	2.1 Product perspective
15	Data transition	Current System	2.1 Product perspective
16	Requirement for data storage	Current System	2.1 Product perspective
17	Affiliation with other systems	Conditions	3.1 External interface requirements
18	Affiliation with medical device	Conditions	3.1 External interface requirements
19	Constraint on systematization	Constrains Schedule Budget	2.4 Constraints
20	Function requirement	What,Examples, Why,Current system	2.2 Product functions
21	Non-function requirement	What,Examples, Why,Current system	3.3 Performance requirements
22	Hardware requirement	What,Examples, Why,Current system	3.7 Other requirements
23	Network requirement	What,Examples, Why,Current system	3.7 Other requirements
24	Constraint on function	Constrains Schedule Budget	2.4 Constraints 3.5 Design constraints
25	Development period	Schedule	Not applicable
26	Development budget	Budget	Not applicable
27	Requirement for development plan	—	Not applicable

As a result, the requirements elicitation support system prepares the progress management table corresponding to the scenario, to manage the progress of interview-driven requirements elicitation work. The example of progress management is indicated in Table 3, and the status of the progress at the time of question Q11 is indicated in Table 5. The fourth characteristic is that in the case that an answer to the SE's question changes after the interview is completed, the interview can be continued by going back to the point where the change occurs.
The fifth characteristic is the ability to prevent variance in topics for the requirements elicitation work by establishing a dictionary function for comments on professional terms as well as for difficult business terms.

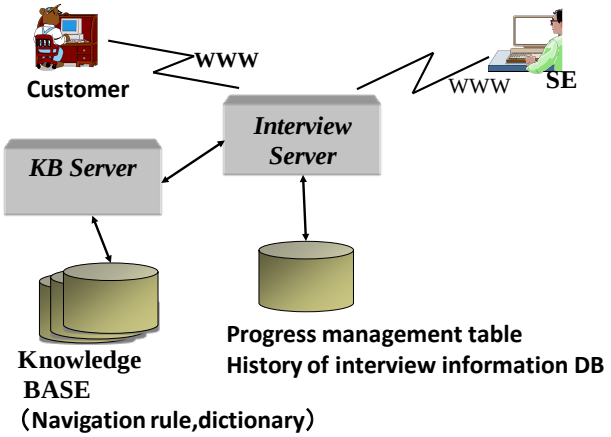

Fig. 6 Overall picture of the system

5.3 Overview and method of comparative experiment

(1) Method of the experiment without utilizing the structure
In this experiment, requirements for the medical image information system are elicited through the interview by the subject (role of the SE) to the experimenter (role of the customer) in reference to materials provided in advance. At this time, the subject records the content of the question asked to the customer and the answer from the customer, fills the requirements elicited from the customer in the format of specification provided in advance, and prepare the requirements specification. The experimenter gives the answer to the question from the subject in reference to the sample requirements specification prepared in advance. Prior to the experiment, each subject is given a document summarizing the experiment and a material to refer to at the time of the interview work, and also receives prior explanation about the format of the experiment. The time to end the interview is when the subject himself determines the completion by eliciting all information to be described in the specification from the customer.

(2) Method of the experiment utilizing the structure proposed in this paper
This experiment was conducted by using the requirements elicitation support system. This is the system to present the subject (the role of the SE) who conducts the requirements elicitation work candidate questions to be asked to the customer by utilizing the rule of the order to present questions stored in question sentences.
Candidate questions to be asked to the customer are presented to the subject who conducts the requirements elicitation work, by utilizing the rule of the order to present questions stored in question sentences from the requirements elicitation support system. The content itself is asked to the experimenter. The experimenter gives the answer to the question from the subject, in reference to the material of candidate answers to the question prepared in advance. Since the subject is presented candidate answers to the question from the requirements elicitation support system, he or she selects the candidate answer in the case that the expected answer comes back from the experimenter. Next, a candidate for the next question is presented by the requirements elicitation support system, which is repeated to the experimenter. The time to end the interview is when all candidate questions from the requirements elicitation support system are asked. The subject then fills the requirements elicited from the customer in the format of specification provided in advance and prepares the requirements specification.

(3) Members of the experiment
Members of the experiment are 10 subjects (the role of the SE), including two expertised SEs with more than 15 years of experience, three mid-level SEs with less than 5 years of experience and five beginner SEs with no experience in information system development for the requirements analysis work, and both the experiment utilizing the structure proposed in this paper and the experiment without utilizing the structure were conducted. The experiment without utilizing the structure was conducted first, and then the experiment utilizing the structure proposed in this paper was conducted by staggering periods. Consideration was given so that the results of the experiment conducted later would not work favorably. Both experiments utilizing and without utilizing the structure were

conducted in regards to the role of the customer as well. The customer was common to all subjects.

5.4 Analysis of the experimental data

In regards to the experiment method without utilizing the structure proposed in this paper, the subject (the role of the SE) conducted the interview work on the experimenter (the role of customer), and the record of the content of questions asked by the subject to the customer and of answers from the customer (interview process) were obtained as well as the requirements specification prepared by the subject, in the manner similar to Section 5.4. Both of them were combined as the experimental data and used for analysis as the final product of the experiment.

In regards to the experiment method utilizing the structure proposed in this paper, the subject (the role of the SE) conducted the interview work to the experimenter (the role of the customer) through the requirements elicitation support system. During the experiment, candidate questions to be asked to the customer are presented to the subject who conducts the requirements elicitation work, by utilizing the rule of the order to present questions stored in question sentences in the system. The history of the content itself asked to the experimenter (system log) is the interview process, and the specification presented is the final product of the experiment. Both of them were combined as the experimental data and were used in the analysis.

5.4.1 Results of the analysis

Customer requirements elicited through the interview were analyzed by using the precision rate [9] and the recall ratio [9].

A situation indicated in Fig. 7 is considered. At this time, the aggregate consisting of all correct customer requirements data that should be elicited is specified as A. The aggregate consisting of all customer requirements data elicited with the Method X (the method without utilizing the structure for the navigation rule or by utilizing the structure) is specified as B. If the aggregate of correct customer requirements data elicited with the Method X (the experiment method without utilizing the structure for the navigation rule or by utilizing the structure) is specified as C, the precision ratio (rate of correct answers) and the recall ratio (rate of completeness) are expressed with the following formulas respectively:

Two expertised SEs and three mid-level SEs who participated in the comparative experiment are collectively referred to as the experienced SEs, and five beginner SEs are referred to as the inexperienced SEs.

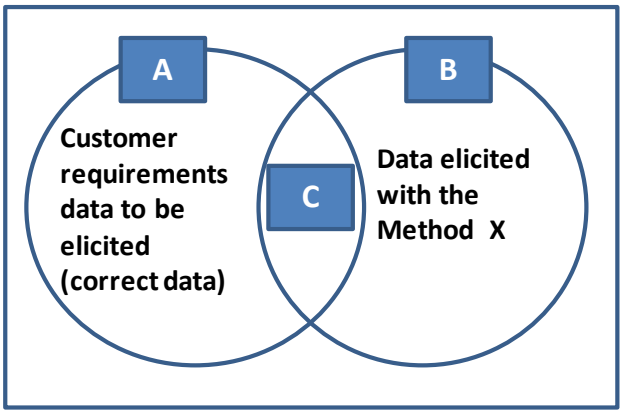

Fig. 7 Diagram to explain the precision ratio and recall ratio

$$P(\text{Precision ratio}) = \frac{C}{B}$$

$$R(\text{Recall ratio}) = \frac{C}{\text{A}}$$

The customer requirements data (including data erroneously elicited) B elicited with Method X by two expertised SEs, three mid-level SEs and five beginner SEs as the subjects is defined as a1, a2, b1, b2, b3, c1, c2, c3, c4 and c5, respectively. The data erroneously elicited with Method X is defined as Ea1, Ea2, Eb1, Eb2, Eb3, Ec1, Ec2, Ec3, Ec4 and Ec5. The correct customer requirements data C elicited with Method X by each subject is defined as Ca1, Ca2, Cb1, Cb2, Cb3, Cc1, Cc2, Cc3, Cc4 and Cc5, respectively.

The analysis results for the experiment without utilizing the structure for the navigation rule are indicated in Table 5. The analysis results for the experiment utilizing the structure for the navigation rule are indicated in Table 6.

5.4.2 Evaluation of analysis results

(1) When conducted as individual work without utilizing the structure for the rule

The precision ratio (rate of correct answers) tends to increase as the years of experiences increase, i.e., 78% for beginner SEs, 98% for mid-level SEs and 99% for expertised-SEs on average, while the rate is 78% on average for the inexperienced, indicating a high value regardless of experience. Therefore it is considered that accuracy of the requirements elicitation work conducted by one person improves as the years of experience increase, but people with poor experience are also able to elicit requirement

items with moderate accuracy (it is less likely to elicit wrong requirement items.)
On the other hand, the recall ratio (rate of completeness) on average is 9% for beginner SEs, 43% for mid-level SE and 70% for expertised SEs, indicating that it is difficult to elicit requirements without omissions if there is no experience. Moreover, while requirements tend to be elicited without omissions depending on the years of experience, there are 30% omissions in requirements elicitation even for expertised SEs, indicating that it is difficult to elicit requirements without omissions.
In the case of expertised SEs, requirements were elicited in the order of question and answer items indicated in Table 4; however inexperienced SEs mainly elicited functions for system requirements and hardly elicited other question and answer items. This is considered to be due to the SE's knowledge and experiences.

(2) When conducted as multiple people's cooperation without utilizing the structure for the navigation rule
In this experiment, all subjects conducted all of the requirements elicitation work as an individual task.
When it is presumed as a cooperative task for the purpose of evaluation at this time, the following is relevant:
When one inexperienced person was doing the task, the precision ratio (rate of correct answers) on average was 78%, 70% in the case of cooperation by five inexperienced people, and 98% in the case of one experienced person, while it was 94% in the case of cooperation by five experienced people, indicating that accuracy is lower compared with requirements elicitation work by one person, regardless of the workers' experience.
This is because the work actually done as an individual task is forcibly presumed as a cooperative task and the mechanism to check others' tasks is not working at all.
On the other hand, the recall ratio (rate of completeness) on average was 9% in the case of one inexperienced person, 20% in the case of cooperation by five inexperienced people and 54% in the case of one experienced person, while it was 84% in the case of cooperation by five experienced people, indicating that by cooperative requirements elicitation work, omissions in elicitation of requirement items decrease compared with the case by one person, regardless of workers' experience.
Although the mechanism to obtain new ideas triggered by other people's remarks as observed in brainstorming, etc. is not working, omission of items in requirements elicitation decreases by cooperative requirements elicitation work, compared with the case by one person, regardless of workers' experience.
Therefore, in view of the results of (1) and (2), it is indicated that requirements elicitation work should be done by cooperation of multiple people, and one reliable SE with abundant experiences should review the results elicited.

(3) Requirements elicitation work utilizing the structure for the navigation rule
The precision ratio (rate of correct answers) was 100% regardless of workers' experience, when the requirements elicitation work was conducted by one person and by cooperation of multiple people. This suggests that the requirements elicitation work utilizing the navigation rule can be conducted more accurately than any form of requirements elicitation work without utilizing the navigation rule, regardless of workers' experience.
On the other hand, the recall ratio (rate of completeness) was 99% regardless of workers' experience, when the requirements elicitation work was conducted by one person and by cooperation of multiple people. The remainder of 1% is because four requirement items were not successfully elicited with the navigation rule due to incomplete preparation of the navigation rule.
Thus, by maintaining the navigation rule, the rate will certainly become 100% regardless of the workers' experience, when the requirements elicitation work is conducted by one person and by cooperation of multiple people.
Consequently, effectiveness of the method to conduct requirements elicitation work by utilizing the structure for the navigation rule proposed in this paper is indicated from the results of (1) to (3).

6 Conclusion

As explained in the above, the requirements elicitation work to determine the requirements from the customer is a very important task in software development. However, it is not an easy work to elicit customer requirements for software without omissions, to accurately analyze requirements elicited and to summarize them into a specification.
In this paper, the structure to navigate interview-driven requirements elicitation work conducted by the SE was proposed using the interview technique.
Furthermore, requirements for the medical image information system for hospitals were actually defined, the order of questions to the customer was clarified to effectively elicit customer requirements,

the conditions to present each question item elicited as well as the order of presentation were summarized, and the navigation rule was prepared.

Table 5 Experiment results without utilizing the structure for the navigation rule

Method	Method not utilizing the structure for the navigation rule: Method X									
Group	Experienced group (group of skilled SEs and mid-level SEs)					Inexperienced group (group of beginner SEs)				
Experience	Expertised SE		Mid-level SE			Beginner SE				
Subject	a1	a2	b1	b2	b3	c1	c2	c3	c4	c5
Elicited data (including erroneous data)	a1 = 285	a2 = 204	b1 = 159	b2 = 170	b3 = 139	c1 = 26	c2 = 56	c3 = 39	c4 = 40	c4 = 35
	(a1＋a2) / 2= 245		(b1 + b2 + b3) / 3= 156			(c1 + c2 + c3 + c4 + c5) / 5= 39				
	(a1 + a2 +b1 + b2 + b3) / 5= 191									
	(a1 U a2 U b1 U b2 U b3) = 310					(c1 U c2 U c3 U c4 U c5) = 141				
	(a1 U a2 U b1 U b2 U b3 U c1 U c2 U c3 U c4 U c5) = 357									
Correct data	(a1-Ea1) = 285	(a2-Ea2) = 201	(b1-Eb1) = 154	(b2-Eb2) = 165	(b3-Eb3) = 132	(c1-Ec1) = 16	(c2-Ec2) = 47	(c3-Ec3) = 30	(c4-Ec4) = 33	(c5-Ec5) = 27
	((a1-Ea1)+(a2-Ea2)) /2 = 243		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) /3 = 150			((c1-Ec1)+(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) /5 = 31				
	((a1-Ea1)+(a2-Ea2)+(b1-E1b1)+(b2-Eb2)+(b3-Eb3)) /5 = 187									
	(a1 U a2 U b1 U b2 U b3) − (Ea1 U Ea2 U Eb1 U Eb2 U Eb3) = 290					(c1 U c2 U c3 U c4 U c5) − (Ec1 U Ec2 U Ec3 U Ec4 U Ec5) = 98				
	(a1 U a2 U b1 U b2 U b3 U c1 U c2 U c3 U c4 U c5) − (Ea1 U Ea2 U Eb1 U Eb2 U Eb3 U Ec1 U Ec2 U Ec3 U Ec4 U Ec5) = 294									
Precision ratio	285 / 285 = 1.00	201 / 204 = 0.99	154 / 159 = 0.97	165 / 170 = 0.97	132 / 139 =0.95	16 / 26 = 062	47 / 56 = 0.84	30 / 39 = 0.77	33 / 40 = 0.83	27 / 35 =0.77
	((a1-Ea1)+(a2-Ea2)) / (a1＋a2) = 0.99		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (b1 + b2 + b3) = 0.96			((c1-Ec1)+(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) / (c1 + c2 + c3 + c4 + c5) = 0.78				
	((a1-Ea1)+(a2-Ea2)+(b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (a1＋a2 + b1 + b2 + b3) = 0.98									
	((a1 U a2 U b1 U b2 U b3) − (Ea1 U Ea2 U Eb1 U Eb2 U Eb3)) / (a1 U a2 U b1 U b2 U b3) = 0.94					((c1 U c2 U c3 U c4 U c5) − (Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) / (c1 U c2 U c3 U c4 U c5) = 0.70				
Recall ratio	all correct data:((Method X1 U Method X2)− (Ea1 U Ea2 U Eb1 U Eb2 U Eb3 U Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) = 347									
	285 / 347 =0.82	201 / 347 =0.58	154 / 347 =0.44	165 / 347 =0.48	132 / 347 =0.38	16 / 347 =0.05	47 / 347 =0.14	30 / 347 =0.09	33 / 347 =0.10	27 / 347 =0.08
	((a1-Ea1)+(a2-Ea2)) / (347*2) = 0.70		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (347*3) = 0.43			((c1-Ec1) +(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) / (347*5) = 0.09				
	((a1-Ea1)+(a2-Ea2)+(b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (347*5) = 0.54									
	((a1 U a2 U b1 U b2 U b3) − (Ea1 U Ea2 U Eb1 U Eb2 U Eb3)) / (347) = 0.84					((c1 U c2 U c3 U c4 U c5) − (Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) / (347) = 0.28				

Table 6 Experiment results utilizing the structure for the navigation rule

Method	Method utilizing the structure for the navigation rule: Method X2									
Group	Experienced group (group of skilled SEs and mid-level SEs)					Inexperienced group (group of beginner SEs)				
Experience	Expertised SE		Mid-level SE			Beginner SE				
Subject	a1	a2	b1	b2	b3	c1	c2	c3	c4	c5
Elicited data (including erroneous data)	a1 = 343	a2 = 343	b1 = 343	b2 = 343	b3 = 343	c1 = 343	c2 = 343	c3 = 343	c4 = 343	c5 = 343
	(a1＋a2) / 2= 343		(b1 + b2 + b3) / 3= 343			(c1 + c2 + c3 + c4 + c5) / 5= 343				
	(a1 + a2 +b1 + b2 + b3) / 5= 343									
	(a1 U a2 U b1 U b2 U b3) = 343					(c1 U c2 U c3 U c4 U c5) = 343				
	(a1 U a2 U b1 U b2 U b3 U c1 U c2 U c3 U c4 U c5) = 343									
Correct data	(a1-Ea1) = 343	(a2-Ea2) = 343	(b1-Eb1) = 343	(b2-Eb2) = 343	(b3-Eb3) = 343	(c1-Ec1) = 343	(c2-Ec2) = 343	(c3-Ec3) = 343	(c4-Ec4) = 343	(c5-Ec5) = 343
	((a1-Ea1)+(a2-Ea2)) /2 = 343		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) /3 = 343			((c1-Ec1)+(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) /5 = 343				
	((a1-Ea1)+(a2-Ea2)+(b1-E1b1)+(b2-Eb2)+(b3-Eb3)) /5 = 343									
	(a1 U a2 U b1 U b2 U b3) - (Ea1 U Ea2 U Eb1 U Eb2 U Eb3) = 343					(c1 U c2 U c3 U c4 U c5) - (Ec1 U Ec2 U Ec3 U Ec4 U Ec5) = 343				
	(a1 U a2 U b1 U b2 U b3 U c1 U c2 U c3 U c4 U c5) - (Ea1 U Ea2 U Eb1 U Eb2 U Eb3 U Ec1 U Ec2 U Ec3 U Ec4 U Ec5) = 343									
Precision ratio	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 =1.00	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 = 1.00	343 / 343 =1.00
	((a1-Ea1)+(a2-Ea2)) / (a1＋a2) = 1.00		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (b1 + b2 + b3) = 1.00			((c1-Ec1)+(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) / (c1 + c2 + c3 + c4 + c5) = 1.00				
	((a1-Ea1)+(a2-Ea2)+(b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (a1＋a2 + b1 + b2 + b3) = 1.00									
	((a1 U a2 U b1 U b2 U b3) - (Ea1 U Ea2 U Eb1 U Eb2 U Eb3)) / (a1 U a2 U b1 U b2 U b3) = 1.00					((c1 U c2 U c3 U c4 U c5) - (Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) / (c1 U c2 U c3 U c4 U c5) = 1.00				
Recall ratio	all correct data:((Method X1 U Method X2)- (Ea1 U Ea2 U Eb1 U Eb2 U Eb3 U Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) = 347									
	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99	343 / 347 =0.99
	((a1-Ea1)+(a2-Ea2)) / (347*2) = 0.99		((b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (347*3) = 0.99			((c1-Ec1) +(c2-Ec2)+(c3-Ec3)+(c4-Ec4)+(c5-Ec5)) / (347*5) = 0.99				
	((a1-Ea1)+(a2-Ea2)+(b1-Eb1)+(b2-Eb2)+(b3-Eb3)) / (347*5) = 0.99									
	((a1 U a2 U b1 U b2 U b3) - (Ea1 U Ea2 U Eb1 U Eb2 U Eb3)) / (347) = 0.99					((c1 U c2 U c3 U c4 U c5) - (Ec1 U Ec2 U Ec3 U Ec4 U Ec5)) / (347) = 0.99				

Then, a comparative experiment was conducted in regards to the case that the SE conducts the requirements elicitation work for the medical image information system through interviews to the customer by utilizing the structure for the navigation rule as well as to the case without utilizing the structure. As a result, it was clarified that the customer requirements elicitation work influences business knowledge and the experiences of each individual, resulting in differences in the quality of requirements elicitation. Furthermore, it was also clarified that customer requirements can be elicited with consistent quality in a condition with less omissions or errors regardless of the SE's business knowledge and experiences by utilizing the structure to navigate interview-driven requirements elicitation work, and the effectiveness of the proposed structure was successfully verified.

References:

[1] Seiichi Komiya, Junzo Kato, Morio Nagata, Atsushi Onishi, Motoshi Saeki, Shuichiro Yamamoto and Hisayuki Horai, "How to Realize System to Navigate Interview-Driven Requirements Elicitation Work," Paper presented in the 19th IPA Symposium, pp.37-48, Oct. 11-12, 2000.

[2] Toshiyasu Kunii and Issei Fujishiro, "Chapter 2: System Design Theory," System Theory 14th Edition, Compiled by the Information Processing Society of Japan, Information Processing Handbook, pp.1216-1225, 1990.

[3] "Problem Solving Technique in Requirements Definition Stage," Nihon Unysis, Ltd., 1991.

[4] R. Lecoeuchi, C. Mellish and D. Robertson, "A Framework for Requirements Elicitation through Mixed-Initiative Dialogue," Proceedings of 4th International Conference on Requirements Engineering, pp.190-196, 1998.

[5] Julio Cesar Sampaio do Prado Leite and AnaPaula Pinho Gilvaz, "Requirements Elicitation Driven by Interviews: The Use of Viewpoints," Proceedings of 18th International Workshop on Software Specification and Design (IWSSD-8), pp. 85-94, 1996.

[6] Shuichiro Yamamoto, "Goal-Oriented Requirements Management Technique," Soft Research Center, 2007.

[7] IEEE Recommended Practice for Software Requirements Specifications, IEEE Std. 830-1998.

[8] John M. Carroll, "Design Based on Scenario – Secret for Successful Software Development Project," Kyoritsu Shuppan, 2003.

[9] Takeo Nagashima, "Proposal of Risk Identification Method Based on Improved Kepner-tregoe Method and Evaluation of Effectiveness," Journal of the Institute of Electronics, Information and Communication Engineers, Vol. J91-A, No.9, pp.883-897, 2008.

[10] Seiichi Komiya, Junzo Kato, Morio Nagata, Shuichiro Yamamoto, Motoshi Saeki, Atsushi Ohnishi, Hisayuki Horai, "A Method for Implementing a System to Guide Interview-driven Software Requirements Elicitation, " Proc. of the 4th *Joint Conference on Knowledge-Based Software Engineering (JCKBSE'2000)*, Brno, Czech Republic, Sep. 2000, pp.175-182.

[11] Deniss Kumlander, "Communication Gaps and Requirements Uncertainties in the Information Systems Design, " Proceedings of the 6th WSEAS International Conference on Applied Informatics and Communications, Elounda, Greece, August 18-20, 2006 , pp.400-405.

[12] Sangkuk Kim, Taewon Kyung "A Study on the Priority Selection for Information System Project Management Model, " Proceedings of the 6th WSEAS International Conference on Applied Computer Science, Hangzhou, China, April 15-17, 2007 , pp.639-647.

[13] Zhiqi Shen, Chunyan Miao, Robert Gay, Chor Ping Low, "Personalized e-Learning – a Goal Oriented Approach, " Proceedings of the 7th WSEAS International Conference on Distance Learning and Web Engineering, Beijing, China, September 15-17, 2007 , pp.304-309.

[14] Juan Antonio Pernas, Santiago Pellit, Francisco Javier Novoa, Jose Manuel Vazquez, Ruben Grande, Javier Pereira, Jorge Teijeiro, Alejandro Pazos, " E-Health application: Development of a Web Framework for the creation and application of metric systems to the digital medical image, " 6th WSEAS International Conference on E-ACTIVITIES, Tenerife, Spain, December 14-16, 2007 , pp.328-332.

[15] Atsushi Ohnishi, "Scenario Generation with Differential Scenario, " Proceedings of the 6th WSEAS Int. Conf. on Software Engineering, Parallel and Distributed Systems, Corfu Island, Greece, February 16-19, 2007 , pp.45-50.