



## Requirements Engineering of Village Innovation Application Using Goal-Oriented Requirements Engineering (GORE)

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**Abstract** — The delay in the absorption of village funds from the central government to the village government is due to the village government's difficulty preparing village development innovation programs. The innovation tradition will grow if the cycle of transformation of knowledge and acceptable practices from one village to another, especially villages with similar conditions and problems, can run smoothly. For the process of exchanging knowledge and experiences between villages to run smoothly, it is necessary to codify best practices in a structured, documented, and disseminated manner. This research aims to design an application that functions as a medium for sharing knowledge about the use of village funds through government innovation narratives. The application is expected to become a reference for villages to carry out innovative practices by conducting replication studies and replicating acceptable practices that other villages have done. Therefore, it is necessary to have a system requirements elicitation method that can explore the village's requirements in sharing knowledge so that the resulting system is of high quality and by the objectives of being developed. There are several Goal-Oriented Requirements Engineering (GORE) methods used, such as Knowledge Acquisition in Automated Specification (KAOS) and requirements engineering based on business processes. In this research, the KAOS method was demonstrated as the elicitation activity of a village innovation system. Then the results were stated in the Goal Tree Model (GTM). Model building begins with discussions with the manager of the village innovation program to produce goals. The goals are then broken down into several sub-goals using the KAOS method. The KAOS method is used for the requirements elicitation process resulting in functional and non-functional requirements. This research is the elicitation of the requirement for the village innovation system so that it can demonstrate the initial steps in determining the requirements of the village innovation system before carrying out the design process and the system creation process. The results of this requirement elicitation can be used further in the software engineering process to produce quality and appropriate village innovation applications.

**Keywords** – requirements engineering, android application, innovation village, GORE, elicitation

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### I. INTRODUCTION

The village government is still having difficulty accessing good knowledge about village funds to affect village innovation programs. The lack of knowledge about the village innovation program results in the less rapid preparation of the Village Income and Expenditure Budget (APBDes) to affect the fast or slow absorption of village funds budgeted by the government. This issue impacts delays in the

absorption of village funds from the central government to the village government because it is challenging to prepare village development programs.

The government issued Presidential Regulation Number 131 of 2015 concerning the Determination of Underdeveloped Areas of 2014-2019. Data statistic shows there are 122 districts included in the list of underdeveloped regions. An area is underdeveloped if

community economic development, human resources, facilities and infrastructure, regional financial capacity, accessibility, and regional characteristics are deficient. As a consequence of the above regulations, programs for handling disadvantaged areas require a unique and specific approach to trigger development's acceleration. Accelerated growth is needed to reduce the level of gaps between underdeveloped regions and other regions.

For this reason, development activities in villages and disadvantaged areas must be able to produce creative and innovative traditions. The innovation tradition will grow if the cycle of transformation of knowledge and acceptable practices from one village to another, one region to another - especially villages/areas with similar conditions and problems, can run smoothly. For the process of exchanging knowledge and experiences between villages and between regions to run, we codify best practices in a structured, documented, and disseminated manner [1]. Village innovation can be divided into several types, namely scientific and technological innovation empowering agricultural modernization, institutional innovation management, network innovation, and intermediary platforms to accelerate resource mobility [2].

The village innovation application is expected to become a reference for villages to carry out innovative practices by conducting replication studies and replicating acceptable practices done by other villages. Therefore, it is necessary to have a system requirements elicitation method to explore the village's knowledge-sharing requirements. The resulting system is of high quality and follows the developed objectives. A proper requirement engineering method is needed so that the village innovation application's functional requirements and non-functional requirements will be designed entirely and precisely. A quality and reliable system are created using the appropriate elicitation and requirements analysis methods [3] [4]. Besides, knowing the requirements can impact estimation, which is a crucial phase that can determine the success of a software project [5].

Many methods and models were developed to assist in gathering and understanding the software system requirements. Requirements engineering is one of the processes used to collect and understand the requirements of a software system. Requirements engineering uses theory, technique, language, and tools for more effective analysis, documentation, and evolution of user requirements to meet user requirements [6]. Requirements engineering is the process of obtaining, analyzing, documenting, validating, and managing the requirements of users and decision-holders [7]. Based on these definitions, it can conclude that requirements engineering is a determinant of the success and failure rate of a software system that depends on the level and quality

of service it provides, as requested by users and stakeholders.

The requirements engineering stages include requirements elicitation, requirements analysis, requirements specification, validation verification, and requirements evaluation [8]. The system requirements elicitation process is the initial stage of the software requirements engineering process to collect, categorize, and prioritize business requirements to be analyzed and validated into system requirements to be developed [8]. One of the existing requirements engineering techniques is Goal-Oriented Requirements Engineering (GORE) [7]. GORE is a model used to collect and analyze initial requirements for software development in the forward engineering process. That is an advantage for GORE as an excellent model to use in tracking and requirements analysis. Some of the methods that have been developed in GORE include Knowledge Acquisition in Automatic Specification (KAOS), Goal-Based Requirements Analysis Method (GBRAM), I\* / Tropos, and so on [9].

One method that is still being developed now and is often used is the Knowledge Acquisition in Automated Specification (KAOS) [10] [11] [12], and there is also the Goal Requirements Language (GRL) [13] approach and the Organization Goal-Oriented Requirements method. Engineering (OGORE) [14] to obtain information system requirements. KAOS can be described as a framework of several paradigms that combine several different levels of thinking about system requirements and their reasons. KAOS is a framework for eliciting, specifying, and analyzing the goals of the system (goals), system requirements (requirements), scenarios, and task responsibilities of system users (agents) [15].

KAOS ontology includes objects (objects), namely exciting things in the system that can develop between conditions or circumstances. The object in question can be an entity, relationship, or event. The elements in KAOS are shown in Fig. 1. A goal is defined as a collection of behaviors/conditions that the system must meet or accepted in a specified condition [15]. The definition of goals must be clear to verify that the system can meet these goals. The soft goal is used to document the system's alternative behavior, not to verify satisfaction. The satisfaction level of the soft goals will be limited using the specified limitations. Agents are a type of object that act as processors for operational activities. Agents are active components that can be humans, hardware, software, and others that have a specific role in satisfying a goal.

KAOS has several term goals (goals) [16]. The goals including satisfaction goals, namely functional goals whose requests are satisfied by the agent, information goals are also functional and aim to keep the agent informed about the objective statement. Accuracy goals are non-functional goals needed so

that the objective statement can observe accurately in its environment.

Three types of dependence show in Fig. 1. among the goals and other KAOS entities, namely AND / OR-decomposition, potential conflict, responsibility assignment. AND / OR-decomposition is a relationship that connects a goal with a collection of sub-goals that illustrate the goal is achieved. If all sub-goals are fulfilled, or at least one of the soft goals is met. The potential conflict is a relationship that describes if a goal is completed; it can lead to the fulfillment of other goals under certain conditions. Responsibility assignment is the relationship between the agent and a goal, which means that the agent is responsible for fulfilling the goals connected to him.

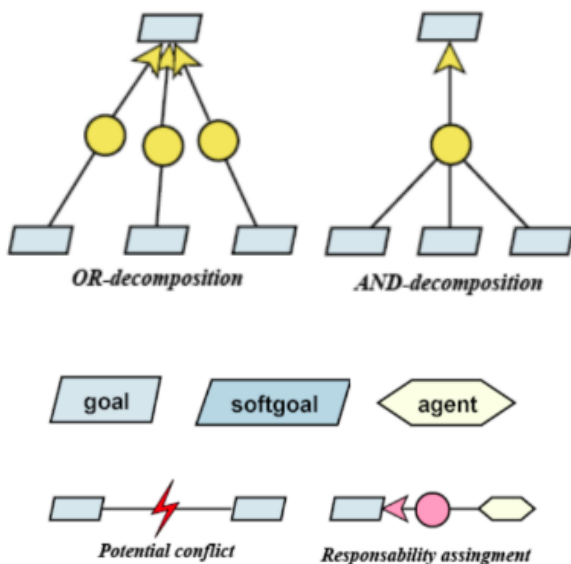


Fig. 1. Basic construction of KAOS in modeling Goal, Agent, and duties [17]

Village innovation encourages village development to improve community welfare, improve quality of life, and reduce poverty through meeting basic requirements, building village facilities and infrastructure, developing local economic potential, and sustainably utilizing natural and environmental resources. Law No. 6 of 2014 concerning villages provides authority and budget for villages to safely and transparently regulate and manage the village. However, this hope is collided with the lack of village capacity to carry out development and community empowerment. The village innovation system is designed to provide a reference for villages to learn about acceptable practices that have been implemented by the village, including facilitating knowledge exchange through the Village Rembug Forum (FRD). It is necessary to have a proper requirement engineering process so that the village innovation system used to exchange knowledge and experience between villages and between regions can run well, reliably, and with quality.

In this study, requirements elicitation focus on the village innovation system as a development project,

then the results described using the KAOS method [9]. The modeling of the elicitation process for the village innovation system can demonstrate the initial steps in determining the village innovation system's requirements before carrying out the design process and making the next system so that the resulting village innovation system is expected to have the best quality. Following the problems formulated, the purpose of this study is to model the requirements of an application that functions as a medium for sharing knowledge about the use of village funds through government innovation narratives.

## II. RESEARCH METHODS

In this study, the research methodology included literature study, data search, use of the KAOS method, and Goal Tree Model (GTM) modeling. Literature study to get a literature review of the KAOS method as a goal-oriented requirement engineering method and modeling the results of requirements elicitation in the form of a Goal Tree Model (GTM), used in the process of eliciting the requirements of the village innovation system. Next, look for data and information from the village innovation knowledge sharing business process. After that, use the KAOS method to felicitate requirements by asking "why" and "how" questions to elicit requirements. And modeling the results of the requirements elicitation process in the form of a Goal Tree Model (GTM). The following sub-section will be divided into two significant parts of research implementation: the results of a literature study in the form of literature review and rare 2 to 4 discussed in a sub-section regarding the elicitation process for village innovation system requirements using the KAOS method.

Based on previous explanations and research, it is necessary to describe and define the steps carried out during the village innovation system's elicitation process. The process steps use the KAOS method.

### A. The Process of Village Innovation System Requirements Elicitation Using the KAOS Method

There are several goal-oriented requirements engineering methods for performing the elicitation process and modeling the collected and defined requirements in system development activities. In this study, the KAOS method is used because initial research focused on the requirements elicitation process. The GRL method is used to perform a requirements analysis based on the elicitation process being carried out. The GRL method is a Goal-Modeling language to describe the relationship of each element. The GRL method will generate a Goal Tree Model (GTM), which will show each element's relation.

Furthermore, the OGORE method is used specifically to reduce requirements based on organizational goals. The OGORE requirements an engineering method, an extension of GORE that can

reduce the risks that arise due to user requirements based on their desires and focus on organizational goals. The result of the OGORE method is the Goal Tree Model (GTM).

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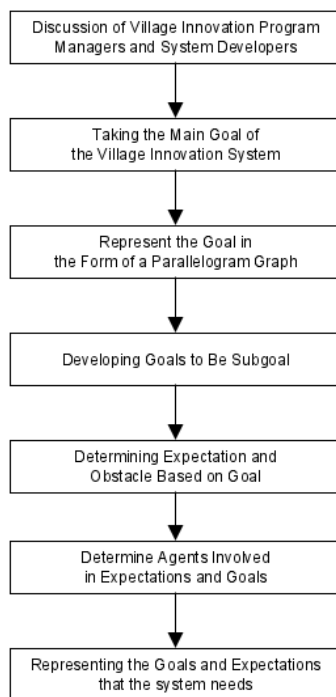


Fig. 2. Elicitation Process for Village Innovation System Requirements

The first process is a discussion of village innovation program managers and system developers. This activity runs a small discussion group attended by village innovation program managers, requirements engineers, and system analysts from the village innovation system's development team. The group discussed to determine the goal of creating a village innovation system.

The second process is to take the primary goal of the village innovation system. This activity analyzes and produces priority goals (goals) achieve by the new system that developed. Primary goals are the basis of the requirements that arise to meet these goals.

The third process is to represent the goal in the form of a parallelogram graph. After getting the primary goal, define the main goal in the form of a

parallelogram graph. A parallelogram graph is a graph that resembles a branched tree that will map the reach of a goal in an application system. This graph describes the system's goals to become a requirement that the agent must do. The graph will be the result of the decomposition of the main goal in the system. The goal will be in the form of a parallelogram, which can become a node or leaf on the graphic, then decomposed back into a sub-goal.

The fourth process is to develop goals into sub-goals. At this stage, the primary goals or goals that have been obtained previously are set or decomposed into sub-goals. A sub-goal is a goal derived from the parent goal, where must do the fulfillment of all these sub-goals so that the parent goal is achieved. Each goal can be decomposed into one or more subgoals or even cannot be spoiled. Subgoal analysis results from the expansion of the previously described main goals. Sub goals extend the reach of the goals down to the details of the decision holder's tasks. The decomposition process on the subgoal will stop when it has achieved goals delegated to an application system's components.

The fifth process is to determine the expectation and obstacles. The next step is to determine the obstacle and expectation for each previously obtained goal. The obstacle is a condition that can prevent the achievement of a goal. Obstacles can also be said as an undesirable condition that occurs in the system. The expectation is one type of goal in the form of a state desired by an agent who is part of the system environment. The KAOS obstacle method is marked with a red parallelogram. In contrast, the expectation is marked with a yellow parallelogram. Determination of the obstacle aims to prepare solutions related to the obstacles that will arise. In contrast, the decision of expectation seeks to get the requirements according to the system environment's agents.

The sixth process is to determine the agents involved in expectations and goals. The expectations and goals that have been previously obtained are linked to the agents in the application system. The purpose of determining this agent is that every expectation and goal can be traced by the agent involved in an expectation.

The seventh process is to represent goals into requirements. A goal that becomes a requirement is a goal that becomes a leaf in a parallelogram graph related to the agent. Agent in the KAOS method is a subject who is responsible for fulfilling a requirement. The expectation is included in the types of goals related to agents and can be a requirement. The goals, which are the requirements, are represented by a parallelogram that has a thick border.

The results of the main elicitation steps discussed the earlier requirement to be modeled in a diagram to see the relationship between each existing entity more clearly. Using the KAOS method, the model used to

describe the results of requirements elicitation is the Goal Tree Model (GTM), depicted using the KAOS modeling notation (see Fig. 1). Furthermore, from this modeling, the organization can understand the requirements of a village innovation system developed and become material for discussion and continuing the system development process, namely design, coding, and testing before implementation.

### III. RESULTS

Modeling using KAOS, several alternatives and variations of the system function to be created can be selected by the village innovation program manager to get the process of sharing village innovation knowledge that is closest to its requirements. The steps described and examples of modeling the village innovation system's requirements so that the community and village officials can share village innovation knowledge through the village innovation system. The KAOS method's implementation in the village innovation system described in the previous section illustrates that the requirements elicitation process can be carried out.

#### A. Discussion of village innovation program managers and system developers

The goal (goal) of the new system is to collect a variety of acceptable practices in village governance and underdeveloped areas in Indonesia. Every sound practice is an inspiration and an achievement, which deserves a positive appreciation as a form of innovation in improving poor villages and regions. The purpose of the organization with the village innovation system is to exchange knowledge and experiences between villages and regions to run to codify best practices carried out by the community and village officials in a structured, documented, and disseminated manner. After determining these primary objectives, the next step is to determine the entities and relationships between entities that describe the village innovation system's requirements to be created.

#### B. Taking the main goal of the village innovation system

At the next meeting with the officeholders, the development team defines goals and their derivatives, such as soft goals, tasks, and agents based on the predetermined system's main objectives. The method used to obtain the following entities and the relationship between entities is by answering the questions "Why" and "How" in extracting goals into their derivatives in the form of new goals, tasks, or agents. Requirements engineers from the development team ask questions and discuss with program managers about plans for daily operational procedures carried out to extract expected goals and seek information based on problems that the running system has not solved. This primary activity a village innovation system's requirement will be obtained in

goals, soft goals, tasks, resources, and agents. Some of the main goals of the village innovation system are: (1) a catalog of innovations in villages and disadvantaged areas; (2) Innovation map; (3) contributor registration; (4) Account management; (5) Guidance information; (6) Village innovation management;

#### C. Represent a goal in the form of a parallelogram graph

The main goals obtained based on the management group discussion are made into a parallelogram graph illustrated in Fig. 3.

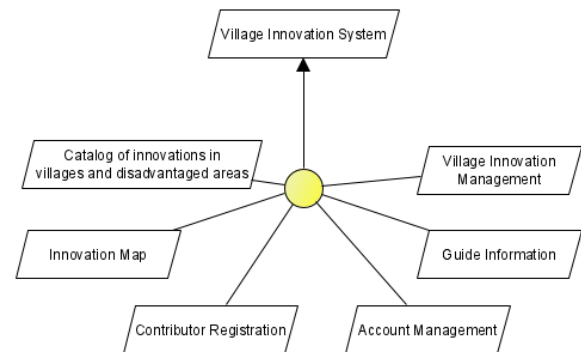


Fig. 3. Representation of Main Goal in Parallelogram Graph

The parallelogram graph shown in Fig. 3 is the result of the requirements elicitation in stage one. Based on Fig. 3, it can see that it must meet six goals to meet the village innovation system's objectives. If only one goal is not achieved, it will not achieve the village innovation system's goal. The representation of the main goal in Fig. 3 will become a basic graph, wherein each main goal will be decomposed back into a sub-goal to get the system requirements.

#### D. Develop goals into sub-goals

Based on the management group discussion, the sub-goals handled by the system consisted of access to the system and leaving the system. Fig. 4 is a parallelogram graph resulting from the refinement of the subgoal of the village innovation system. Access to the system is achieved by fulfilling the "login form" goal. The login forms that the system must achieve are: (1) Providing login form facilities in the form of a username and password; (2) Displays the account name if successfully logged into the system; (3) Displays a warning message in the form of an alert if the username and password are wrong.

For login activity information, what the system must achieve, namely: (1) Storing data on the date the user entered the system; (2) The accumulated number of activities entered into the system by users. Access out of the system that the course must fulfill includes: (1) Providing a button facility to exit from the system; (2) Displays a message in the form of an alert if successfully leaving the network.

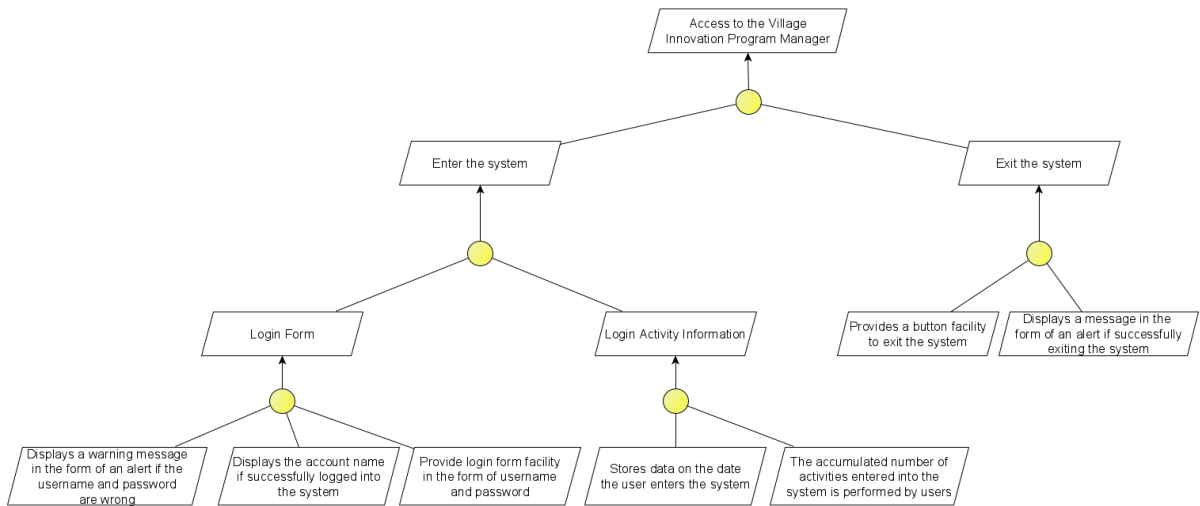


Fig. 4. Sub Goal Analysis

E. Determine the expectation and obstacle

Based on the manager group discussion, the village innovation system has three expectations for goals achieving goals. These expectations include: (1) Registered as a user; (2) Fill in the login form; (3) Pressing the logout button. Expectation "registered as a user" is a scenario or condition in the form of facts that the type of user must do to meet the goal of "user access." Expectation "filling in the login form" is a condition or the fact that the user must do to meet the goal of "entering the system." Expectation "pressing the logout button" is a scenario or condition in the form of facts that the user must do to fulfill the goal of "getting out of the system." The goal of "getting into the system" has an obstacle or condition that hinders the goal's achievement, namely, the user forgets the account username or password. Fig. 5 and Fig. 6 are parallelogram graphs that analyze the expectations and obstacles of the village innovation system goals. Determination of the obstacle aims to prepare

solutions related to the obstacles that will arise. In contrast, the decision of expectation seeks to get the requirements according to the system environment's agents of Village Innovation Application.

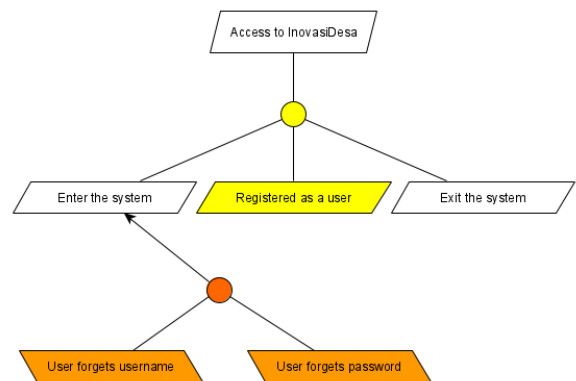


Fig. 6. Obstacle Analysis

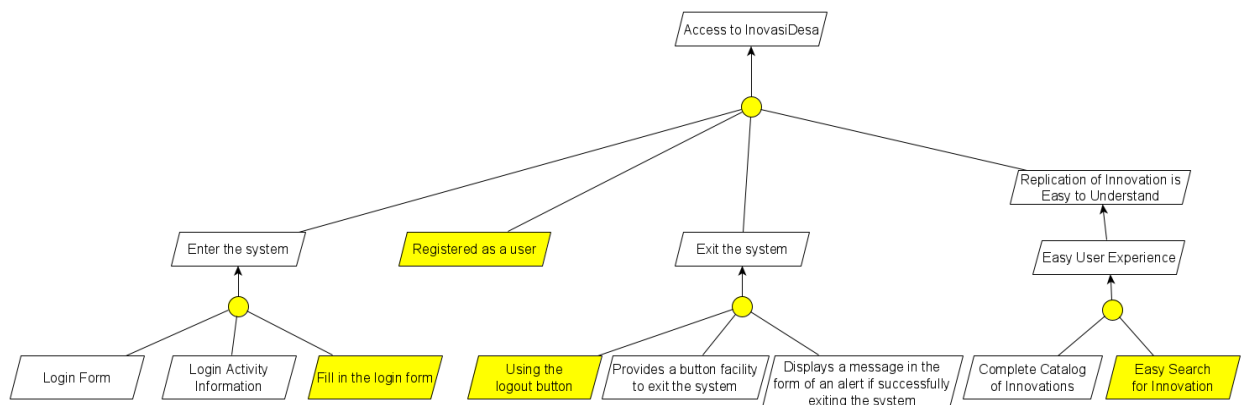


Fig. 5. Expectation Analysis

**F. Determine the agents involved in expectations and goals**

Based on the analysis process using the KAOS method, the results obtained by agents who play a role in the village innovation application system's functional requirements are contributors and editors.

Agents in the KAOS method are subjects who are responsible for fulfilling a requirement. The agent in the KAOS method is depicted using a light-yellow hexagon shape. Fig. 7 is a parallelogram graph resulting from the agent analysis with the KAOS method.

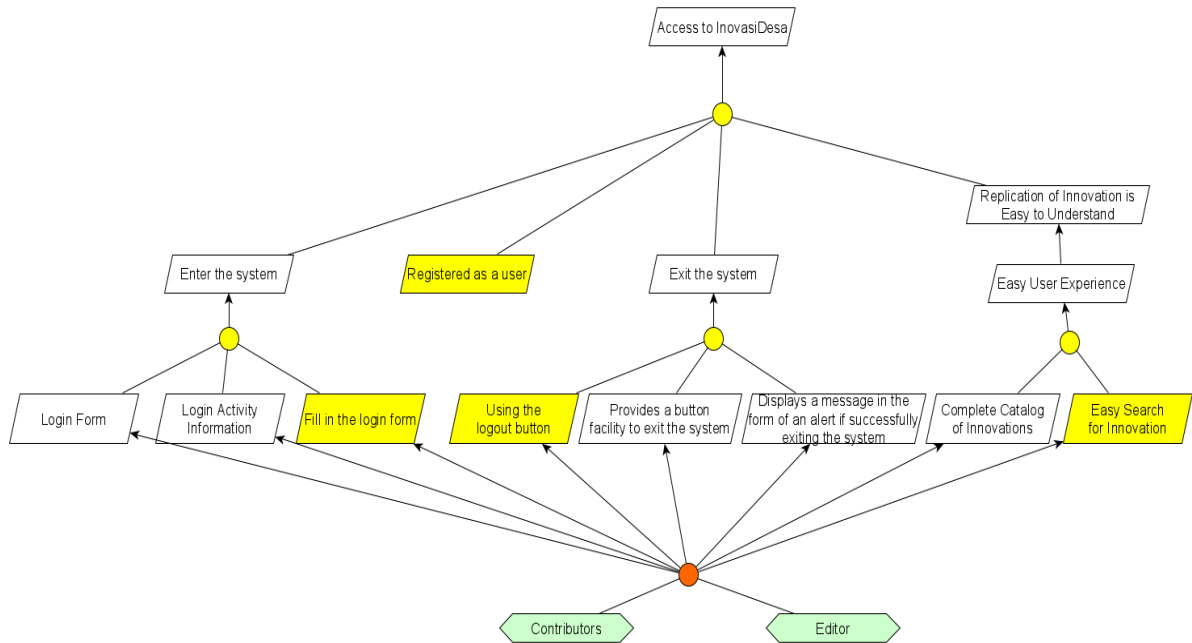


Fig. 7. Expectation Analysis with Agent

**G. Represent goals become requirements**

The requirement in the parallelogram graph is a goal in the form of a task that an agent must achieve a goal. The parallelogram graph's requirements are described using thick borderlines on the goal, a system

requirement. The representation of requirements for each sub-goal shown in Fig. 8 is described using thick borderlines.

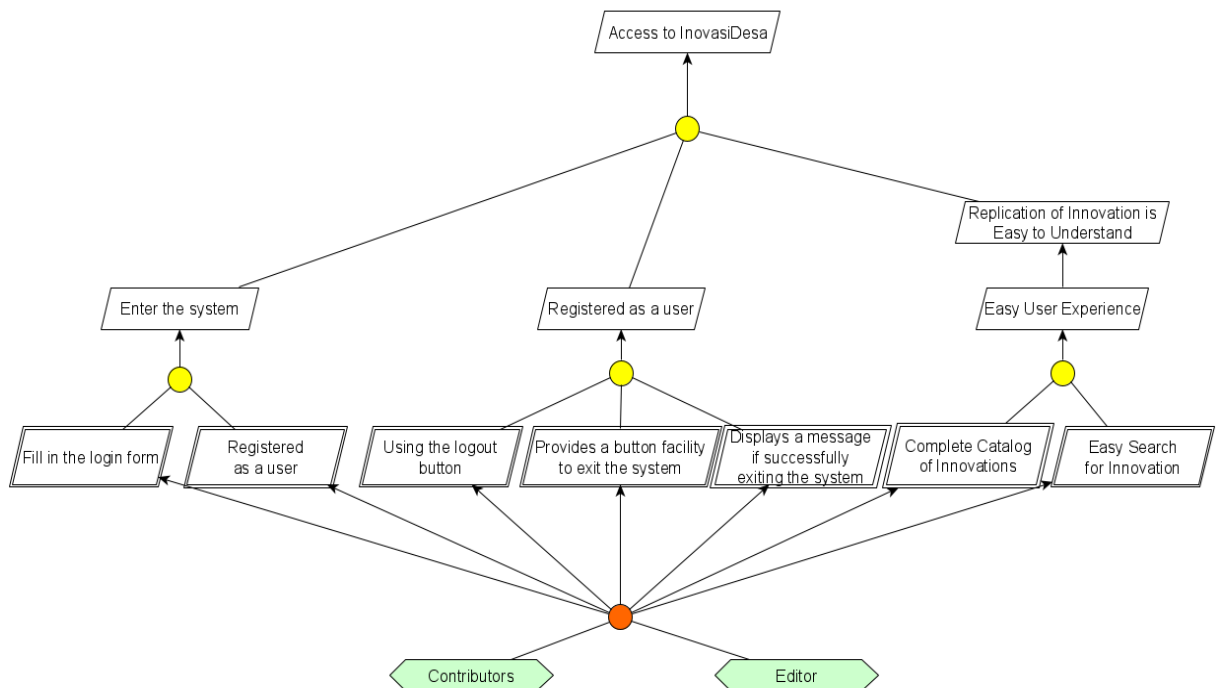


Fig. 8. Results of Representation of Requirements in the Village Innovation System Goal

#### IV. DISCUSSION

Many studies discuss village innovation. However, these studies have only touched the surface level and have not provided a comprehensive and comprehensive picture. The implementation of village innovation using the village website still finds many obstacles in its management [18]. That is because the village government must actively manage the village website independently to be maximum, updated, and informative. Therefore, this research contributes to the engineering requirements regarding village innovation applications. Modeling the requirements for village innovation applications that have been carried out and discussed in the results section can help understand the village innovation system's requirements.

In this case study, it has been demonstrated that it aims to "Implementing Access to Village Innovations for the village innovation system to be created." Furthermore, from the resulting GTM, can also obtain the results that the soft goals can be derived to achieve the main goal, namely "Replication of Innovation Easily Understood." This soft goal can contribute to the achievement of the goal of creating a village innovation system. It can achieve these soft goals with sub-goals that can be reduced to system functional requirements, namely "Easy User Experience," "Complete Innovation Catalog," and "Easy Innovation Search," according to the diagram in Fig. 2. Agents required to run a village innovation system are a village community.

The advantage of using the KAOS method and GTM modeling in eliciting the village innovation system requires is that it is easy to read the functions available in the system based on the GTM obtained. The village innovation program managers still have difficulties in embodying technical matters regarding the village innovation system. The use of the KAOS method is more precise and easier to understand and use in requirements elicitation. Fig. 2, the village community can immediately understand how can meet each goal. The functional requirements obtained from this elicitation process, such as the soft goal "Easy User experience", can be fulfilled if there is a functional requirement for "Complete Innovation Catalog" and "Easy Product Search".

It can exemplify these steps and explanations that the village innovation system's requirements can be analyzed and modeled in the GTM using the goal-oriented requirements engineering method, namely KAOS. With this method, the village innovation program manager can lower the goal of having a system in fulfilling his desire to create a village innovation system. After this elicitation process, the existing GTM can be further analyzed to find the best system requirements and can be done by the next development team.

Implementing of the requirements elicitation process using the KAOS method shows that the

KAOS method can precisely identify and obtain system objectives based on requirements based on creating the system from the village innovation program manager. KAOS can identify goals, soft goals, agents. KAOS can carry out elicitation activities for village innovation system requirements, identify soft goals generated from goals, and achieve goals, elicit functional requirements and non-functional requirements. KAOS can be modeled in the form of GTM and the results documented.

#### V. CONCLUSION

The development of a village innovation system requirements to be carried out with a requirements engineering process with the correct method so that the goal of the village innovation program manager is to collect a variety of good practices in the management of villages and disadvantaged areas in Indonesia, according to the requirements of the system being developed. The GORE model's design using the KAOS method can be made and applied to obtain functional requirements. It can use the KAOS method and KAOS modeling in GTM to elicit the requirement to develop a village innovation system. The KAOS method can quickly explain the functional requirements that the village innovation system should have. The managers expect the village innovation program and the village community, even though it has limitations in resources and technical knowledge of the software development process. The process of requirements elicitation begins with conducting literature studies and interviews with managers of the village innovation system to produce goals that are still general. These goals are then broken down into several sub-goals using KAOS modeling, resulting in functional requirements and non-functional requirements. This study proves that the use of KAOS as a requirements elicitation method provides a hierarchical description of existing conditions and is easier to trace. It can do further research to continue this elicitation with a requirements analysis process and use the final product to design the next village innovation system. The design results can be used to build the system up to the implementation stage.

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