User requirements elicitation in web-based Participatory Geographic Information System interface design

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Abstract. This ongoing work is aimed to collect a set of specific user requirements to develop a participatory web-based Geographic Information System using the User Centered Design approach. By using several techniques of requirement specification as the part of the User Centered Design such as observation of user behavior, interview session and paper prototyping design for testing user interaction, this initial stage in the development of the application could identify the important features to increase the usability of the application. These key features needed by the user are divided into three categories; the type of available maps, the data input features, and the data management features. The categories founded will help the system developer prioritize the important features to create an application to support spatial-based planning and to support the coordination between government agencies in Banda Aceh Municipality.

1. Introduction

Banda Aceh municipality is the capital of Aceh Province in Indonesia. Being the most developed city in Aceh province, Banda Aceh should improve the quality of service towards its citizen.

To achieve the goal of efficiency and effectiveness of the service in the public sector such as the government agency, the utilization of the Information Technologies, and all internet related mean of communication is preferred [1]. Thus, the e-government is then occurred as the term to explain the system to facilitate the communication between citizen and the government [2] and to deliver information and service to the citizens [3].

The City Development Agency of Banda Aceh Municipality (Bappeda Kota Banda Aceh), as the agency that is directly involved in the development planning in Banda Aceh is responsible for creating an e-government system innovation that promotes the implementation of more efficient community services, and to achieve this goal, the system needs an active participation from all stakeholders [4], in this case related to the provision of the information relating to the city development and coordination between other agencies, as such the active participation system is still rarely adopted by the government, although it has very positive benefits for improving community services [5].
To improve the service for Banda Aceh citizens, an e-government application was developed with the aim of building a web-based focal point Geographic Information System (GIS) application that can be used as a reference for agencies in Banda Aceh city and answering the need of participative cooperation from government agency of Banda Aceh to coordinate and share city planning and development spatial object and location, wherein later the data can be accessed openly to the public.

In an application development focused on the user needs, to be able to produce a good system requires the process of gathering the user requirements, so that the developers can focus on developing the features that are truly used and easy to use by users [6]. Therefore, as an initial stage in creating the application, the approach in user requirements elicitation at the beginning of the design is very helpful for shaping the final product of the system.

In our work, we address research questions to find answers of the user need for a participatory web-based GIS application, using various methods in the user requirement elicitation, and then to test it in a simple prototype to improve and refine the user's needs, before entering the system development stage.

The entire paper has the following structure. The first section provides the background of this research. In the second part we present previous research related to this research, then in the third part explain the use of several User Centered Design methods in determining user requirement elicitation, and in section four we show the implementation of the methods that we use. Section five explains the evaluation process of the results obtained by testing it in the prototyping stage, and the sixth section concludes the paper.

2. Related works
Implementation of spatial data in the development of e-government systems has been carried out worldwide. In Indonesia alone, several researchers have tried to develop spatial based systems aimed at government needs.

RA Maryam in her research developed a web-based GIS application aimed at accommodating information about port facilities and infrastructure in Tanjung Perak Surabaya [7], ME Kusuma developed a web-based web application for tourism purposes [8], while Danang Kusnadi and Jamal Ma’ruf also researched a GIS system that was used to map the potential of regions in Java, Indonesia [9].

From the overall research, it was found that the spatial-based web applications that were developed were only used for one specific service function, and the content could not be used for the purposes of coordination between government agencies. In addition, the resulting applications also have many shortcomings where the previous authors feel that even though they achieve the desired results but lack other features that should also exist in the application they developed.

To fill the gap that still existed in the previous research, the focus of this system development is to look for the needs of users using the user centered design method, which will make the features that applied to the system are only the desired and useful features used by the users [10].

3. Method
In the software development process, user centered design is one of the method that emphasizes the design process iteratively by involving users at each stage of the research process and design techniques [11]. The advantage of involving the user in the development of the system is that the results of the process will produce a system design that is very relevant to the target user and the product created will be very useful and in accordance with user needs without having to create features that are not or rarely used [12].

The form of the system development process using the User Centered Design method can be seen in the following figure:
To increase the effectiveness of the application development, the research in this paper is focused at the beginning of the process as depicted from figure above, namely to specify user requirements. Before the user requirements elicitation conducted, the first process according to the user centered design process is to understand the goal of the targeted user in using the application. This is called the context of use specification [14]. After the usage context has been determined, then the user requirements data collection can be carried out to support the process of producing the design solution based on the list of the features gathered from users.

In gathering user requirements, several techniques can be implemented. The first technique is to conduct background initialization interviews, which aim to collect data related to the needs and expectations of users with the system. After that, the second technique that can be used is field observation. This technique is used to observe the tools used and how users behave in collecting and creating spatial data, as well as how each of these government agencies coordinates in the data exchange activity. Then, from the two techniques, the data collected can be revised again using the Forum Group Discussion technique, sequential interview or questionnaire [15].

As the last stage in the determination of user requirements, data sets derived from the user needs in the previous activity can then be translated in the form of paper prototypes to test how the user interacted with the interface and the fulfillment of the user needs in the application.

4. Implementation
From the initialization stage, it was determined that the GIS system to be built must be able to assist the activity of spatial data coordination and sharing between agencies in the Banda Aceh City. In addition, to produce spatial data that is always up-to-date, active participation of users in filling-up the content to the application will be the main goal that must be met by this system. From these primary goals, it can be derived that the users of this system are primarily the agencies in the Banda Aceh city environment, as well as the community and those who want to know the development map and development planning in the city of Banda Aceh. These goals are then translated into the context of use of the system.

After the context of use is determined, the collection of user requirements is done through several stages, namely initialization interviews with the user who initialized the idea to build the system, then by observing patterns and tools used in the user coordination activities before the system is built, then improving user requirements with further detailed interview, and ended with the prototype paper process to test the eligibility of user requirements before entering the system implementation stage.

4.1. Initial interview
The first stage of the user requirement elicitation is to conduct an initial interview with the main user of this application. This interview was held in Bappeda Kota Banda Aceh, where this agency was the
initiator of this system innovation. From the results of the initial interview, we obtained the information regarding the system requirements, where users can use the map to enter the coordinates along with supporting information at each point. This data should be stored online and used in each coordination meeting between government agencies to determine the development area within the city of Banda Aceh.

4.2. Direct observation
To find out how coordination between agencies related to spatial data was conducted, we conducted direct observations by participating in inter-agency coordination activities at the Banda Aceh City government office. From the results of these observations, we get the user behavior data in inputting coordinates and spatial data information using the Google Earth application. It is known that using this tool only stored the spatial data offline, in the related agencies, and each agency then collects other agencies data if necessary. This certainly hinder the coordination process since it reduces the completeness of the available data and overlapping the development planning data between agencies.

From this stage, we also observe the Google Earth tool which will later be considered in the process of designing the system interface to make it easier for users to translate their knowledge from the previous tool into the newly built system. Also, some features used by users on Google Earth are also accommodated as requirements in the system. Those features are:

- The form of the map display
- Basic layer that they can add freely to the map
- Detailed area boundaries between sub-districts and villages
- Availability of area and distance measurement tools

4.3. Follow-up interview
To refine user requirements, the authors then collected further data by conducting a short interview with 15 respondents who came from several agencies in Banda Aceh City, such as officers from the Bappeda Kota Banda Aceh, the Public Works and Public Housing (PUPR) office and the Office of Investment and One-Stop Integrated Services (DPM-PTSP).

Through this interview stage, we explained to the respondents the system interface to be built and list the features they use from the old model they are using, as well as the features they will use later.

4.4. Paper prototype
From the requirements obtained in the three previous stages, we transformed the result in the form of prototype paper. The same respondents can interact with the system and propose the layout of each interface component. In addition, respondents could also propose their thoughts about requirements that were not previously listed but they felt important for the system.

Figure 2 shows an example of how users can manipulate interface components and freely add the features that they feel will be used in the system by using a paper prototype.
5. Result
From the implementation of the process of user requirements elicitation, three main user interface category sections should be available to increase the participation of user for using and sharing data in the application. The three categories are the help layers on the map, which is classified in the map category, the input category features on the map, and the data management category.

5.1. Map category
The availability of the various basic map to facilitate the user in finding the location of the requested spot is deemed important for the supporting features by the user. The respondents' agreement on the type of map and map-related features can be seen in the following figure:

![Figure 3. User requirements, map type category.](image)

5.2. Input features category
The next feature that should be available in the spatial data input is explained in Figure 4, where all respondents agree that when inputting location, the ability to point-and-store coordinates and information related to these coordinates are two main features that absolutely must be present, while other features such as layer grouping, and the ability to take measurements on the map is considered relatively important because it is in the range above 50%.
5.3. Data management category
In addition to input features and maps that are directly related to the use of the system, the data management features also become an important part that must be present in this participatory application. These features are needed to support the coordination between agencies through the generated data. Some features related to data management can be seen in the following figure:

Figure 5. User requirements, data management category.

From the three categories of the interface components, the developer can determine which features are the priorities in developing the interface design. Some components with a smaller percentage compared to other features can be considered less important to be the main features and developed later.

6. Conclusion
From the results of investigations using requirement specification techniques in user centered design, a list of user requirements can be collected and used as a reference in developing the Web-Based Participatory Geographic Information System (GIS) interface. For the participating users in the user requirement elicitation process, there are three categories identified as the key features to help increase their participation in using the Web GIS application. The first category is the user requirement in map type category, that should include the basemap, satellite map and several boundary and Point of Interest map layers. The second category is the input category where the user needs some tools of
measurement to precisely input the new coordinate point into the map, along with additional information and ability to group the point into custom layers. The last category is the data management where the user able to manage the existing coordinate data, able to access other agencies data and export data to table format to easily collaborate with other agencies.

Finally, the categories derived from user requirements elicitation should be able to clearly identify features that will become the main functionality of the system in the development phase of the User Centered Design process. By focusing only on the required features, it is expected that the development phase of the system can be conducted efficiently.

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