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Proposed Framework and Features of the Data-Driven Web Decision Support System for Rural Water District in the Philippines

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Abstract. As mandated by the Philippine government to provide clean potable water to households and other users in the country, water districts ensure the effective management and sustainable operation of their organization. They wield efforts to institute quality services to their customers' demands of ensuring water safety and maintenance of water distribution in different barangays under their jurisdiction. Customers' feedback plays a significant part in the decision-making task of the management and to the improvement of their services. Managers can use systems that access current and historical data to support their decision-making tasks. Decision Support Systems potentially increase access to data and help managers gain insight of the organization processes, customer concerns and feedback in a form that can be instantly understood and acted upon. The researchers looked into the processes of water districts in collecting customer requests for maintenance/repair tasks and complaints about water quality and how these data are processed by the district to prioritize maintenance tasks hence maximize their available resources. This paper proposes a framework for a data-driven web decision support system that captures customers' complaints and feedback, perform short-term data analysis that leads to maintenance task prioritization for water districts. The framework includes underlying inputs such as the customers' complaints and request for maintenance tasks, available database and web technologies, a general description of themodel and the expected outputs.

Keywords—data-driven web decision support system, water district, framework

1. Introduction

Water is an essential product for survival of life. It is a fundamental resource to human survival and cannot be compared to other products. In 2010, the United Nations explains that clean water is a basic human need, and one that should be easily accessible to all as it is essential to the realization of all human rights (United Nations General Assembly 2010)[1]. In 2016, water and sanitation were promoted as the Sustainable Development Goal No. 6, to "Ensure availability and sustainable management of water and sanitation for all."[2] With these global and national priorities, significant number of water utilities and schemes were developed around the globe. Delivery of water services were given as responsibility to the local governments through the water districts. Water districts play a significant role in ensuring water accessibility and sanitation by properly managing water resources and providing services to theconsumers.

A public utility such as a water district faces enormous challenges in meeting the water needs of a growing population. Many of these challenges are results of inappropriate utility management principle. They wield efforts to institute quality services through customers' feedback mechanisms which aids in the planning and decision-making tasks of the management for the improvement of their services. In the case of the water district company, determining the critical issues is important for them to plan and to decide which among those issues will be prioritized. Therefore, a data-driven web decision support system that collects, organizes and analyzes data to facilitate decision-making for management, operations and planning is necessary.[3] It is indeed a good tool in decision making.

2. Review of Related Studies

Review of Related Literature

Decision support system is based on the data warehouse, through query tools and analysis tools to complete the extraction of information to meet the various needs of users. The entire data warehouse system is composed of data source, data extraction, storage, management, and data performance. The data source is the foundation of data warehouse system, storing the data source of the whole system, usually including internal and external information. [4]

Decision Support System is a significant area of information system research because it has been used in managerial decision making functions and has the ability to solve complex problems. It primarily consists of three major components namely: data management, model management and dialog/interface management. [5]

Data-driven decision support system provides access and analysis to large and volumes of data coming both from inside and outside of an organization and through this, managers can have reliable, consistent and high quality information that can help them perform own analysis and decisions.[6]

Decision Support Systems (DSSs), applied to the management of water resources, play an essential role since they must allow the different stakeholders and competencies involved[7] to summarize results and produce decisions on a common and shared basis [8] Furthermore, DSS have merits to enhance the sustainability of the water resources in the study area, and to shift the stakeholders' network towards cooperation and collaboration [9].

3. Research Problem

With the aim of providing immediate response, water districts utilize different platforms to accommodate concerns and requests which are acquired through several means such as walk-in, Facebook, their official website and hotlines. Data gathered are usually entered in spreadsheets and are forwarded to concerned departments (hydraulics division, production division or maintenance division) for analysis, estimation and response. Consolidation of data is done using excel software which contain comparable comments and identifying the most prevalent concerns The management approves the plan of work depending on the availability of the resources needed to address the concern. In case there is a need for maintenance task, the person in charge will prepare a job order that will be given to the contractor. Upon deployment of job orders, person in charge will monitor the status from time to time. There is also a system that handles repair transactions and it can also generate excel reports. With the current processes, consolidation of data is a challenge because receiving numerous complaints daily from different sources and filtering them manually will take time and delay in execution of maintenance task may happen if the data will not be provided on time. Moreover, there should also be an efficient monitoring of maintenance tasks as assigned to the contractors.

The authors aim to address these issues through the design of a data-driven web decision support system that will provide fastconsolidation of real-time data for analysis and easy monitoring of maintenance transactions.

4. methodology

The researchers used the Input Process Output (IPO) model in conducting this study as shown in Figure 1. For inputs, interviews with the process owners of the Water District agency to determine the issues and concerns with their current business processes covering receiving of complaints from their clients to resolving these issues were conducted. Review of forms and documents being used were also done to determine significant data and information that will be used in designing the proposed system. For the process, the researchers were able to brainstorm on the how these problems can be solved by automating these business processes and provide the decision makers with relevant reports that can be used in strategic plan. Based on the analysis and as part of the output, the team came up with the design of the proposed decision support system and its framework and features as part of the system architecture which are presented thru graphs and charts. Moreover, the researchers were able to create a prototype that was used for simulation of transactions.

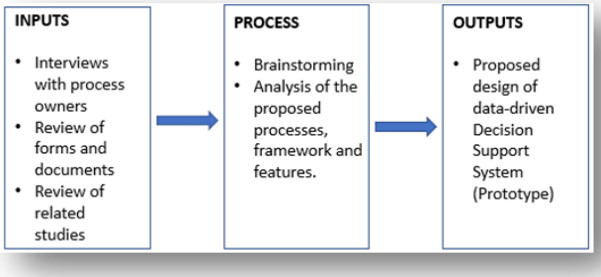


Fig. 1. IPO Model

5. Results and Discussion

5.1. Proposed Data-Driven Web Support System Framework

Decision support systems are tools that improve decision making process by transforming some inputs in outputs required to make a decision. The proposed Data-Driven Web Decision Support System is designed as a responsive cloud-based system that could respond to the behavior of users as it can be accessed through a web browser using different kinds of devices with different platforms. The users of the system are the customers, the contractors who are responsible for performing maintenance tasks and the management who decides for maintenance task prioritization. Each user has their own view of the system, and can retrieve and view information specific to their role in the water district. The inputs and outputs for a Water District Data-driven DSS are shown in Figure 2.

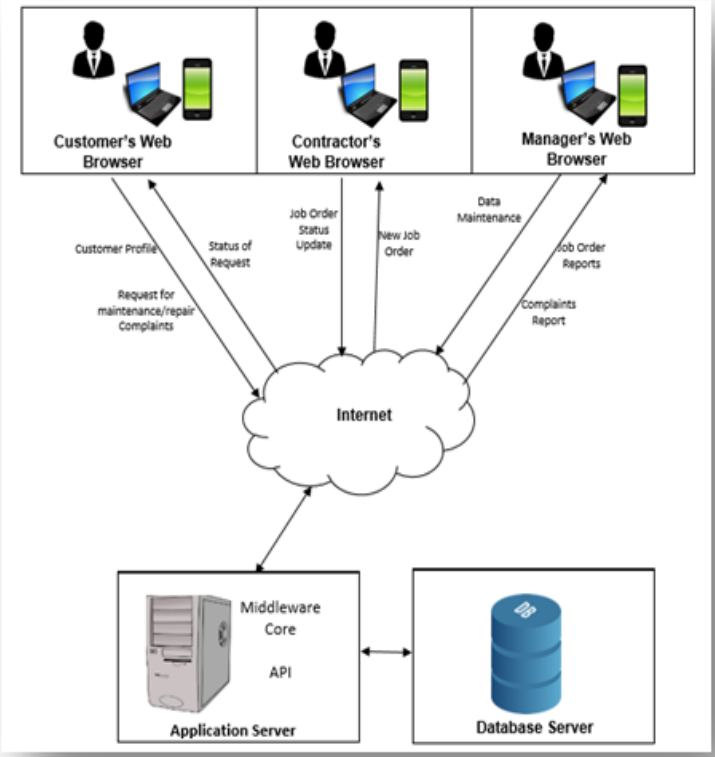


Fig. 2. Proposed Framework

The customers can view the water district static promotional information through his computer or mobile device, can submit and update his profile through the Customer Profiling Tool and can submit complaints/concerns through the Customer Profiling and Reporting Interface. Submitted data are saved in the database for review of the management. The management can view summarized reports, graphical presentation of analyzed data that could be used for decision-making and planning activities. These reports/graphs include Concerns Received on a specific period and the Types of Concerns. The management is responsible for maintenance task prioritization based on the reports. Identified maintenance tasks to be addressed are forwarded to the contractor in a form of a New Job Order and waits for updates regarding the status of the maintenance task performed.

The contractor can view summarized reports, graphical presentation of analyzed data and can view maintenance requests in a form of a Job Order. The contractor also updates the status of the maintenance tasks performed that allows the customers to view the status of their request. These reports/graphs cover Job Order reports and Job Order Status (Requested, On-going and completed). Use cases or transactions of each user are shown in Figure 3, Use Case Diagram.

The proposed DSS consists of the Application Server that process any request from the users by connecting them to the database server and returning information. It acts as an intermediary between the users' web browser and provides a connection to the database in order to send and retrieve information. It provides an environment in which applications can run, no matter what the applications are or what they do. The Application server is also responsible for delivering static contents in the form of HTML pages, files, images and videos. Figure 4 shows the schematic visualization ofthe Middleware Core and the DSS.

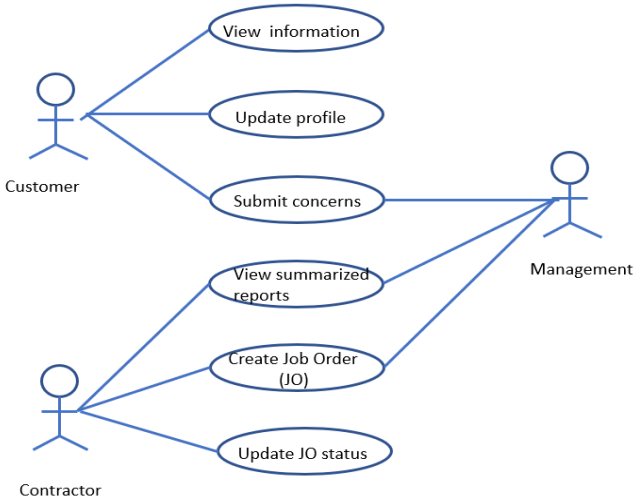


Fig. 3. Use Case Diagram

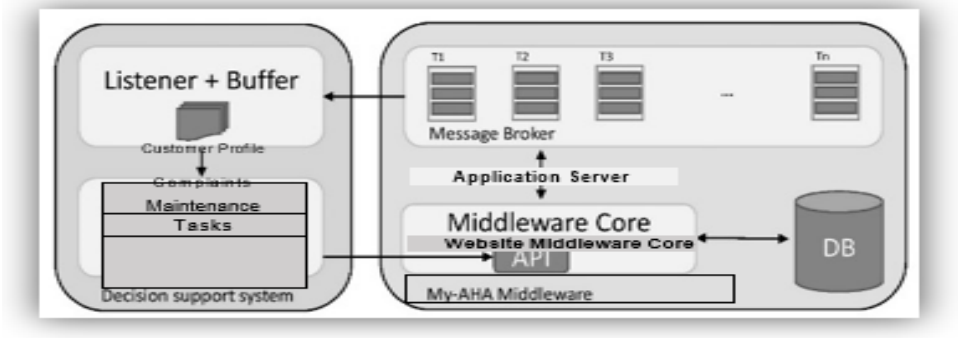


Fig. 4. Schematic Visualization of Middleware and DSS

When the users submits or sends request through their web browser, the web browser employs brokers to enable other applications, systems and services to communicate with each other and exchange information. These brokers validate, store, route and deliver messages to the appropriate destinations and serves as intermediaries between other applications, allowing senders to issue messages without knowing where the receivers are, whether or not they are active, or how many of them are. Thus, each user of the system (customer, contractor or manager) could simultaneously submit data to and retrieve information from the system anytime desired and necessary. The system then automatically analyzes the data and sends it to the database through the applicationserver.

The database server is used to store and manage databases that are stored on the server and to provide data access for authorized users. It keeps the data in a central location that can be regularly backed up and allows users and applications to centrally access the data across the network. All data submitted and analyzed by the system are stored in the database servers and can beaccessed by the different users.

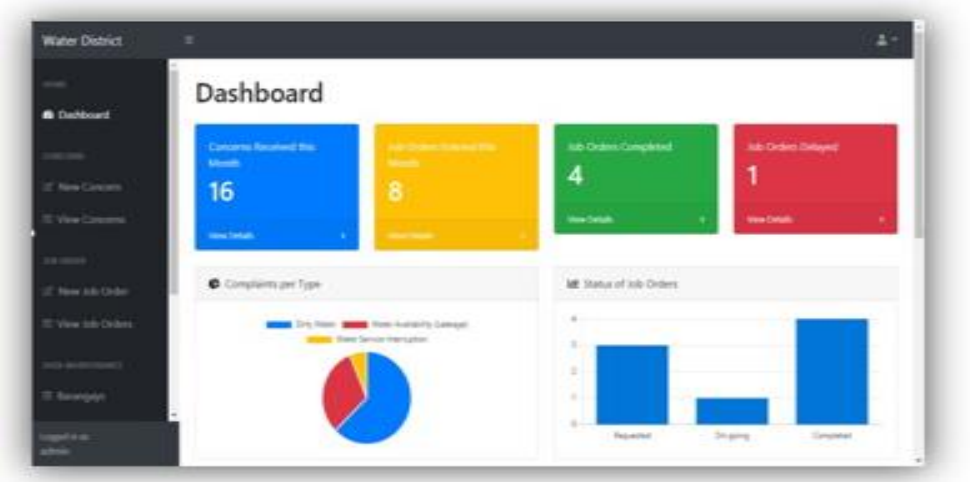


Fig. 5. Graphical Data Display

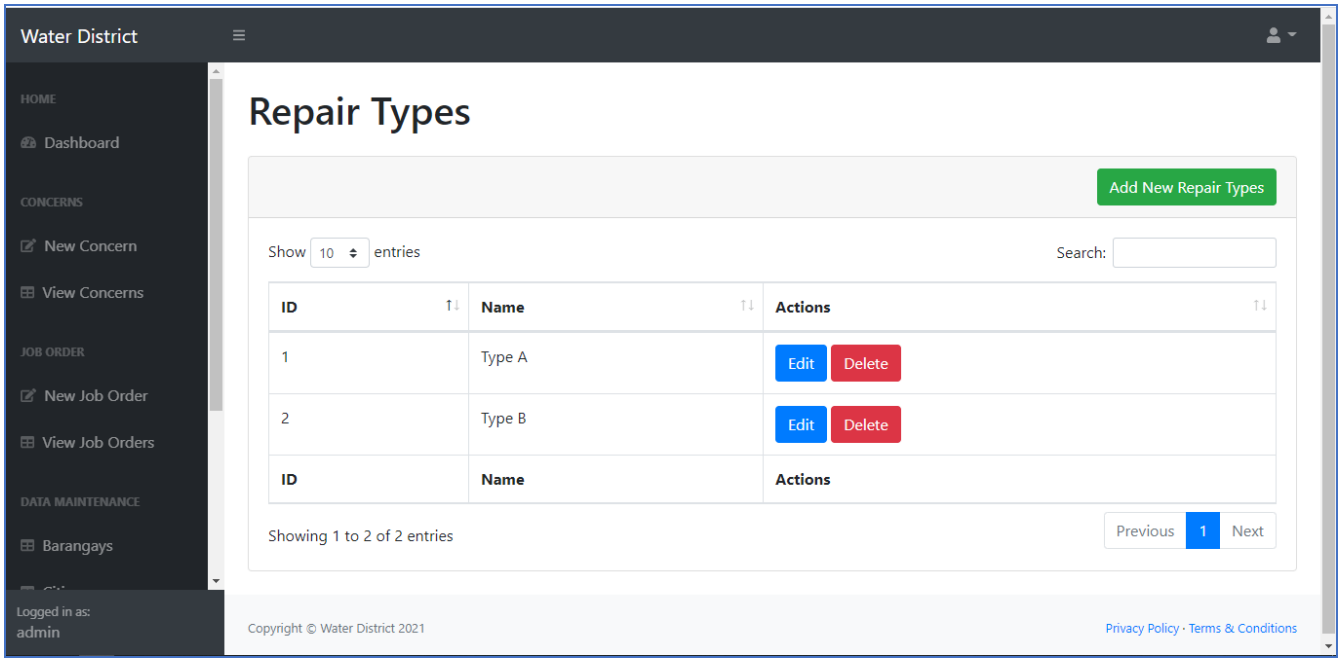


Fig. 6. Data Summarization

5.2. Features and User Interface of the proposed Data-Driven Web DecisionSupport System

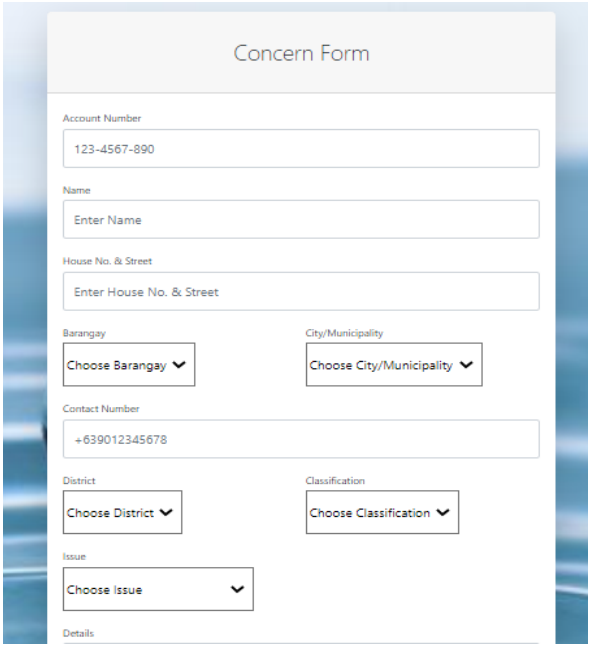


Fig. 7. Reporting of Issues and Concerns

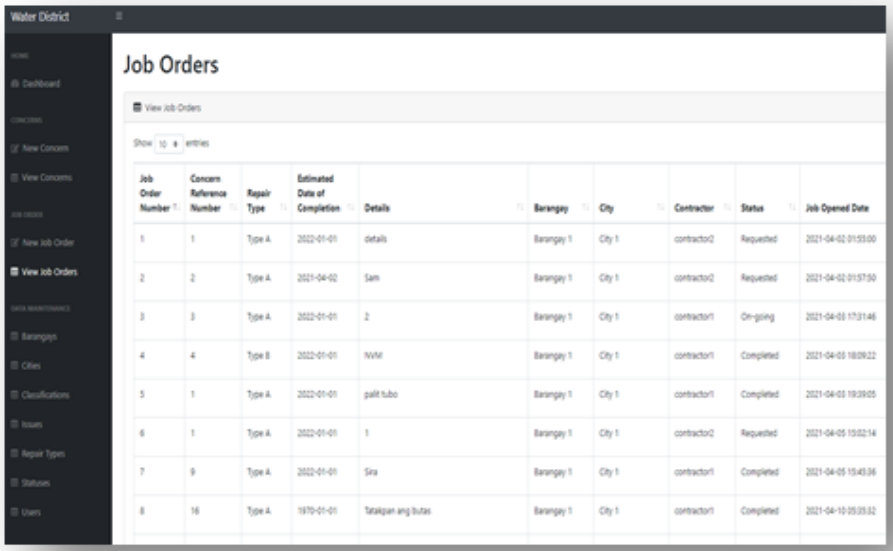


Fig. 8. Creation of Job Order

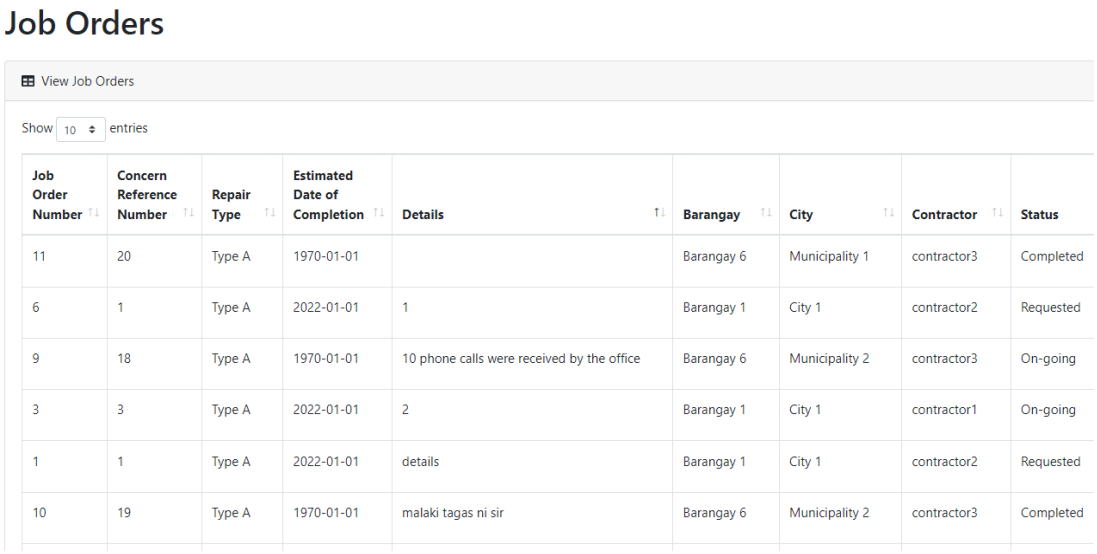
Data filtering and retrieval. The system helps users systematically search for and retrieve computerized data, filtering is often done using drop down menus, queries are often predefined, and users have drill-down capabilities. Users can often change aggregation levels, ranging from the most summarized to the most detailed (drill- down).

Graphical data displays. The system provides quick-analysis displays like bar and pie charts that shows summary of reports. These graphical presentation of data shows the management what concerns and request need to be acted upon immediately. These are shown in Figure 5.

Data summarization. The system automatically provides smmary of the data as shown Figure 6.

Statistical analysis. The system uses descriptive statistics to summarize or describe data, and create trend lines for data relationships. Reporting of issues/ concerns is displayed in Figure 7. Creation of job order based on priorities is displayed in Figure 8.

Furthermore, the system provides real-time reports on the job orders which include repair type, status, estimated date of completion, contractor and date completed as shown in Figure 9. This report aids in monitoring of status of requests by the client to ensure that the timely accomplishments of job orders for customer satisfaction.



Job Order Number	Concern Reference Number	Repair Type	Estimated Date of Completion	Details	Barangay	City	Contractor	Status
11	20	Type A	1970-01-01		Barangay 6	Municipality 1	contractor3	Completed
6	1	Type A	2022-01-01	1	Barangay 1	City 1	contractor2	Requested
9	18	Type A	1970-01-01	10 phone calls were received by the office	Barangay 6	Municipality 2	contractor3	On-going
3	3	Type A	2022-01-01	2	Barangay 1	City 1	contractor1	On-going
1	1	Type A	2022-01-01	details	Barangay 1	City 1	contractor2	Requested
10	19	Type A	1970-01-01	malaki tagas ni sir	Barangay 6	Municipality 2	contractor3	Completed

Fig. 9. View Job Orders

6. Conclusion

With the proposed framework and features, the web decision support system will address the current issues because it will provide (1) fast and real-time submission of concerns/ complaints from the customers since it will be done through the web application and these concerns can also be monitored by the customers. This will likely increase customer satisfaction, (2) prioritization of maintenance task to be executed based on the analysis of complaints, (3) strict monitoring of maintenance task that will prevent delays in execution and completion of tasks since the status will be updated by the contractor through the web appl ication from time to time, and (4) reports and data visualization which are significant in the analysis of the different types of complaints received and handled; monitoringof maintenance task status to prevent delay incompletion.

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