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Water Billing System with Business Intelligence and Data Analytics

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Abstract

Water resource management involves the day to day operations such as computing water consumptions and collecting payments of water consumers. It also includes the activity of planning, developing, distributing, and managing the optimum use of water resources. Two of the major problems in water resource management are the lack of an automated system for collection and the distribution of water facilities. This study is about the development of a Water Billing System with Business Intelligence and Data Analytics for Water Resource Management using Linear Regression a web-based application that implements business intelligence and linear regression. In the development, the researchers used the agile model to systematically create the system. The system is evaluated by IT- Experts to meet the software Industry standards. The developed system can generate a dashboard through the implementation of business intelligence particularly data aggregation that can produce different graphs in terms of water consumption, consumer distribution, revenue collections, and collectibles. The developed system can generate data analytics through the implementation of a Linear Regression Algorithm that can also produce forecasts and patterns in terms of water consumption, revenue collections, and collectibles based on previous data trends. As a result, there is a significant increase in collections based on the last four months' implementation of the system. Using the ISO-9126 as an evaluation instrument the system has passed the industry standard because the evaluation results show only two verbal interpretations; “Highly” and “Very Acceptable”.

Keywords— Business Intelligence, Water Resource Management, Linear Regression, Water System, Information System

I. INTRODUCTION

The water system is one of the necessities of every community. It is better not to have electricity than not having water. People can live without food for three days but losing water will mean death. That is how important water is.

Meanwhile, the water system has been a major problem for everyone. The effect of climate change and the excessive use of humans are the two major reasons for water shortage. If global temperatures continue to rise, rainfall will increasingly become a beast of extremes: long dry spells, dangerous floods there, and in some places, intense water shortages. As early as 2025, the World Health Organization estimates that half of the world’s population will be living in water-stressed areas [1].

Part of the water system is the people who use and consumes water including the management who implements guidelines in the distribution process of water facilities. In some way, the inability to find the right location to build water facilities for water distribution creates problems. This problem is part of water management’s responsibilities. Water management is the activity of planning, developing, distributing, and managing the optimum use of water resources [2].

Today, technology like a prediction system is being utilized to craft an adequate solution to the setback of society. A prediction System is the estimation of some variable of interest at some specified future date. Usually, it is based on statistical and time series forecasting methods [3].

On the other hand, new techniques in data analytics are also introduced like business

intelligence. Business intelligence (BI) is a technology-driven process for analyzing data and presenting actionable information that helps executives, managers and other corporate end-users make informed business decisions. BI encompasses a wide variety of tools, applications, and methodologies that enable organizations to collect data from internal systems and external sources, prepare it for analysis, develop and run queries against that data and create reports, dashboards, and data visualizations to make the analytical results available to corporate decision-makers, as well as operational workers. The field of business analytics has improved significantly over the past few years, giving business users better insights, particularly from operational data stored in transactional systems. An example is e-commerce data analysis, which has recently come to be viewed as a killer app for the field of data mining [4].

Meanwhile, the analysis of data in prediction is simplified through linear regression. Linear regression is used for finding a linear relationship between the target and one or more predictors [5].

In the province of Laguna, water is said to be rich since its landmark is surrounded by water because of Laguna De Bay. But water shortage has been a big challenge to the entire province. [6] Based on the Philippine Water Districts Directory majority of the municipal water district in Laguna are still using a manual procedure in managing their day-to-day business transactions that lead to mismanagement. At present, water system automation is not well established in the province of Laguna. Different concessionaires are operating per municipality most of them are privately operated. One of the reasons why a water problem arises is the lack of an automated system that can be used for water operation. Many of the Local Government Unit (LGU) relies heavily on a manual billing system which resulted in some human errors and manipulation (Philippine Water Districts Directory).

This study developed a water billing system that capable of providing prediction with the application of business intelligence using linear regression. This will help the municipalities in the province of Laguna to identify places that need more water system installation based on water consumption, provide automation on day-to-day transactions, and will result in better water management.

II. THE OBJECTIVE OF THE STUDY

The general objective of the study is to develop a "Water Billing System with Business Intelligence and Data Analytics in Laguna" Specifically, it aims to:

1 Create a web-based system that can automate, and improved the process of collecting payments, and generating reports in the municipalities in Laguna;
2 Create a web-system that utilizes linear regression that produces predictions on the consumption of water in the municipalities of Laguna.
3 Create a web-based system that offers business analytics to provide dashboards that generate graphs based on the collection, consumptions, and collectibles from the different barangays and other related categories;

III.METHODOLOGY

This research study focused on the development of a Water Billing System with Business Intelligence and Data Analytics using the Linear Regression Algorithm. Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable.

Linear Regression Formula

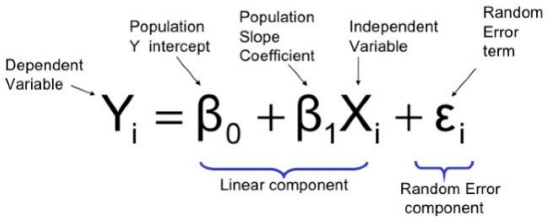

Figure 1. Linear Regression Formula

Figure 1 shows the formula applied in the system that is used for prediction.

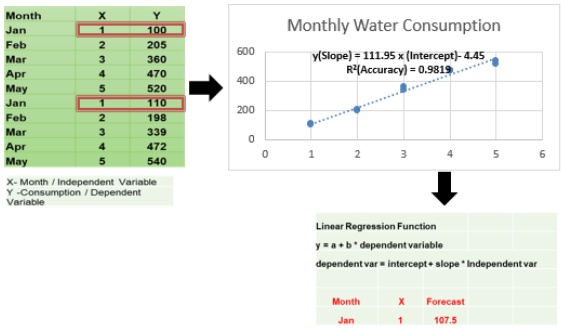

Figure 2. Liner Regression sample implementation

Figure 2 shows the sample illustration of how the Linear Regression Model was implemented in the system.

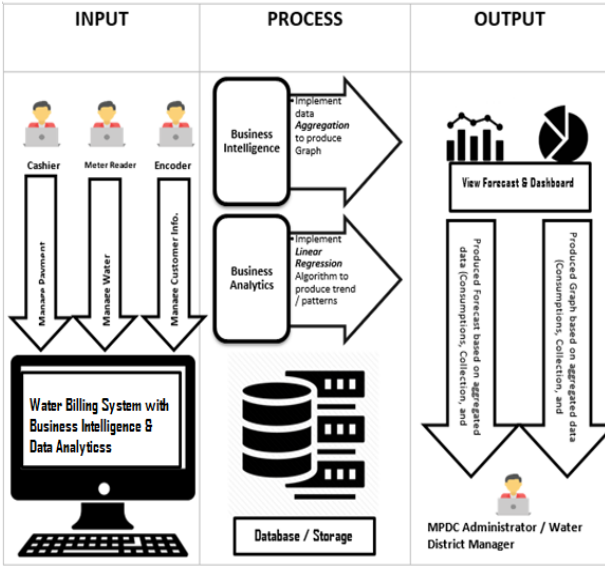

Figure 3. Conceptual Framework

Figure 3 shows the Conceptual Framework of the Study which shows how the water billing system will work with the application of data and business analytics and with the implementation of linear regression. The system will be the center of the entire transactions of water management in the municipalities of Laguna.

All the transactions are saved to the centralized database, particularly consumers' water consumption encoded by the municipal waterworks encoder, and consumers' payment transactions encoded by the municipal waterworks cashier. The system utilizes data aggregation (One of the parameters of business intelligence) to produce a dashboard that consists of graphs and charts.

Moreover, the system will also implement a linear regression algorithm that utilizes the aggregated data and finding the correlation between consumers' monthly water consumption to produce predictions based on the data trend in a graphical view.

IV. RESULTS AND DISCUSSION

The system is designed to improve and automate water resource management day-to-day business transactions in the municipality of Laguna, also the system offers a dashboard to track and monitor water management transactions such as collection, collectibles, and water consumption with the application of business intelligence and analytics.

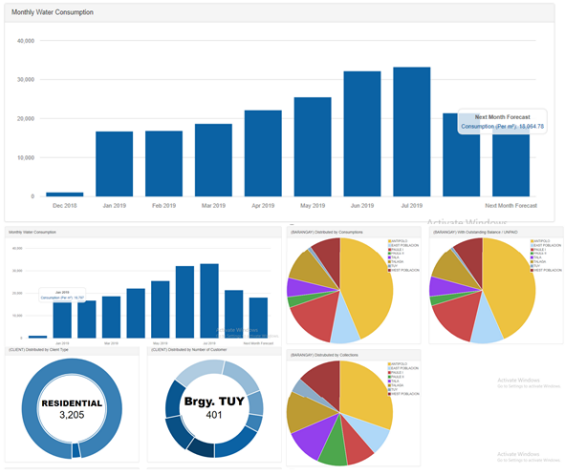

Figure 4. System's Screenshots

Figure 4 shows the system main features, with the implementation of "Business Intelligence" in the study, the Local Government Unit can view better insights into water management through the visual representation of water consumption trends. Also, the chart or graphs shows the number of water consumers distributed per barangay. Moreover, the collection and collectibles were also visually represented through graphs or charts.

Meanwhile, the used of "Linear Regression" as a model to predict water consumption, collections, and collectibles for the next

succeeding usage based on past trends are completely related to the implementation of "Business Intelligence" The same results have been formulated by the study.

Table 1: Overall Evaluation Summary based on ISO 9126 evaluation instrument

Criteria	Sub - criteria	Overall Mean	Interpretation
Functionality	• Accuracy • Compliance • Interoperability • Security • Suitable	4.19	Very Acceptable
Reliability	• Fault Tolerance • Maturity • Recoverability	4.17	Very Acceptable
Usability	• Learnability • Operability • Understandability	4.5	Highly Acceptable
Efficiency	• Resource Behavior • Time Behavior	4.19	Very Acceptable
Maintainability	• Analyzability • Changeability • Stability • Testability	4.25	Very Acceptable
Portability	• Adaptability • Conformance • Installability • Replaceability	3.88	Very Acceptable

Based on the evaluation as shown in table 1, the three types of respondents, IT Experts, Water Consumer, and Water District Staff, usability and functionality got the highest verbal evaluation score, this served as evidence that the developed system meets the required functions, and user-friendliness based on the summary of the evaluation. However, portability got the lowest score which the developed system is a web-based system that requires an internet connection.

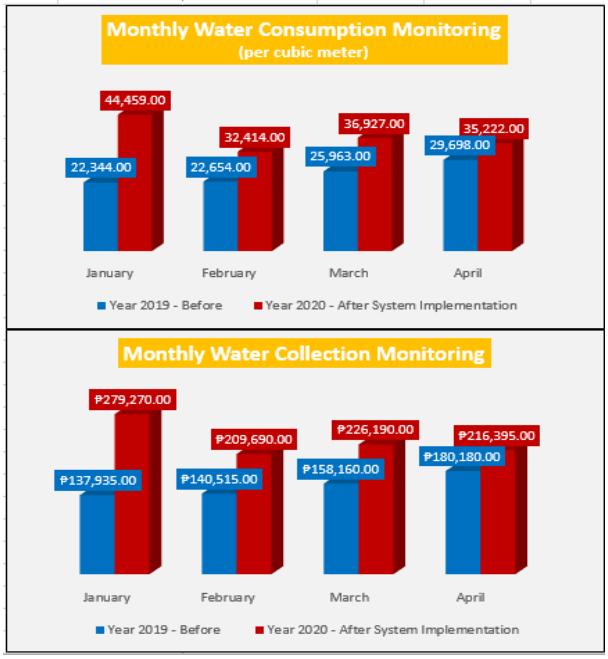

Figure 5. Month Water Consumption and Collection Monitoring

During the implementation of the system in Rizal, one of the municipalities in Laguna the developed system helped them a lot in the collection aspect. There is a significant increase in the collection and that is based on the last four months of implementation as shown in figure 5.

Figure 5 also shows the difference between using the manual operation of water resource management versus the implementation of the developed system.

V. CONCLUSIONS

Based on the conducted evaluation by the researchers the following conclusions were derived;

1. The study is a helpful tool in managing water resource in the municipality of Laguna for their day to day operations;
2. The developed system in this study can perform business intelligence which is a helpful tool in visualizing water management-related data;
3. The study can perform prediction through the implementation of the linear regression technique

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