Development of Data Warehouses and Decision Support Systems for Executives of Educational Facilities in Northern Thailand to Increase Educational Facility Management Capacity

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Abstract
This paper presents the development of a data warehouse and a decision support system for executives of educational facilities in northern Thailand. The aim of this research is to support executives' decision-making, teacher's work operations, and students' learning. The present studies of the work system development are based on the System Development Life Cycle (SDLC), the SQL Server, a web-based application using HTML5, and JavaScript. They are operated on the Windows Server providing all services on .NET technology. Both PivotTable and PivotGrid are employed to improve the business intelligence. They are also used as a tool to analyze and to create all information in terms of both tables and graphs (e.g. query, dice, slice). The sample group is chosen from twenty-six educational facilities in Northern Thailand because this area is directly involved by using the data warehouses for the educational facilities. As the results, the improvement of the data warehouses, this research provides data systems for three different groups: the work operation of the educational facility, teachers, and students. These data systems can be processed by producing the sixteen sets of desired values and data dimension. Furthermore, they also report all information in terms of tables and graphs for sixty-five different reports. System test results can be divided into two groups: the Alpha Stage and the Beta Stage 5. First, the Alpha Stage is tested by the system developers. The test results of this stage show that the system works perfectly without any faults. Second, the Beta Stage 5 is tested by the sample groups. The results of this stage can be sorted in ascending by users' satisfaction as follows: the Functional Requirement (very good: 4.39 points), the System Design (good: 3.98 points), the Usability (good: 3.92 points), the Performance (moderate: 3.82 points), and the Reliability (satisfied: 3.70 points) respectively.

1. Introduction

Nowadays, the information technology is changing rapidly. This is the reason to transform Thailand to be a high society competition. The advancement of new technology has been taking place in the role and form of Thai education to the new era. The education system is an indeed vital cog of societal development in the country. If the internal efficiency of an educational system is credible enough, it will improve Thai people skills to compete for another country. To raise the quality of education is difficult, but is possible. The key is not to focus on the quantity but the quality of the students in the Thai education system. As a result, it will make the country developed in the right direction. (Hanushek and Woessmann, 2007). The technological advances affect the change of social structure. They also encourage many people to use them in the various applications for the educational system extensively. Therefore, information technology plays a key role in both the formal and informal educations in Thailand. Educational institutions must be adapted themselves to respond for using those technologies, which are moving forward rapidly. For example, both computer technologies and communication systems help many students to participate in learning, to search information, to get the desired

data, etc. Moreover, they also provide for procedural guidelines to an effective implementation of the educational management. (Poovarawan, 1997).

Using information technology to enhance quality in education is the first priority for all levels of each education personnel. Hence, by setting the policy from chief executives to executors, it does not provide the existed education for sustainable development. The cooperation with all educators involved is the only way to motivate them to learn new things. (Konthieng, 2007). In addition, the education system must offer to all people in the organization so that they can use all knowledge to their fullest potential at all times. (Sange, 1990). Geographic Information Systems (GIS) are a special case of information systems with a capability to integrate spatial and descriptive data (Murphy, 1995). The warehouse site selection decision is not merely the question of choosing sites. It involves the comparison of the spatial characteristics of a market with the overall corporate and marketing goals of the firm. A geographic information system-aided process to the warehouse site selection decision is presented and the use of the presented process is demonstrated with a practical example (Vlachopoulou et al., 2001).

As mentioned above, this is the reason why the development of both the data warehouses and the decision support systems is significant in schools in the Northern Thailand. It is used for supporting the quality management of educational facilities. Furthermore, they are not only improving the quality of the education system, but also supporting the teaching online effectively. Therefore, all users can access information and perform tasks without the limitations of time and place. (Bersin, 2004) and consider to the geographic area in Northern Thailand GIS are ideal for overlaying different sets of information from different sources. They allow the rapid comparison of data from different sources and can be used to produce regional surveys rapidly (Guzzetti and Tonelli, 2004). The functional form of the data warehouses serves as a data center for all users to conveniently access and analyse (Sturm, 2000). It is responsible for collecting, calculating, storing, and managing all data in the system. Then, the executives of educational facilities can use these data for decision-making accurately. It can also be used for analysing of the future organization's direction by employing the Online-Analytic Processing (OLAP) technique, which utilizes the data analysis with dimensions and fact tables. The results are obtained in the form of the multi-dimensional cubes, which contain all beneficial data for analysing. All data inside the data center have to correct from various sources in order to better respond to search queries and data predictions (Kamolklomkloom, 2003). This paper presents the business intelligence system. It assists all users to predict their work performance and to reduce their workloads such as learning/teaching management, quality assurance in education, workflow management. The data center collects all information from users, their daily tasks, and other external sources. This information will be provided to all chief executives in the form of the decision support system (Warren et al., 2011).

2. Methods

The main purpose of this research will focus on the development of the data warehouse and the decision support system. It relies on the business process model notations for system analysis and design. In addition, the Visio 2014 is used for report preparation and model drawing. The tool of the system development is the web application technology providing services through a server computer with cloud computing. In the part of basic tools in the data web development such as .NET, the Windows Server, the SQL Server, the HTML5, JavaScript, and AJAX, they will be used in this research as well.

The purposed business intelligence is built by two software systems, which are both PivotTable and PivotGrid. Their responsibility is to display all information in the form of tables and graphs. Also, the desired data can be queried, diced and sliced independently. The quality evaluation of user satisfaction will be used both a questionnaire and a performance evaluation form to improve the service quality of the system in the future. The solution process of this research has four processes: the Analysis and Design, the Dimensional Data Model, the System Development, and the System Testing.

2.1 Analysis and Design.

The main task of this process is to develop the data warehouses based on all information from various tasks of the educational facilities. It is an important step that will affect the efficiency of the system performance. The system analysis relied on the business process modelling design and then, the data flow diagram will be built as the Unified Modeling Language (UML) diagram. The main task of the UML is to illustrate the workflow of the system. It also shows in the forms of the Use Case Diagram, the Sequence Diagram, and the Class Diagram. These diagrams provide information to users both the correlation among data tables and the data dictionary. The data dictionary presents users' record, which are names, data types, data length, and data description.

It is also used to provide the consistency in the work between the database structure analysis and the relationship of the data files.

Figure 1 shows the Use Case Diagram of both the data warehouses and decision support systems respectively.

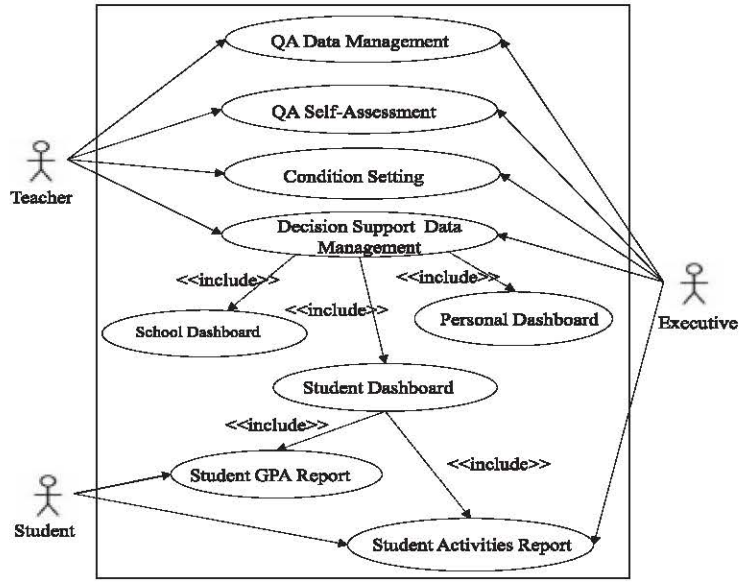

Figure 1: Use case diagrams, a) the use case diagram of data warehouses

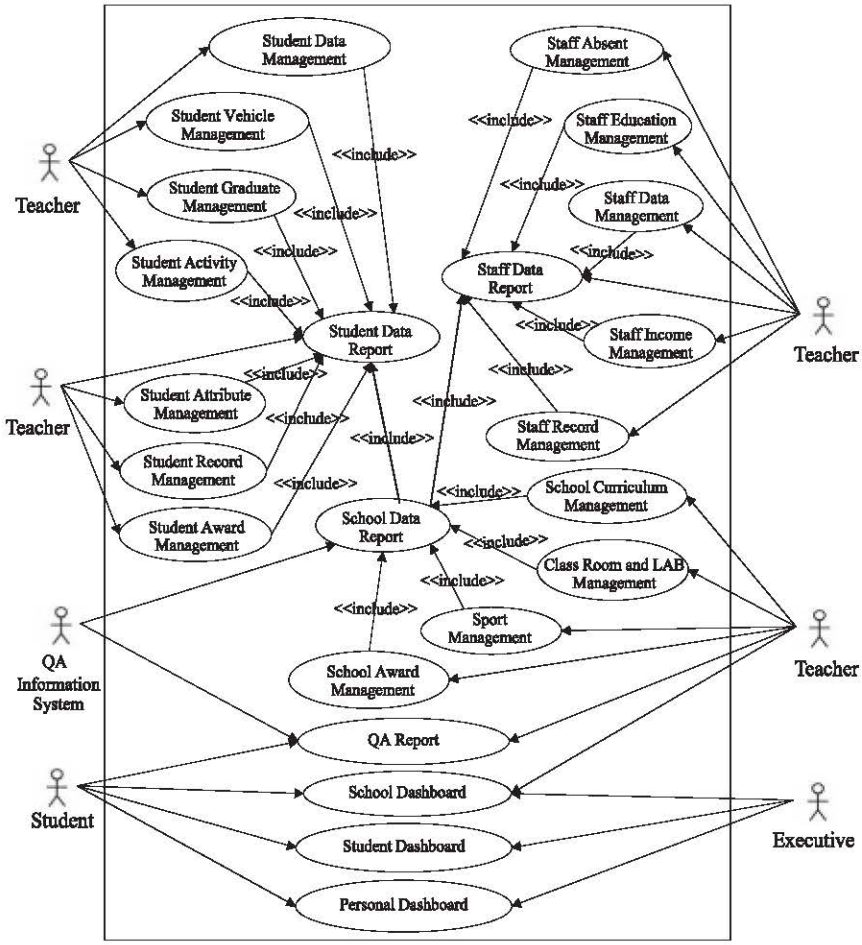

Figure 1: Use case diagrams, (b) the use case diagram of decision support systems

2.2 Dimensional Data Model

It is used to design the data model structure by analysing from both the workload systems and the correlation among data files. It can be shown as various diagrams. These diagrams are based on the process of the aforementioned system design. In the part of the development of data warehouses, this project relies on the Relational Database designing. It can be shown in the form of the E-R diagrams. The Relational Database is used to collect all information for the system reports such as the education personnel information, personnel leave systems, personal income collection systems, personnel training systems, student absenteeism, class repeats and retirement report systems, student graduate report systems, student activity participation report systems, student quality report systems, student grade report systems, student journeys to school report systems, and student award systems. After that, the measurement process synthesizes the relevant results of the data warehouse system from the operation data of the schools. Then, the de-normalization process transforms the E-R diagram to be the dimension tables. Finally, these tables are used for designing the dimensional data model by creating the surrogate keys, which are occurred in the fact table with extraction transformation and loading (ETL).

ETL development process is used Microsoft SQL Server Integration Services to achieve input data toward loading by input data toward fact table database and dimension table database by used slowly changing dimension for input data and the change with the creation of a new dimension row and add new dimension column and no information was lost. For example, import data to fact table and dimension that set each value to achieve data flow task included: download database, data conversion, slowly changing dimension and execute package as shown in Figure 2.

This was the development of data warehouses in the step of the data staging process with the objective of using in the settings for the use of various related data. Next, a site map was constructed to show the overall structure of the system and the correlations among each web page within the data warehouses and decision support systems of the educational facilities in Northern Thailand as shown in Figure 3.

2.3 System Development

This process builds the database, which is relied on MySQL, of the data warehouses from the operation data of the schools. The tasks of MySQL are to create both web-applications and metadata. Note that the responsibilities of web-applications and metadata are to manage all system data and to storage keywords for the data searching respectively.

The cleaning and filtering data processes are used in data warehouses to catch the useable data. Next, the filtered data is analysed by the online-analytic processing generator. The results of this process will be in the form of a report. This report will be built using the principles of the business intelligence, which is mixed between information technology products and collected data in the organization. Finally, the top executives will use this business information for decision-making and practice resulting to efficiently improve the business operation in the future (Williams and Williams, 2007).

2.4 System Testing

This process is divided into two stages: the Alpha stage and the Beta stage.

2.4.1 Alpha stage

The task of this stage is to seek to the system errors by researchers for fixing all mistakes in the system. All steps to check for errors in the system can be listed as follows: checking the sequence of operations of the program, verifying the connection between the display screen and control buttons, checking all messages displayed on each screen, and checking the accuracy of the searching results.

2.4.2 Beta stage

The aim of this stage is to test the system quality on URL:http://app.up.c.th/QABI. The system is installed on this URL. Then, the sample people will be defined to test the real system. Finally, there will be an evaluation of the system by using a designated questionnaire. The rating scale in the questionnaire is divided into five levels of the users' satisfaction: 4.21 to 5.00 rated as very good, 3.41 to 4.20 rated as good, 2.61 to 3.40 rated as moderate, 1.81 to 2.60 rated as low, and 1.00 to 1.80 rated as lowest (Saengkaew, 1998). The non-probability sampling (or purposive sampling) is used to randomly choose the sample people on the Beta stage. The chosen people for system testing are selected from twenty-six educational institutes in Northern Thailand: fifty-two chief executives, fifty-two teachers, and fifty-two students (totally one hundred and fifty-six people). Note that the descriptive statistics are used to rate both the arithmetic mean and the standard deviation respectively (Saiyos and Saiyos, 1995).

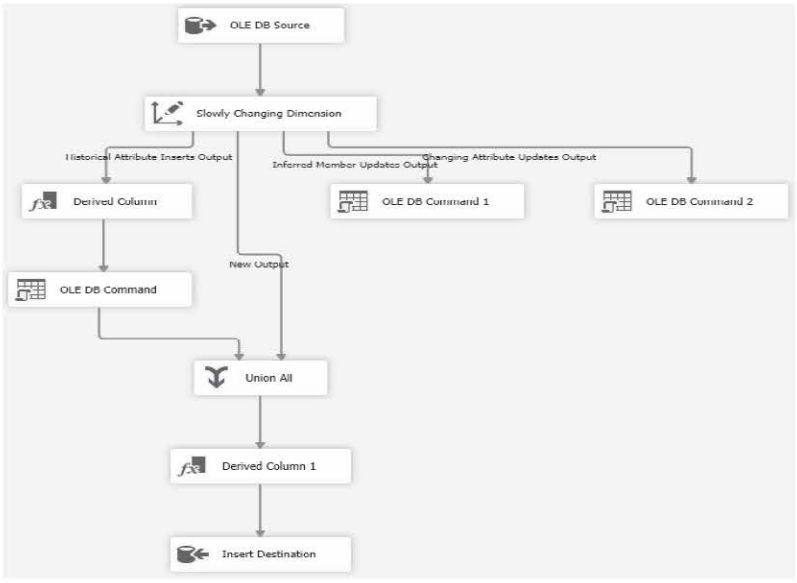

Figure 2: Data flow and execute package of fact tables, a) data flow of fact tables

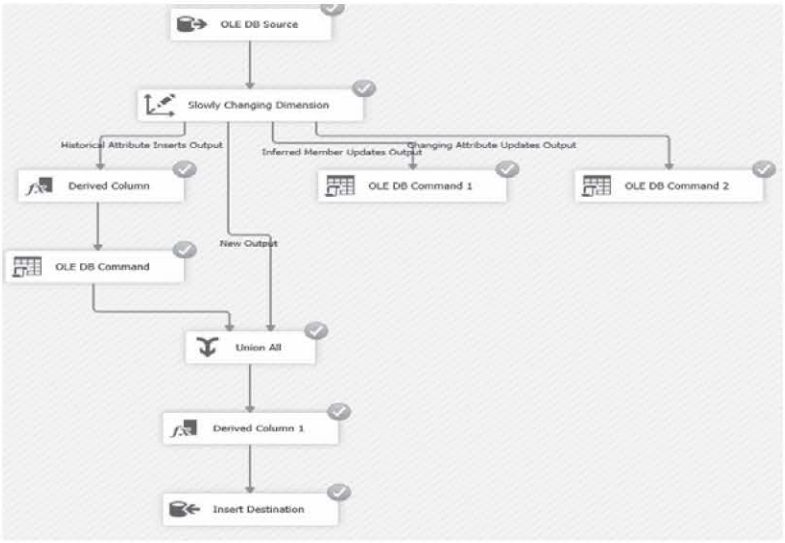

Figure 2: Data flow and execute package of fact tables, b) Execute package of fact tables

3. Results and Discussion

The development of the data warehouses relies on the information from the various sources and different formats. It is used to support the decision systems of the schools in Northern Thailand. All information is based on users' daily tasks and will be converted to the same format in order to use conveniently. In the part of the data warehouse designing, achieving maximum enterprise benefit is the first priority of this project (Elamy and Alhajj, 2005). The three most important parts must be considered that are data security, data ownership and data standards. They are provided to report to the chief executives (Koha and Watson, 1998). By these processes, all information will be synthesized from multiple sources in order to use them effectively (Post and Anderson, 2003). As the results, there is the flexible database in Northern Thailand. It can be adjusted and is linked into the data warehouse. Note that this data warehouse relied on the conversion data process and the manipulation of the raw data (Laudon and Laudon, 2001). Figure 4 shows that the principle functions of the proposed method. It can provide many services to all users such as the flexible multi-dimensional data, the online data analysis (dimensional variables), the measurement value, and the selection of statistical services. Moreover, all services can be reported in the forms of both tables and graphs. The six-teen data sets will be used to improve and support the decision-making process.

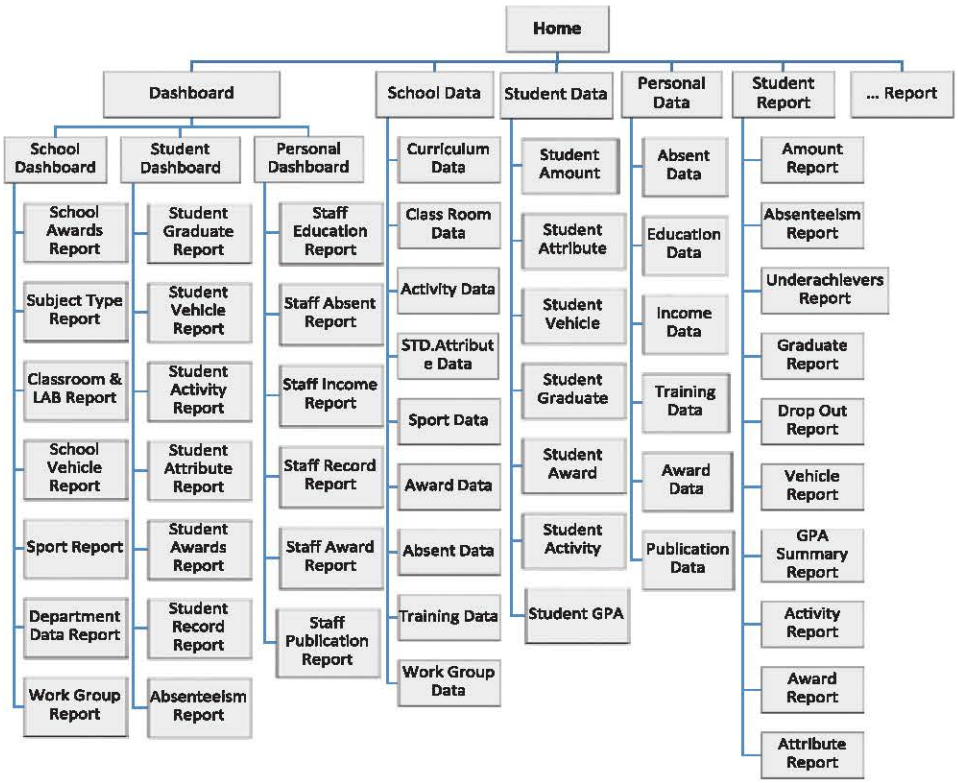

Figure 3: Site map of data warehouses and decision support systems

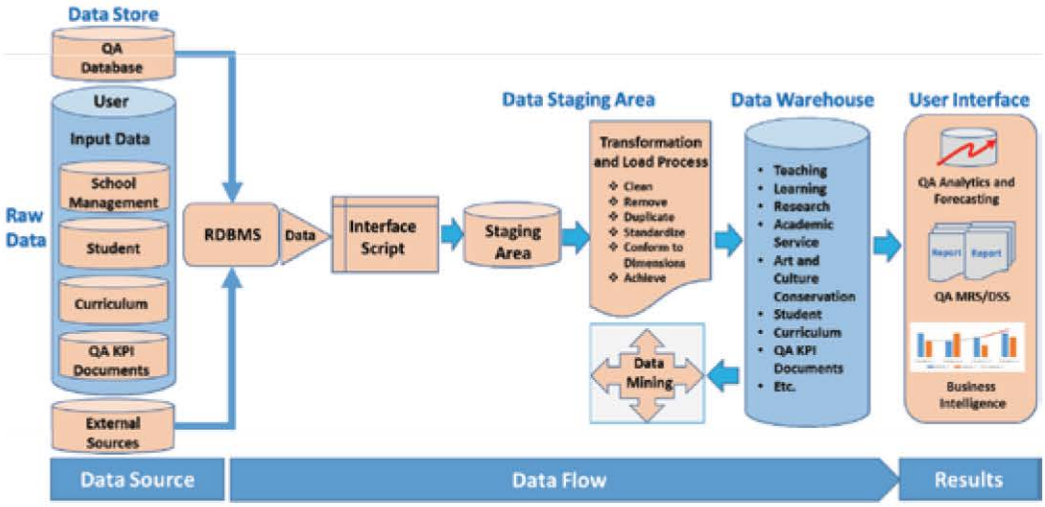

Figure 4: Principle functions of data warehouses and decision support systems

These data sets will be represented as the number of students, absents, underachievers, graduated students, student resignations, on-campus students, grades, students participating in activities, students receiving awards, students with extra skills, and employees. Moreover, for the employees, it can be classified by title, the level of education, income, absents, original affiliation, and type of the special training. By this technique, the organizing information access provides the data processing for solving all problems by data warehouses. It can be used to assist all users to get the better decisions in their institute (Veerman et al., 2010). Figure 5 shows the captured screen from the proposed method. It provides sixty-five reports in forms of both tables and graphs. The aim of the testing in the Alpha stage is to seek all errors in the system by researchers. First, they employ the test data in the term of both valid and invalid data to the system. Then, the feedback results from the test are used to

improve the system and the system will be retested again. Finally, there is a system that is complete and ready to use in a real environment. All test results can be divided into four sections as shown in Table 1. In the Beta stage, the evaluation form of an information system is divided into five aspects: the Functional Requirement, the System Design, the System Performance, the Reliability, and the Usability. According to the results, the satisfaction scores will be represented as the Table 2 and the comparison graph of the evaluations divided into five aspects is shown in Figure 6.

4. Summary and Conclusion

This paper presents the development of both data warehouses and decision support systems. It provides information to support the decision-making, to monitor the work performance, to predict the direction of future operations, to assist the daily tasks, to recall on the sub-work units, and to access desired data by online. These services are used to provide to the executives, teachers and students for educational institutes in Northern Thailand respectively.

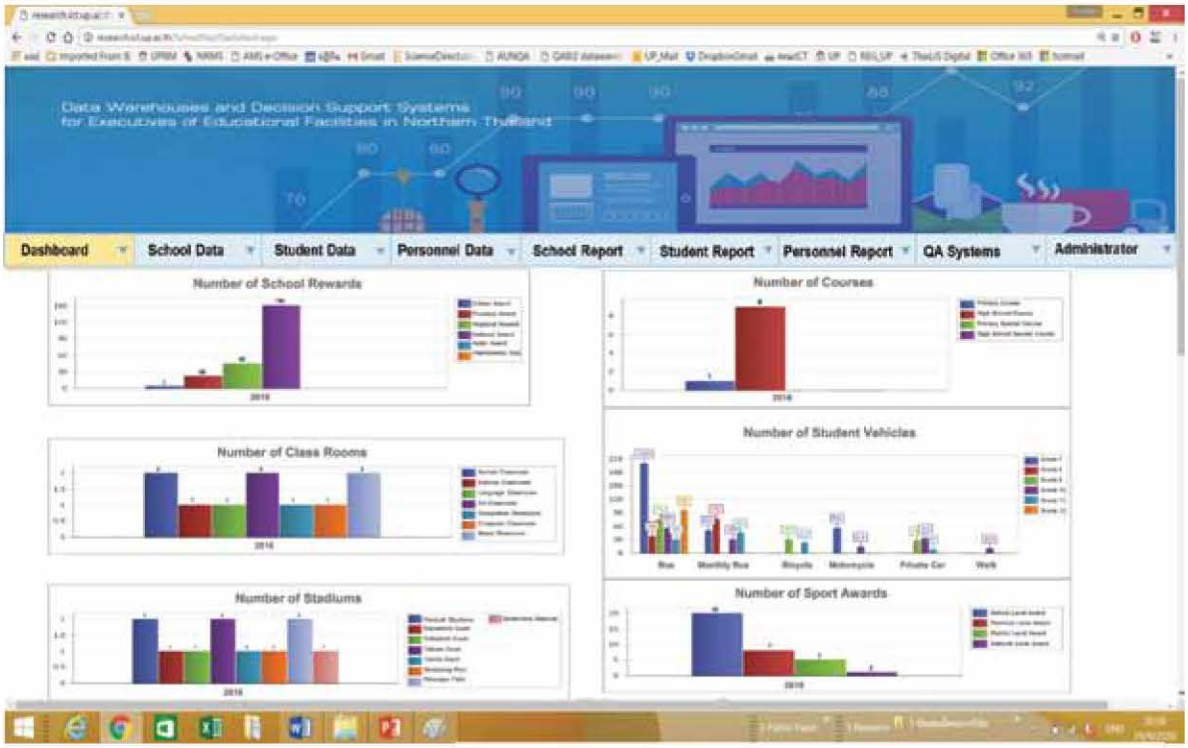

Figure 5: Captured Screen from data warehouses and decision support systems

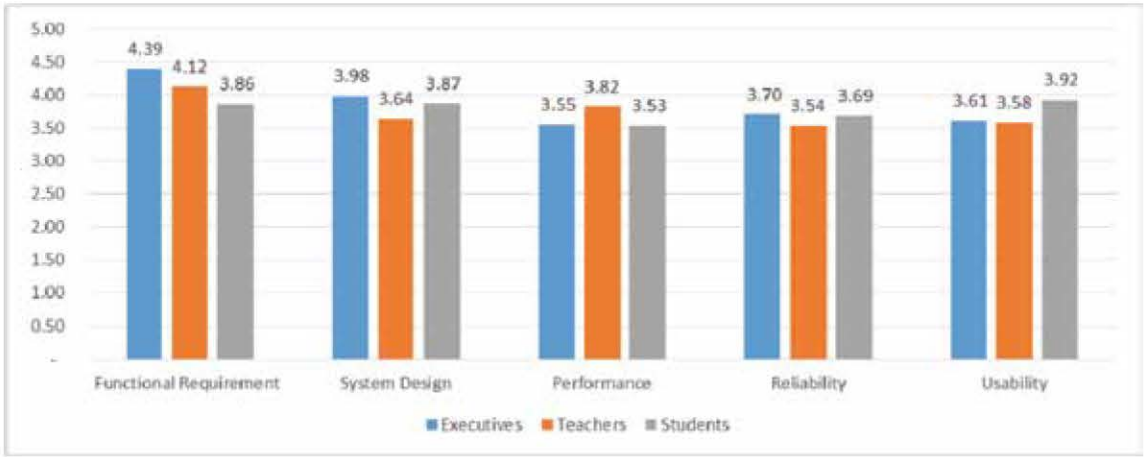

Figure 6: Evaluation of functional efficiency of mean system function

Table 1: Alpha stage test results

Test Items	Test Results
1. System Accessibility	
1.1 Enter correct username and password.	Showed correct results.
1.2 Enter the wrong username and password.	Showed correct results.
1.3. Enter the username and password.	Showed error with a warning.
2. Test Data Accessibility	
2.1 Specified correct parameters.	Showed correct results.
2.2 Specified wrong parameters.	Showed correct results.
2.3 Unspecified parameters.	Showed errors.
3. Test Basic Data Recording of the System	
3.1 Import correct data.	Showed correct results.
3.2 Import wrong data.	Showed correct results.
3.3 Import incomplete data.	Showed errors.
4. Test Database Management	
4.1 Accuracy of data recording in the database.	Functioned correctly.
4.2 Accuracy of data edit and deletion.	Functioned correctly.
4.3 Accuracy of data calling	Functioned correctly.
5. Test Report Display	
5.1 Select correct data and duration.	Showed correct results.
5.2 Select incorrect data and duration.	Showed correct results.
5.3 Select data without specifying time duration.	Showed error and warning.
6. Test Work Operation on Server Computer	
6.1 Limit access to block according to the designated IP address range.	Functioned correctly.
6.2 Speed of request system access	Performed with speed.
6.3 Ability to communicate between software in the server computer and the client computer.	Functioned correctly.

Table 2: Beta stage test results

Test Items	Executives (52 people)	Teachers (52 people)	Students (52 people)
Functional Requirement	Very good: 4.39 points	Very good: 4.12 points	Good: 3.86 points
System Design	Good: 3.98 points	Good: 3.64 points	Good: 3.87 points
System Performance	Good: 3.55 points	Good: 3.82 points	Good: 3.55 points
Reliability	Good: 3.70 points	Good: 3.54 points	Good: 3.69 points
Usability	Good: 3.61 points	Good: 3.58 points	Good: 3.92 points

Moreover, the proposed technique can effectively furnish information to all users with speed, accuracy, and punctuality. As the results, the proposed system can reduce time, cost, and complexity from the previous systems.

For the stability of the operation, the data warehouses relies on the subject-oriented. It does not focus each specific operation as other database management systems. By this idea, all the operations are integrated into the data warehouses in one place. The data inside the data warehouses has the time variant related to the operations of the business unit. This is important because the decision-making of the chief executives have to compare information in each time period. Each point of the data has to correspond to the time points and it can be used to compare by the time axis. All data in the data warehouses cannot be easily changed by all users (addition or editing). The can only access all information (Inmon, 1996). The management of the data inside data warehouses must have restricted rules. To achieve the highest benefit, both a clear scope and a log file are necessary to employ in this part. The multiple data from the different sources should be converted into the same scope before transferring to the database (Middleton, 2007).

The proposed technique is compatible with the work of Elamy and working group, they have also presented the development of the data warehouses for decision-making support (Elamy and Alhajj, 2005). This concept can be used for geospatial data such as maps, attributes, and satellite image data respectively. GIS are a special case of information systems in general that are distinguished by advanced capabilities for integrating spatial and descriptive data in powerful displays. However, in the same sense that decision support tools are proliferating for specific support functions in business, specialized tools (i.e., SDSS) taking advantage of the power of spatial displays are being implemented with GIS as a base (Murphy, 1995). For a data warehouse, it can be shown in Web-GIS such kind of spatial data distribution (Choosumrong et al., 2016). For the next phase of this project, the proposed system needs to have the further development. For instance, the searching system has to develop to seek information more easily with various search filters, the report system should have

many different styles, and the system should be durable and accessible 24/7. Moreover, the network administrators need to study and understand the system architectures, system maintenance and report systems through the special training in the future. Finally, the collecting requirements from all users have to gather continually to improve the system itself all times.

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