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DEVELOPMENT OF A WEB-BASED TRAFFIC INFORMATION MANAGEMENT SYSTEM FOR THE MUNICIPALITY OF IMUS, CAVITE

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Abstract: The development of a web-based traffic information management system for the Municipality of Imus, Cavite is one of the two projects aimed to explore the use of web technologies as a low-cost solution to address information requirements of local traffic management offices in the country. Primarily targeting the information requirements in the planning of traffic schemes, the project maximizes the capabilities of existing online mapping technologies and traffic models to provide a traffic simulation tool aimed to allow local traffic managers to identify, test and determine appropriate traffic scheme to reduce potential traffic problems.

In the information requirement analysis of the problems encountered by the local traffic management office of Imus, the group was able to identify the lack of information management and processing of traffic data collected as one of the reasons for the experienced difficulties in making traffic scheme decisions to minimize traffic congestions. Furthermore, the limited manpower of the local traffic management office necessitates the use of available computing and information technologies to allow them to perform planning tasks based on actual data (amidst current practice of speculation) at a more efficient and effective way. With the complex system of traffic and its management, the project was limited to consider only the following as part of this study – (a) Use of a macroscopic traffic simulation model
(b) urban-environment scenario based (c) simulated traffic environment variables.

The team used a Rapid Prototyping Methodology as a development methodology. With the target users' limited exposure to technology and its capabilities, it was necessary to adopt a development where requirements could be gathered and continuously refined in an iterative fashion alongside with the presentation of prototypes in order to bridge target user's understanding of technological capability and limitations to negotiate expectations and requirements.

Key Words: Information Systems; Traffic Management System; ICT for Development

1. INTRODUCTION

The development of a web-based traffic information management system for the Municipality of Imus, Cavite is one of the two projects aimed to explore the use of web technologies as a low-cost solution to address information requirements of local traffic management offices in the country. Primarily targeting the information requirements in the

planning of traffic schemes, the project maximizes the capabilities of existing online mapping technologies and traffic models to provide a traffic simulation tool aimed to allow local traffic managers to identify, test and determine appropriate traffic scheme to reduce potential traffic problems.

The research team's general objective is to develop an information system that would help the Imus Traffic Management Office (ITMO) to have a more efficient and effective way in handling traffic situations and conditions through the use of available information technologies. The research team aims to identify what technologies and system design appropriate to enable ITMO to plan traffic schemes and routes, to properly disseminate traffic schemes to enforcers and allow the Imus commuters to contribute in reducing traffic congestions.

2. METHODOLOGY

The effectivity of an information systems solution depends on the extent to which it matches the information needs as well as the processing behavior of its users affecting their ability to make decisions. In order to do this, the research team selected a methodology that is known to have a higher predicted user acceptance of the system as well as cover other requirements that may not be identified and known at the onset of requirements gathering. The team used a Rapid Prototyping Methodology (RAD) as a development methodology. With the target users' limited exposure to technology and its capabilities, it was necessary to adopt a development where requirements could be gathered and continuously refined in an iterative fashion alongside with the presentation of prototypes in order to bridge target user's understanding of technological capability and limitations to negotiate expectations and requirements. According to (Maner, 1997) RAD is a system development methodology that favors creating a prototype faster. Prototypes allow high user involvement where they can test and assess the projected solution through working models of the information system allowing them to give feedback and check the models for bugs and deviations from expected objectives before the actual product is assembled and finalized. Aside from this, the iterative nature of the methodology involving the prototypes slowly introduces the users to the mechanics and maneuvers eventually required in using the new system thereby reducing the transition pain from the old set of tasks and mechanics to the new processes the solution will eventually require them to do.

RAD is composed of activities iteratively performed on a regular period. These activities are (a) Identify initial customer requirements (b) Identify actions and tasks that will be modeled in the prototype (c) develop a working prototype (d) prototype use and feedback (e) improve prototype. The regularity and frequency of prototypes is key to the success of this method. The research team decided to iterate prototypes based on decision scenarios against typical iterations based on functionality. Decision scenarios are closer to the natural events surrounding the users and will allow them to connect easily with the prototype.

3. PROBLEM and SITUATION

With the objective of designing and implementing an information systems solution that will support efforts in managing traffic and hopefully reducing its effect to society, information-related problems were identified during data gathering and requirements analysis. Furthermore, the 6-month period limitation in order to implement the solution, other factors that will manage the scope of the solution and still deliver a usable and effective solution were also identified. For this project, the strategy to solve traffic management is two-fold – ITMO decision-making perspective and commuter decision-making perspective. Through this perspective, solution to reduce traffic congestion will be both an effort by the ITMO as well as the commuters passing through the roads of Imus. Information requirements that will allow ITMO and commuters make decisions to help decongest and prevent further road decongestion were targeted.

Commuters play a vital role in decreasing traffic congestion situations in the roads of Imus. In order to do this, they have to make a decision to pass through or avoid certain roads and pass through alternative roads in order not to contribute to existing and projected congestions
on certain roads. During requirements gathering, the following were identified as key information to support commuter's decision-making: (1) Projected Traffic situations and trends (2) Current Traffic situation (3) Alternative Routes to take.

The effectivity of information systems relies on the presence of a record management system that will regularly collect and store data to allow access and use of these data for tasks like planning and decision-making. This situation is missing in the ITMO. The ability to manage and address traffic congestions rely on the ability to predict traffic conditions within the municipality, use existing and historical traffic information in order to plan and make alternative traffic scheme decisions to prevent or lessen probability of traffic congestions to go worst.

Furthermore, the limited manpower of the local traffic management office necessitates the use of available computing and information technologies to allow them to perform planning tasks based on actual data (amidst current practice of speculation) at a more efficient and effective way. Reducing office manpower with the solution and maximizing manpower on the roads to enforce traffic schemes necessitates that information to properly identify where traffic enforcers will be best deployed should also be provided by any solution.

4. SOLUTION

The key solution to the problem of ITMO is a simulation system that will enable analysis, maximization of traffic data and decision making in terms of appropriate traffic

scheme identification. With the complex system of traffic and its management, the project was limited to consider only the following as part of this study – (a) Use of a macroscopic traffic simulation model (b) urban-environment scenario based (c) simulated traffic environment variables. From the data and requirements gathered, the simulation model should be enough to simulate traffic conditions based on traffic scheme variables representative to last for a few minutes to several hours. With this, the research team considered a macroscopic simulation model that is less detailed than its microscopic model counterpart that requires the measures the speed and location of each individual vehicle included in the simulation (Boxill & Yu, 2000). According to (Lansdowne, 2006), this macroscopic model takes into assumption that all vehicles would be of the same speed and behavior; and traffic in-flow and volume (vehicles/hr) as important input and output variables. To increase the accuracy of the simulation, environmental factors such as road architecture that determines road length and width were modeled through a variable Q (output of a road segment in vehicles/second). Q values are adjusted depending on the road architecture and are pre-recorded in the database. The decision to take the macroscopic model is also based on the ability of the ITMO to gather data for all the road segments in Imus. Their limited manpower necessitates that the simulation model to be used require less data to be gathered.

The situation of the Imus roads being an urban environment where intersections, traffic lights, roundabouts among others are present requires that whatever simulation model, roads will be segmented into finer granules. This poses an issue with the amount of data that needs to be encoded into the system due to the volume of segments found in an urban scenario like Imus. To address this concern, the research team has pre-encoded all the traffic data before implementation in the ITMO. This will reduce their data encoding effort and concentrate on recording real-time traffic situation on key problematic areas thereby increasing the accuracy of the previously encoded data as the system is being used. Urban scenario that involves obstructions, situations and other factors were modeled as either a positive (+) or negative (-) influence to traffic variables such as traffic in-flow, out-flow and vehicular volume used in the macroscopic simulation model. Traffic enforcers are modeled similar to stop lights and is represented as the amount of time to which vehicles are allowed to pass to a segment thereby having a (+) or (-) effect to in-flow or out-flow of affected road segments.

To better analyze and compare existing and proposed traffic schemes, the simulation will be integrated with a special report system wherein the existing and proposed scheme are placed side by side to compare effect of both schemes (see figure 1.0).

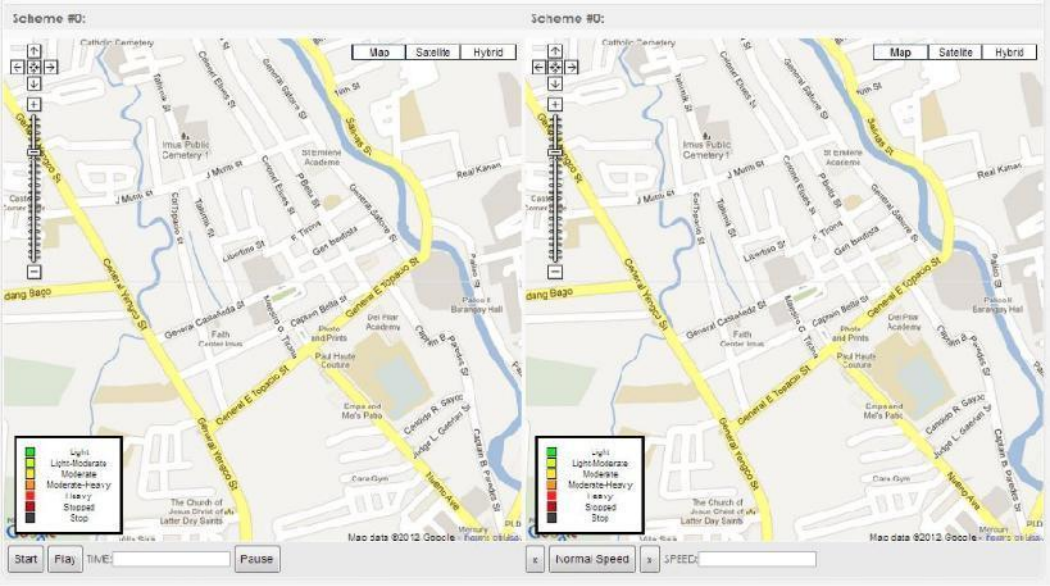

Figure 1.0: Two side-by-side simulation screen

5. RESULTS AND DISCUSSION

The completed system undergone User Acceptance Testing (UAT) (aside from system testing that assesses the reliability of the functionality of the software by the research team) based on identified scenarios that will surface the implementation of features consistent to the objectives. The iterative nature of the development methodology used in the study has allowed six user-based testing of the completed system and a final user acceptance testing. Selected officers of ITMO, representing the organizational functions represented in the system, went through testing the system on specific scenarios consistent with their functions in managing traffic. Two types of UAT's where conducted for as there are also two users of the system. The UAT's of both users are different because both have different functions and objectives. The UAT of the ITMO consists of 4 sections, Reports, Simulation, Forecasting, and Data Gathering. On the other hand, the UAT for the public only consists of Reports, Information, and Proposition. The ITMO was able to test and use the system six times in a span of 3 months and the result of the testing is shown in table 1.0. As for the UAT for the public, this was only done once in the Hall of the ITMO by random citizen that was present and was asked to share their insights of the system. The results of the UAT with the public is shown in table 2.0

Criteria Rating	5	4	3	2	1	5-Very Satisfied 4-Satisfied 3-Just Acceptable 2-Not Satisfied 1-Not Very Satisfied	5	4	3	2	1
Reports						**Forecasting**					
Easy access to reports	2	1				Objects are properly aligned	2	1			
Proper font size and style	3					Graphs are easy to comprehend	2	1			
Buttons and other navigation buttons are clear	3					Proper font size and style	2	1			
Graphs are easy to comprehend	1	2				Design is appealing	3				
User interface is appealing	3					Properly labelled	2	1			
Information report is significant	3					Information is significant	2	1			
Colors are appropriate for report	2	1				Availability of instructions	2	1			
Objects are properly aligned (labels, table, graphs)	2	1				**Data Gathering**					
Properly labelled	2	1				Ease of data gathering	1	2			
Availability of instructions	2	1				Data gathered are essential	3				
Simulation						Availability of data gathering tools (timer, counter, human)	2	1			
Ease of navigation through the simulation	2	1				Buttons and other navigation buttons are clear	2	1			
Colors are appropriate during simulation	3										
Appealing design	3										
Input fields are available and properly aligned	2	1				Design is appealing	3				
Ease of use of simulation (selecting roads, creating scheme, intersections)		1	2								
Flooded page (too much information on a single page)			1	2		Input fields are available and properly aligned	3				
Information is significant	3										
Properly labelled	2	1				Availability of instructions	3				
Availability of instructions	2	1									

Table 1.0: Results of User Acceptance Testing with ITMO users

Criteria Rating	5	4	3	2	1		5	4	3	2	1
Reports						**Information**					
Easy access to reports	5	5				Sufficient and essential information	5	4	1		
Proper font size and style	7	2	1			Information is educational and helpful	8	1	1		
Buttons and other navigation buttons are clear	8	2				Ease of access to information	8	2			
Graphs are easy to comprehend	6	2	2			**Proposition**					
User interface is appealing	9	1				Suggestion and Complaints section effectiveness	4	4	2		
Colors are appropriate for report	8	2									
Objects are properly aligned (labels, table, graphs)	5	5				Imus citizens are given a voice	8	2			
Properly labelled	8	1	1			Enough fields for suggestion and complaints	9	1			
Availability of instructions	6	3	1								

Table 1.0: Results of User Acceptance Testing with Imus Citizens

Some citizens said that how will they be assured that the ITMO has received their complaints/suggestion. The main goal of the group for the citizens of Imus is for them to be notified whenever there are occurrences or advisories in the city that they should be knowledgeable of. The result of the UAT was also positive, some asked about how their suggestions/complaints will be answered so the research team developed a chat function so that the citizens will be able to directly talk to the IT staff of ITMO and rest assured that their inquiries are being handled by the ITMO.

UAT Results have shown that the system was able to meet the information requirements of the Traffic Management Office and the acceptance of the users of the system has shown the consistency of the developed system to the expectations of the users. The main goal of the research team for the ITMO is for them to be able to gather data and make use of the these data to be able to foresee traffic trends and create schemes to test and compare to be able to come up with a better scheme to implement. The positive experience of the target users with the system has progressed to its adoption awaiting proper transfer of the technology developed governed by legal memorandum

6. CONCLUSION

The system developed has a data gathering capability that will enable the ITMO to document previous traffic situations and events. The end result of this data gathering will be used for a traffic forecasting module wherein the ITMO will be able to know the trends of traffic conditions every day, depending on which day the ITMO prefers to forecast. The implemented system has been developed with the ability to generate reports that will intensify ITMO's planning and analyzing phase. The most important part of the implemented system is the simulation system wherein the ITMO will be able to try out and simulate different traffic schemes that will greatly help the reduction of traffic congestion or it will be able to avoid certain formation of congestion anywhere in Imus. The technological features of the system implemented have allowed ITMO to process traffic information even with their limited manpower. This has proved that technological innovations such as this system can help manpower deficient agencies in the local government perform their mandates effectively.

Since Imus is now a city, the ITMO have plans on installing CCTV cameras around the city. With this, the ITMO will be monitoring the traffic situations on real-time basis. The work done by the Research Team concentrated on information processing, computer science innovations in the field of image processing is a further area of research that can be conducted that can maximize the capabilities of the CCTV cameras and the use of computer systems to analyze CCTV feeds in order to determine traffic situations in real-time. The problem of manpower will continue to be a challenge in Imus, and technological innovations such as image processing will be consistent to the strategy of overcoming manpower difficulties using technology.

7. REFERENCES

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