

ES-NMS: An Expert System for Non-Motorized Transportation Strategies towards EcoCampus in Universiti Malaysia Sabah (UMS)

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Abstract: The advancement of technology has led to the introduction of Artificial Intelligence such as expert systems to be used in solving issues regarding to transportation. Expert system is a computer program that is able to perform problem solving tasks at the same level as a human expert. This will be useful as an alternative solution to tackle the inaccessibility and shortage of human experts in certain region of the world. The objective of this study is to develop an expert system to implement strategies for non-motorized transportation system within Universiti Malaysia Sabah. The bulk of the data is obtained through the use of questionnaire given to the human experts to provide the strategies for the non-motorized transportation system. Using the feedback given by the human experts, the expert system is developed by using Microsoft Visual Basic 2013. The developed system is then evaluated by the human experts to validate and verify the system to ensure that it is acceptable to be used by the end-user. The developed expert system is then available to be used by the university to improve its sustainable program, EcoCampus.

Keywords: EcoCampus; Expert system; Non-motorized transport; Sustainable transport system; Transportation.

1. INTRODUCTION

Transportation is an aspect that is very important to a functioning society. The heavy reliance on vehicles as a primary mode of transportation can be seen as people tend to use it more for the accessibility, and mobility that it offers. However, the transportation systems today are no longer sustainable for the future. This is due to the lack of environmentally friendly materials usage. This contributes to the environmental pollution that effects mobility of life in general. These problems are caused by many cities that rely on motorized transportation systems that contributes to the negative environmental consequences, and other limitations. Example of such city is Milan, where it introduced the Ecopass program to cut down the usage of vehicle emissions. This was due to the fact that Milan was ranked as the third among the large European cities for the concentration of airborne particulate matter. More than 50% of the citizen in Milan use private cars, and motorcycle, making Milan to rank second in terms of private cars, and motorcycle use among the large European cities [1].

The implementation of a non-motorized transport system is seen as a solution to improve and meet the concept of sustainable transportation to ensure a cleaner, healthier, and higher quality environment. To achieve a more sustainable future, non-motorized transport is a vital part of any transportation system, as it is one of the most sustainable mode of transportation [2]. This is due to the fact that it is an active transport that includes all forms of travel that does not rely on an internal combustion engine for movement, such as walking and cycling [3]. Besides being a more environmentally friendly solution, it also reduces the risk of accidents, and deaths due the vehicle crashes.

With the rapid development of technology, and the internet revolution, applications such as expert system can be accessed by modern devices to aid in solving problems related to transportation. An expert system is a program that attempts to mimic human expertise by applying inference methods to a specific body of knowledge [4]. The main objective of this study is to develop an expert system to aid the university management to implement non-motorized transport alternatives towards the goal of a sustainable future, also known as EcoCampus alternative which was launched in 2013 by the university, Universiti Malaysia Sabah (UMS).

2. LITERATURE REVIEW

2.1 Non-Motorized Transport

Non-motorized transport is defined as any form of transportation that provides personal or goods mobility by methods of other than an internal combustion engine [5]. This is because the two major modes of non-motorized transports are walking and cycling. The reliance on motorized transport has caused many environmental problems where it contributes to air pollution.

As such, the implementation of non-motorized transport will help the development of sustainable transportation. There are many alternatives that can be implemented around the campus area. Some examples that can be used are sidewalks, crosswalks, bicycle rental, covered walkways, speed humps, and integrated bicycle with public transport. Crosswalks are designed to keep pedestrians together where they can be seen and cross safely across the flow of vehicular traffic [6]. Meanwhile for sidewalk, other than providing a safer path for pedestrian to walk along the roads with motorized vehicle, it is also used to increase the accessibility of the area, thus reducing the dependent on motorized transport [7].

Rapid development has generated heat that contributes to the overall increase in global temperature. These heat waves accumulate due to the reflections of the sun's ray among the buildings, and asphalt roads [8]. In order to make provide a more comfortable condition for people to choose a non-motorized transport, providing shaded areas for pedestrians and cyclist is vital. Shaded area does not reduce the heat effect directly, but it does improve the conditions for people that has to travel by a non-motorized transport means.

For bicycle usage, although the range of bicycle users are limited due to several limiting factors, there are still plenty of benefits of cycling. Thus, installing stands and racks for cyclist to park their bicycle can increase the likely hood of people to switch to cycling. To increase the attractiveness of cycling, bicycle storage can be provided especially for storing the bicycle during after dark [9]. Dedicated bicycle lanes serve the needs of all types of cyclists in many ways, such as providing them with their own travel lane on the street surface. Bicycle lanes also enable cyclists to travel at their preferred speed and facilitate a predictable behaviour and movements between cyclists and motorists. Bicycle lanes that has more separation from motorized vehicle lanes is perceived as positive by cyclist [10]. Bicycle can also be used with integration with public transport to provide multi modal transportation option that can cover great distance and can promote health, social equity, and a cleaner environment. Thus, transport chain is helpful in understanding the strength of cycling and public transport. Bicycle-transit integration focuses on the provision of bicycle facilities with the expectation that this will increase utilitarian cycling.

2.2 Expert System

Alternatives provided will be used as a knowledge base in the development of an expert system and the strategies are obtained from domain experts. Expert system in traffic and transportation engineering has been used in various past studies [14-18]. Looking at the examples of the past studies, expert system has been used as far back as 1987 in this context. There are also researches in recent years done on expert system in the field of traffic and transportation engineering [19-22].

There are many advantages of using an expert system as a tool to gain information. For example, purchasing of specific software is not needed by the end user. By using common web browsers, the end users are able to use the decision support tool to search for the results and recommendation. These expert systems are used to solve important real-life problems as the quality and efficiency of these system are not inferior to their human expert counterpart. The systems are also capable of self-learning and they are available to any users [11].

Although expert system cannot replace a human specialist, it can serve as a highly efficient support-tool in the decision-making process. In general, expert system can be used for analysing, diagnosing, monitoring, forecasting, planning, and designing. Other than that, the expert system can provide fast, and reliable answers. The quality of decisions also improves when human decisions are supported by recommendations from an expert system [12]. Since expert system is a computer system, it is able to provide unbiased, and consistent responses regardless the characteristic of the end user, since it is not affected by emotional factors. It also has an advantage in terms of increased efficiency, and data monitoring and analysis capabilities [13].

3. METHODOLOGY

The main goal of developing this expert system is to provide the most effective non-motorized transport alternative to be implemented within UMS. To create an expert system in the related field, various information related to non-motorized transportation was first obtained through several research method. Mainly through researching previous studies, books, and online directories. However, the bulk of the solutions provided in regard to non-motorized transportation was gathered through a survey.

This survey was conducted online by using Google Forms and the respondents for this survey were selected domain experts, also known as human experts in the field of transportation engineering. The domain experts have more than 10 years of experience in the field of highway engineering, road construction and civil engineering. Once the data collected was sufficient, the expert system was developed by using Microsoft Visual Basic 2013. First step in developing a computer program is to study the programming language. A programming language is a computer language that is designed to create a standard form of commands. Whereby these commands are used to create the codes that controls the machine's behavior, and output.

4. ARCHITECTURAL OF SYSTEM

The solution obtained from the domain experts was coded into Microsoft Visual Basic 2013. The list of all the alternatives obtained from the domain experts is summarised in Table 1.

Table 1. Summary of non-motorized transportation strategy

	Strategy
City	<ul style="list-style-type: none"> • Integrated Bicycle with Public Transport • Covered Walkway • Dedicated Bicycle Lane
Campus	<ul style="list-style-type: none"> • Bicycle Parking • Bicycle Rental • Integrated Bicycle with Public Transport
Economy	<ul style="list-style-type: none"> • Integrated Bicycle with Public Transport • Bicycle Rental • Bicycle Parking
Social	<ul style="list-style-type: none"> • Dedicated Bicycle Lane • Covered Walkway • Sidewalk
Environment	<ul style="list-style-type: none"> • Dedicated Bicycle Lane • Integrated Bicycle with Public Transport • Develop Planning and Guidelines for Pedestrian and Cyclist

Using the data shown in Table 1, the strategies was coded into Microsoft Visual Basic 2013. First, the new project was started by clicking the *New Project* button in the start page of Microsoft Visual Basic 2013. Figure 1 shows the project was named as ES-NMS with Windows Form Application was selected to create the system.

Form 1 will appear as shown in Figure 2 as the default main window. There are three main outlines to create the items in the system such as *Toolbox*, *Document Outline* and *Properties* shown in Figure 3. This outline will determine the appearance of the system and act as the control to adjust and add the background image, label, button, font size and colour.

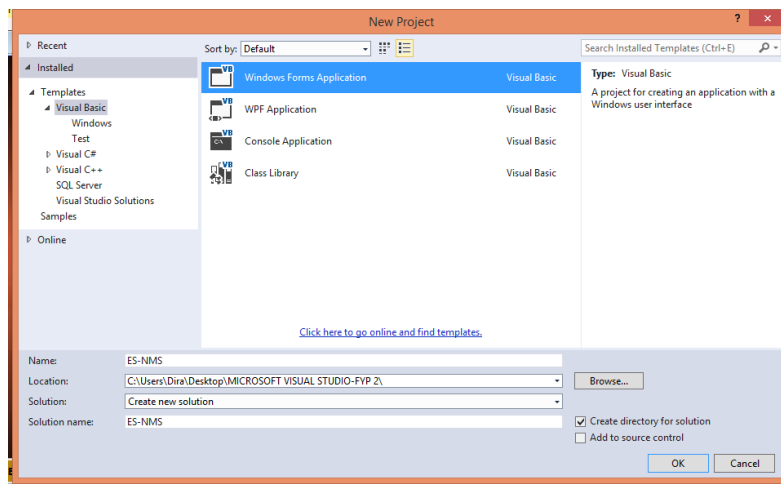


Figure 1. Windows form application

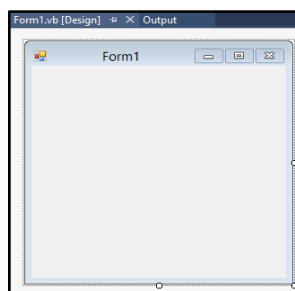


Figure 2. Main window

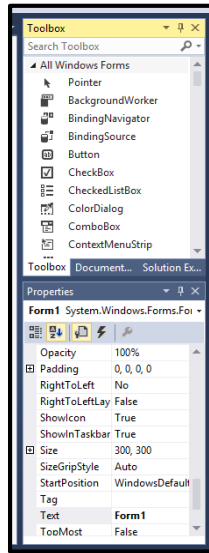


Figure 3. Toolbox and properties of visual studio

Then, form 1 was named as *ES-NMS* and this will be the home page of the system. On the other hand, this system will only use one *Form* and add *Panel* to the form shown in Figure 4. The function of the panel is the same as Form. However, instead of adding forms, the system will use panels, and all the coding is condensed into one form which is Form1.vb. This system consists of two major sections which are *Strategy*, and *About*.

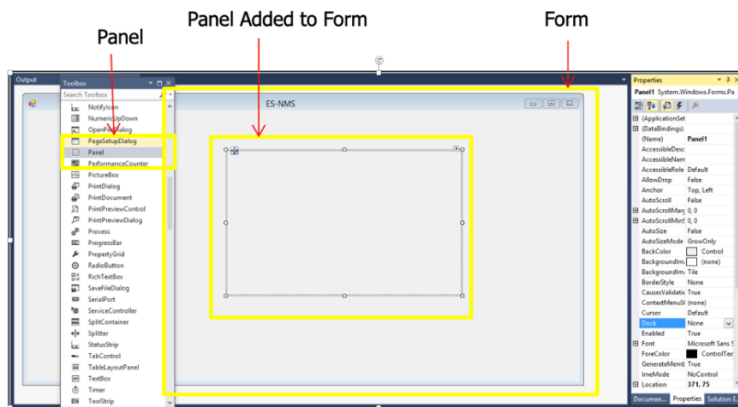


Figure 4. Adding panel into form

The *Strategy* button is where the non-motorized transportation solutions is coded in. The solution is expected to be used within the campus area. It also consists of impact analysis on the three aspects for a sustainable development, which are economy, social, and environment. Within the *Strategy* button, analysis on the facilities in UMS to encourage student to use non-motorized transportation is also included. Meanwhile, the *About* section provides detail information regarding non-motorized transportation to increase the end user understanding.



Figure 5. Home page of system

When double clicked, the coding for each button will be shown. For example, by double clicking the *About* button at the Home page, the coding for that particular button will be shown. Figure 6, shows the selections of strategies according to their categories. In this panel, it requires the user to select the category of non-motorized transportation alternatives by pressing the respective buttons. These categories include economy, social, environment, impacts, and UMS. Every button will direct the user to each of the strategies based on the category chosen.



Figure 6. Panel 5 window

Figure 7 shows the coding for each of the button in panel 5, which is almost similar all throughout the system including the coding for the *About* button discussed earlier. All of which are linked to another panel containing the strategies for implementation of a sustainable non-motorized transport system.

```

Private Sub Button18_Click(sender As Object, e As EventArgs) Handles Button18.Click
    Panel15.Visible = False
    Panel11.Visible = True
End Sub

Private Sub Button27_Click(sender As Object, e As EventArgs) Handles Button27.Click
    Panel16.Visible = True
    Panel15.Visible = False
End Sub

Private Sub Button29_Click(sender As Object, e As EventArgs) Handles Button29.Click
    Panel17.Visible = True
    Panel15.Visible = False
End Sub

Private Sub Button32_Click_1(sender As Object, e As EventArgs) Handles Button32.Click
    Panel18.Visible = True
    Panel15.Visible = False
End Sub

Private Sub Button34_Click(sender As Object, e As EventArgs) Handles Button34.Click
    Panel19.Visible = True
    Panel15.Visible = False
End Sub

Private Sub Button36_Click(sender As Object, e As EventArgs) Handles Button36.Click
    Panel10.Visible = True
    Panel15.Visible = False
End Sub
    
```

Figure 7. Coding of panel 5 window

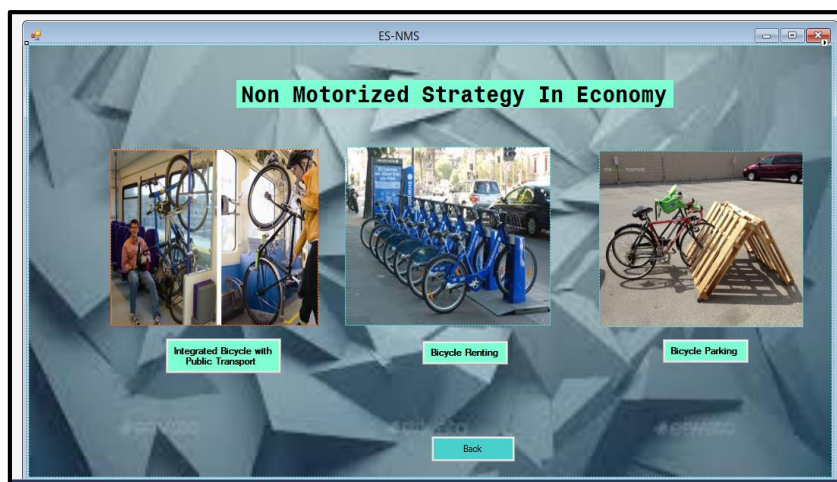


Figure 8. Panel 6 window

By clicking any button in panel 5, it will show the strategies for the type of non-motorized transport in another panel that has been sorted out according to the information obtained from the domain expert. The panel will show the detail explanation and illustration for better understanding. For example, clicking on the *Economy* button will bring up the options as shown in Figure 8. It shows the list of non-motorized transportation strategy in term of Economy. Then by clicking on the button in the *Economy* section, panel 6, it will show a new panel that provide an explanation to the option chosen. In this example, the *Integrated Bicycle with Public Transport* was chosen, the new panel explaining the option is shown in Figure 9.



Figure 9. Integrated bicycle with public transport strategy panel

To finalise the system, the completed system had to be run by clicking the *Start* button. Should there be any coding error, the system will not be able to check or complete its process. Any error in the system must be traced back in the coding lines as shown in Figure 8 and fixed before the system is able to run.

5. CONCLUSION

Non-motorized transport is one of the most sustainable transportation systems that satisfies current transportation, and mobility needs. As such, it is a waste to not implement this kind of transportation mode since non-motorized transport is known as a non-polluting mode of transportation. Therefore, the development of an expert system to show the available solution for a non-motorized transportation system is important. Once the expert system has been developed, the time required to search and consult a domain expert will be significantly reduced. The main objective which is to develop an expert system expert system to aid the university management, has been achieved. This expert system can be used to implement a non-motorized transport alternative within the university, in line with the university's aim towards the goal of a sustainable future, also known as the EcoCampus program started in 2013.

Although the ES-NMS was successfully developed, it still requires continuous improvement. At this time, this expert system can only be accessed by using a computer. Thus, by modifying, and upgrading the system to make accessible to mobile phone will tremendously improve the system. This is due to the fact that in today's day and age, mobile phone has become necessity to society. Thus, by making continuous improvements to this expert system, and making it available online, increases the tendency of users to use this application. As technologies evolve over time, it is recommended to have regular update of the expert system, after consulting with the domain experts. This is important since the data obtained today sometimes are no longer applicable in a few years' time. Thus, it is important to ensure that the system is updated regularly to increase the accuracy and effectiveness of the expert system.

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