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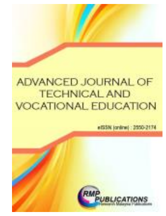

Development of E-ACTIVETRANS for Urban Cycling

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Abstract: This paper presents the development of an expert system for urban cycling as an advisory scheme in finding the solution to problems normally solved by human experts. E-ACTIVETRANS is developed to help young engineers/planners in designing a new cycle lane and the reallocation of the existing lane in urban areas. This paper focuses on the reallocation of the existing lane to the cycle lane whereby the prototype was developed based on data acquired from domain experts who are involved in bicycle facility module design as well as the initial text analysis obtained during the knowledge acquisition stage. The verification, validation and the evaluation (VVE) of the system was performed through a comparison of knowledge content in E-ACTIVETRANS based on experts' opinion. The average level of acceptance of the system is 91.2%, which validates the system and the knowledge of the experts.

Key words: *Bicycle facilities, E-ACTIVETRANS, expert system, human experts*

INTRODUCTION

Car ownership leads to the consumption of energy, which in turn results in additional damages to ecological system and worse still, increased roadway congestion. Developing countries such as Indonesia, Vietnam, Thailand and Malaysia have limited resources in structuring transport systems, especially during peak hours. Usual physical reserves for streets are narrow and crowded and the use of private vehicles is seen to be no longer relevant to accommodate the high level of traffic congestion.

In most developing countries, the private vehicle is the main transport mode that contributes to roadway congestion. In the long run, the resulting emission of carbon monoxide from the increasing congestion would interfere with the quality of life of the population. To address and solve this problem, attention and necessary actions from government are required. This paper aims to outline the application of urban cycling design by focusing on ways to reallocate the existing lane to cycle lane towards implementing tactical steps of shifting from passive to active transportation. Active transportation, also known as non-motorized method of travelling, encompasses walking, riding bicycles and other means like skating, as well as the use of wheelchairs or electric motorized wheelchairs and handcarts [1]. Walking and cycling can contribute to significant participation in efforts to achieve sustainable transportation objectives, leading to healthier lifestyle, better and more maintainable vicinities, as well as decreased pollution and traffic congestion. When the number of vehicles is reduced, many trips are thus replaced with walking and riding bicycles, either totally, or in conjunction with ridesharing and utilisation of public transit. Here, active transports (cycling and walking) are both identified as easy transportation modes which also promote healthier environment.

BICYCLE LANE

Bicycle paths are an important element in the effort to provide protection and convenience to road users, including motor vehicles and bicycles.

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Generally, bicycle paths are defined as "pavements or special pavements or lanes specially designed for the use by cyclists"[2]. According to [3], the bicycle route is part of the road dedicated to the use of bicycles, including the pavement, signage and road signs. This bike path allows cyclists to ride with their choice of uninterrupted traffic flow. Bicycle paths also help more reactions and movements between motorcyclists and other motor vehicle users. Bicycle paths differ from those of bicycle tracks, which do not have physical barriers such as bollard, median, kerb and other articles which prevent motor vehicles from squeezing cyclists. Bicycle paths can be distinguished by paving colors, road signs, signboards and appropriate crossing designs.

Bike trails can be categorised into three: dedicated bicycle lane, shared lane and side path bicycle lane. [4] defines an exclusive bicycle (dedicated bicycle lane) route as a bicycle route located inside or adjacent to the road and physically separated by the route of a motor vehicle. It is a special passage for bicycles only. Meanwhile, for shared lane, bicycles usually use the same route as other motor vehicles. This route is not equipped with signposts and road signs specifically meant for cyclists. Side-path bicycle lane can be defined as a passage marked for bicycle use located next to the road. In some countries such as the United States, Canada and most European countries, it is illegal to disagree if the cyclists do not use this route. Side bike paths are easier to construct as they can fit in the right-of-way (ROW) existing roads [4].

KNOWLEDGE ACQUISITION FOR E-ACTIVETRANS

Knowledge acquisition was obtained from various sources in transportation field. The main source was obtained through domain experts as well as from other sources such as guidelines, textbooks and encyclopedias such as the Victoria Transport Policy Institute (VTPI). These multiple sources provided many advantages in decision making until the expert systems are fully developed. The principle source of knowledge was drawn from the engineering department of city councils and experts of transportation system as well as those who are directly involved in the designing of bicycle facility infrastructure. Information was collected through interviews with experienced domain experts in Malaysia, of which the domain experts for bicycle design were obtained from government and private agencies such as the Country Planning Peninsular Malaysia, Shah Alam City Council, Petaling Jaya City Council and Subang Jaya City Council. They have been selected due to their knowledge and insights on design of cycle lane according to the Malaysia environment.

The factors previously identified from the literature were then analysed by comparing the perspectives and opinions of these experts.

DEVELOPMENT OF E-ACTIVETRANS

E-ACTIVETRANS was initiated by outlining some key guiding principles to help the identification and selection of the available types of bicycle facilities. There are no fast and hard rules in determining the most appropriate type of bicycle facility for a certain location [5]. E-ACTIVETRANS was developed using Visual Basic.NET and MY SQL. VB is an event language designed to interact with the user on a running system. The most widely used type of representation consists of collection of facts, while rules are used to represent IF-THEN reasoning. These rules have the form of “IF ‘condition’ THEN ‘action’.” If the condition part is true within the scope of the knowledge base, then the condition would store the facts portion of the system knowledge engine. Based on this, the condition part is performed [6].

This paper only focuses on the reallocation of roadway space under the urban cycle design.

REALLOCATION OF ROADWAY SPACE

Road space is a scarce public resource. Conventional transport planning practices tend to devote road space to general traffic lanes. Here, reallocation of road space involves shifting the road space from automobile traffic to other active transport modes, namely bike lanes and sidewalks. Reallocation of roadway is particularly appropriate on congested roadways [7]. To accommodate bicycle lanes, wide-curb lanes or paved shoulders along roadways is reduced and narrowed where widening is impractical. This can be implemented when roadway capacity exceeds the demand.

This section describes how roadway design practices can help to enhance the efficiency of transportation system through the reallocation of road space, such as shifting the road space from motorized traffic to the non-motorized one, which is the bicycle mode. Figure 1 and Figure 2 show the flowcharts for the development of the reallocation of the existing roadway space for cycle lane’s diagnostic from the first step.

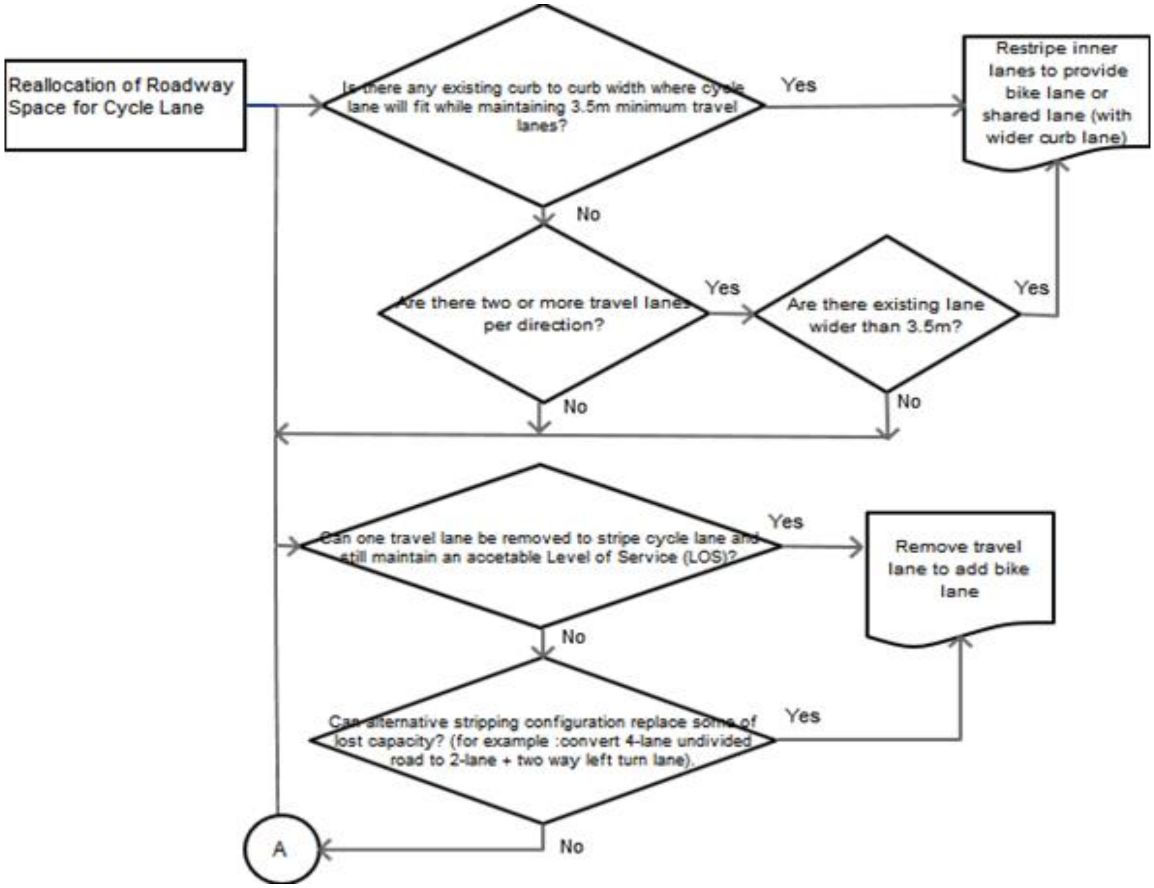

Fig 1 Advisory expert system for the reallocation of roadway space for cycle lane

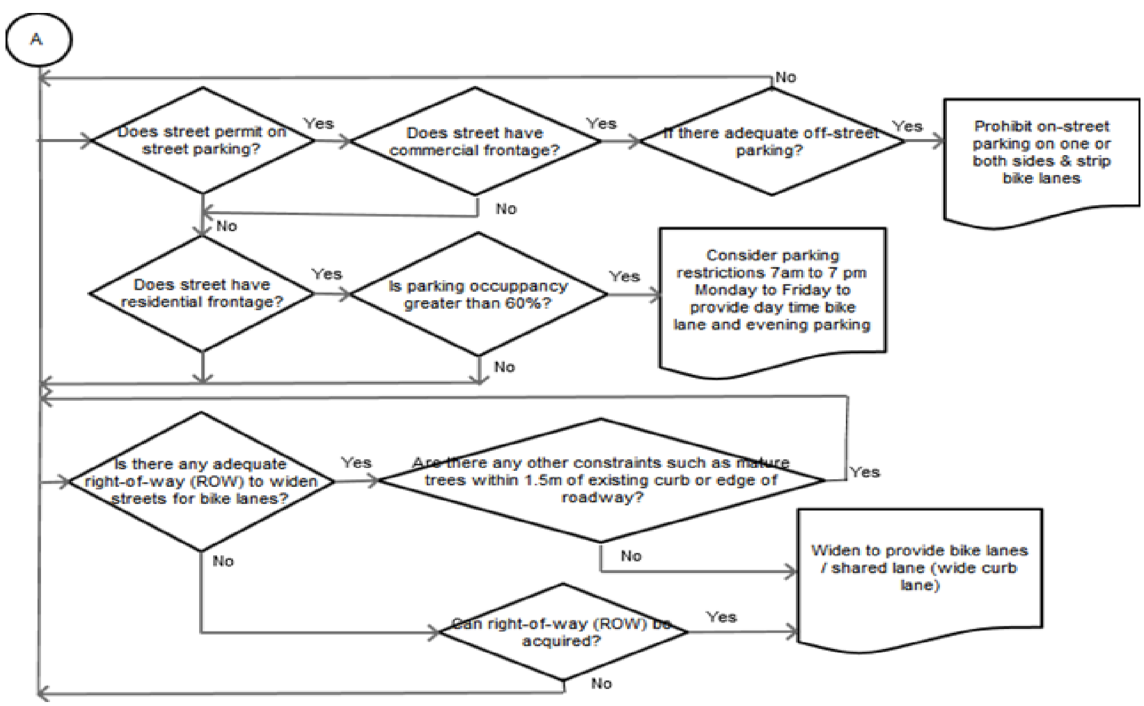

Fig 2 Advisory expert system for the reallocation of roadway space for cycle lane (continued)

The analysis of the data acquisition process is based on interviews and a number of case studies conducted at several locations in Klang Valley to form the items for the redistribution of existing available road space for cycle lane.

E-ACTIVETRANS APPLICATION

The findings of the study were translated using the interface of the E-ACTIVETRANS advisory system under the bike design module: Reallocation of Existing Lane. The interface display for the beginning of access to the bike system design advice system is shown in Figure 3.

Fig 3 Interface to the access of cycle lane design

The findings of the study were translated using the interface of the E-ACTIVETRANS advisory system under the bike design module: Existing Redistribution of Available Space. The interface display of this module is shown in Figure 4.

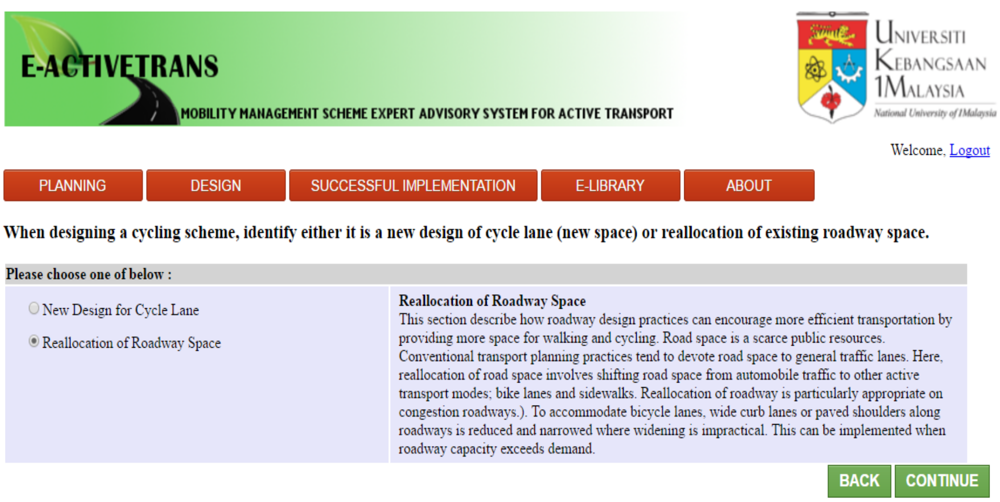

Fig 4 Interface for selecting the reallocation of road space menu

For the user who modifies the existing roadway to the bicycle route, he/she must select the 'REALLOCATION OF ROADWAY SPACE' button, as shown in Figure 4. Evidence of the reallocation of available road space to cycle lane is described on the display as a guide to consumers. Once the user is convinced with the menu option, the user just needs to press the CONTINUE button to the next view, as shown in Figure 4.31.

Figure 3 explains how existing road design practices can provide space for cycling. Here, the user should choose the answer button based on the displayed questions sequentially until the user's answer option for the assigned question issues a decision as an advice to the user in designing a bicycle/walking path via the existing traffic space. The user will be advised based on the current situation selected through the answers to each question shown.

Fig 5 Display results from answer choices based on existing road criteria

VALIDATION, VERIFICATION & EVALUATION (VVE) PROCESS OF E-ACTIVETRANS

VVE refers to Verification, Validation, and Evaluation that form a process of expert system evaluation tested either in terms of conformity or in terms of how it is presented. VVE testing in computer engineering is a process that improves a developed design [8]. He also notes that the complexity and doubt in a study can cause the expert system to be inadequately or improperly tested.

i. Validation Process

When inputs are displayed by the system selected, the system will display information about the Reallocation of Roadway Space in the display box. The same statement will appear when the user goes to the next module under the reallocation of road space to display the user's answer option in designing the route based on the existing road criteria, as shown in Figure 5.3.

Fig 6 Result of interface according to the Reallocation of Road Space option

The display of information is the same although the user chooses different answers. When experimental methods are made on a variety of different answer options, the E-ACTIVETRANS system would still be consistent and stable in terms of the recommendations provided. This demonstrates that the stability and reliability of the developed E-ACTIVETRAN system is high.

ii. Verification Process

The reasoning rules of E-ACTIVETRANS were verified during system testing to ensure the validity of the system. A number of rules, including the logical errors is summarized in Table 1.

Table 1 Number of rules used in E-ACTIVETRANS

Single Rules

N	Condition (IF-Part)	Conclusion (THEN-Part)
1	If there is any existing curb-to-curb width where cycle lane will fit while maintaining 3.5m minimum travel lanes	Restripe inner lanes to provide a bike lane or a shared lane (with a wider curb lane)
2	If one travel lane can be removed to stripe cycle lane and still maintain the acceptable Level of Service (LOS)	Remove the travel lane to add a bike lane

Two Combined Rules

N	Master Rules	Condition (IF-Part) Operator	Sub-Rule	Conclusion (THEN-Part)
3	If there is no one travel lane can be removed to stripe the cycle lane and cannot maintain an acceptable Level of Service (LOS)	AND	If an alternative stripping configuration replaces some of the lost capacity (i.e. convert a 4-lane undivided road to 2-lane + two-way left turn lane).	Remove the travel lane to add a bike lane

4	If there is an adequate right-of-way (ROW) to widen streets for bike lanes	AND	If there are no other constraints such as mature trees within 1.5m of the existing curb or edge of roadway	Widen to provide bike lanes/shared lane (wide curb lane)
5	If there is no adequate right-of-way (ROW) to widen streets for bike lanes	AND	If right-of-way (ROW) is acquired	Widen to provide bike lanes/shared lane (wide curb lane)

Three Combine Rules					
		Condition (IF-Part)			(THEN-Part)
Master Rules	Operator	Sub-Rule	Operator	Sub-Rule	Conclusion
If there is no existing curb to curb width where cycle lane will fit while maintaining 3.5m minimum travel lanes	AND	If there are two or more travel lanes per direction	AND	If there is an existing lane wider than 3.5m	Restripe the inner lanes to provide a bike lane/shared lane (with wider curb lane)
If there is a permit on street parking		If the street has commercial frontage		If there is an adequate off-street parking	Prohibit on-street parking on one or both sides & strip a bike lanes
If there is no permit on street parking		If the street has residential frontage			

The verification process occurs when the built-in E-ACTIVETRANS system shows consistent and stable input even if the selected menu changes.

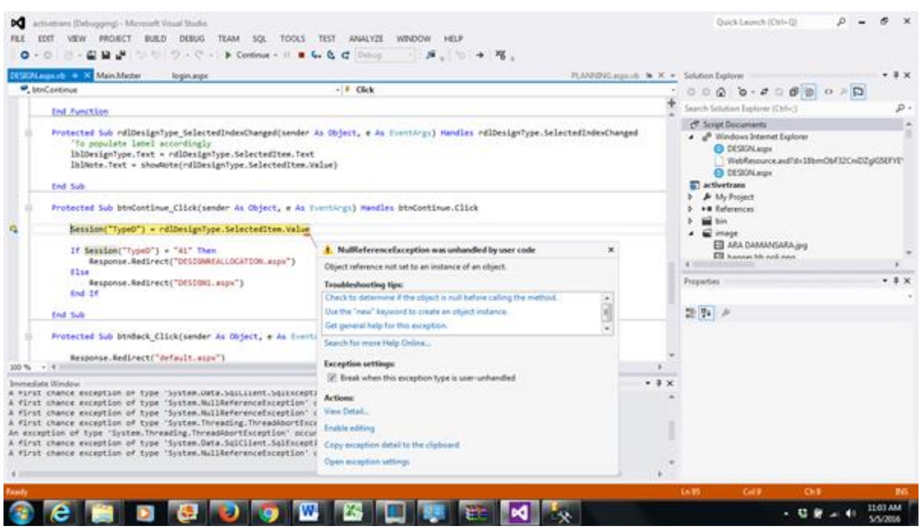

Fig 7 Verification interface using Visual Basic.NET

iii. Evaluation Process

Four (4) domain system experts provided their opinion on the validation process between the domain experts and the knowledge contained in E-ACTIVETRANS, as shown in Table 2.

Table 2 Evaluation of the domain experts for knowledge contained in E-ACTIVETRANS

Module	Expert 1	Expert 2	Expert 3	Expert 4
Module 1	88	100	93	98
Module 2	96	93	92	95
Module 3	93	90	96	87
Module 4	92	88	90	91
Module 5	82	84	90	88
Overall	90	91	92	92

The overall acceptance levels of experts show that the acceptable range of the expert system is at an average of 91.1%. Since E-ACTIVETRANS is an abstraction of reality, perfect performance cannot be expected (O'Keefe, 1987).

CONCLUSION

The Verification, Validation and Evaluation Process (VVE) for the development of E-ACTIVETRANS has been highlighted in this paper. Overall, the E-ACTIVETRANS presentation is effective and satisfying in assisting engineers and new designers in generating decisions. The developed E-ACTIVETRAN system is able to advise and propose solutions to existing problems in parallel with experts' decision. For the evaluation process, the data showed that 91.2% of the advisory system for the planning module is user-friendly based on an end-user rating system that produces an evaluation of this system.

On the whole, the E-ACTIVETRANS presentation is useful and substantial in assisting engineers and new designers in making decisions.

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