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A Computer Clone of Human Expert for Mobility Management Scheme (E-MMS): Step toward Green Transportation

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Abstract. Green transportation refers to a sustainable transport that gives the least impact in terms of social and environmental but at the same time is able to supply energy sources globally that includes non-motorized transport strategies deployment to promote healthy lifestyles, also known as Mobility Management Scheme (MMS). As construction of road infrastructure cannot help solve the problem of congestion, past research has shown that MMS is an effective measure to mitigate congestion and to achieve green transportation. MMS consists of different strategies and policies that subdivided into categories according to how they are able to influence travel behaviour. Appropriate selection of mobility strategies will ensure its effectiveness in mitigating congestion problems. Nevertheless, determining appropriate strategies requires human expert and depends on a number of success factors. This research has successfully developed a computer clone system based on human expert, called E-MMS. The process of knowledge acquisition for MMS strategies and the next following process to selection of strategy has been encode in a knowledge-based system using a shell expert system. The newly developed computer cloning system was successfully verified, validated and evaluated (VV&E) by comparing the result output with the real transportation expert recommendation in which the findings suggested Introduction

1. Background

Demand for travel increases with the assumption that private cars are easy, comfortable, door to door services and judge by traveller as the only solution for mobility. In addition, supplies for infrastructure development such as roads are significantly increase and this is proportional to the increase in traffic volume. At one point, the supply will not be able to meet demand, due to certain factors such as budget problems, limited land or space. According to Frame, 2010 [2], It has become unacceptable that an uncontrolled traveling using private cars in urban areas cannot be accommodated. This is due to concerns about cost factors and the adverse impacts of traffic on local communities and the environment. If we let traffic grow to a level where there is a chronic and widespread congestion and often occurs on certain sections then it will economically become inefficient. On the other hand, although the construction of new roads to increase road capacity may reduce some of the effects of congestion but the benefits can only be matched by the growth of controlled traffic volume. Therefore, another alternative is to implement the Mobility Management Scheme (MMS), i.e. to ensure that people are still traveling but at the same time reducing the use of private cars [5]. In addition, the MMS application initiative will encourage people to reduce the number of trips they travel, travel frequently but use alternatives to driving alone, riding outside peak hours, and overall reducing the length of the trip they make. The main purpose of MMS is to minimize travel by private vehicle during peak hours and at the same time reduce



the need for new road construction. On the other hand, MMS measures make driving alternatives more attractive, build a positive public attitude towards these alternatives, and provide information and incentives to encourage responsible travel behaviour.

1.1. Defining MMS

The Mobility Management Scheme (MMS) and Vehicle Miles of Travel [VMT] refers to a policy and program that can transform travel activities to achieve planning goals and improve the efficiency of a transportation system [5]. The size of an MMS consists of various types of interventions, especially in urban areas that aim at reducing transportation demand in the morning peak until afternoon peak hours or during a certain period.



Figure 1. MMS promote efficient use of street space.

2. How Computer Clone of Human Expert Can Help Us

In recent year, the MMS application guide manual has increasingly accepted as a tool for reducing traffic congestion during peak hours and reducing air pollution problems. A number of documents are available to guide people in implementing and marketing MMS programs, but few guidelines are offered regarding MMS program planning and how to select appropriate and efficient MMS strategies. Consequently, many MMS strategies are ineffective and developed with inefficient trial and error. Furthermore, the implementation of an MMS strategy requires an expert, as with their knowledge they can provide advice on the most appropriate MMS strategy based on location details. Unfortunately, very few expert people can be consider as expert, and are unlikely to be available at all times. These experts are not always there, nor do they always have time to consult all possible references, review existing data, etc. [3]. This will lead to time-consuming scheduling and interview scheduling, thus delaying a project. There is also the possibility that there may be no experts left behind after death, as most of them are in elderly age. Later on, it is a burden for Junior Engineer to refer to the book as part of their references to find solutions in implementing MMS [3]. On the other hand, Md Nazrul Islam [3] stated also in his research that the computer clone of human expert system has the potential to capture such expertise. The development of a computer clone of human expert system is designed to help employers, developers, junior transportation engineer, city council officer, property owners and managers, transportation management associations (TMAs), and MMS consultants. This a computer clone of human a computer clone of human expert system suggests a process for MMS development and implementation, and offers guidance and advice on the selection of effective MMS strategies. It will help to give specific description to choose a more effective MMS program in less time and with less frustration. It provides an overview of the "big picture" of MMS strategy, and then guides us identifying what strategies make sense for us, and in determining how much of those strategies we need to achieve a desired or required trip reduction.

In summary, development of a computer clone of human expert system for implementing suitable strategy in MMS in order to assist junior engineer and the policy maker in MMS would be a valuable tool. The development of a computer clone of human expert system requires both knowledge from transport and software engineers. Software engineers will develop a computer clone of human expert system based on civil engineer's knowledge, sources from books and interview expert persons for

implementations of MMS. Therefore, it is crucial to have knowledge from both fields in order to develop a computer clone of human a computer clone of human expert system as neither can do it alone.

3. A Computer Clone of Human Expert System Architecture

3.1. Knowledge Engineering

There are currently two ways of building a computer cloning of human expert. They can built from zero, or using development software known as "shell". Although there are different styles and methods of knowledge engineering, the approach was the same, knowledge engineers (KE) interview and observe human expert or a group of expert people as domain and know what their intellectual think, and how they practice their knowledge. KE then translate that knowledge into computer-usable languages, and design inferencing machines, the structure of reasoning, which uses knowledge appropriately. KE will determines how to integrate the use of uncertain knowledge in the reasoning process, and what kind of explanation is useful for the end user. The next step is the inference engine and the facility to represent programmed knowledge, and domain knowledge will put into the program piece by piece. At this stage, the inference engine may be incorrect; the awkward form of knowledge representation for the kind of knowledge required for the task; and expert people can decide that piece of knowledge is not correct and finally discovered and modified as the computer cone of human expert system gradually gains competence.

In this project, the knowledge base of the computer clone of human expert system represents expertise in the domain of advice on MMS strategies. Expertise has been acquire and codified in the form of a production rules, an object entity in a particular hierarchy. In this project, knowledge base of computer clone of human expert system represents expertise in the domain of advice on MMS strategies. The expertise has been acquired and codified in the form of production rules, object entities in a specified hierarchy.

3.2. Knowledge Acquisition of E-MMS

The Victoria Transport Institute handbook and encyclopedia, Kuala Lumpur City Council Plan 2020 in MMS section, expert domain and practitioners of MMS in South East Asia accumulated massive knowledge about from its involvement and experience planning and devised of MMS practice and application in many countries in the world especially in SEA. Those parties involved in massive knowledge as stated above are primary knowledge source for this reserach.

3.3. Knowledge Abstraction and Representation of E-MMS

In a computer clone of human expert system, knowledge means the information that a computer system needs before a computer clone of human expert system can be intelligent. It needs to extract it first from the source of knowledge and then represented in a way that can be manipulate by the computer very efficiently. One is using rule-based representation. This method uses the conditions of IF and THEN statement actions to represent knowledge. When conditions in the IF section are met or adjusted, the rules will be eliminated and the actions determined by the THEN section are then triggered. Another representation method of knowledge is frame-based. It uses a network of classes and instances that are link by a relation and organize into a hierarchical structure. Figure 2 shows the relationship between classes and samples.

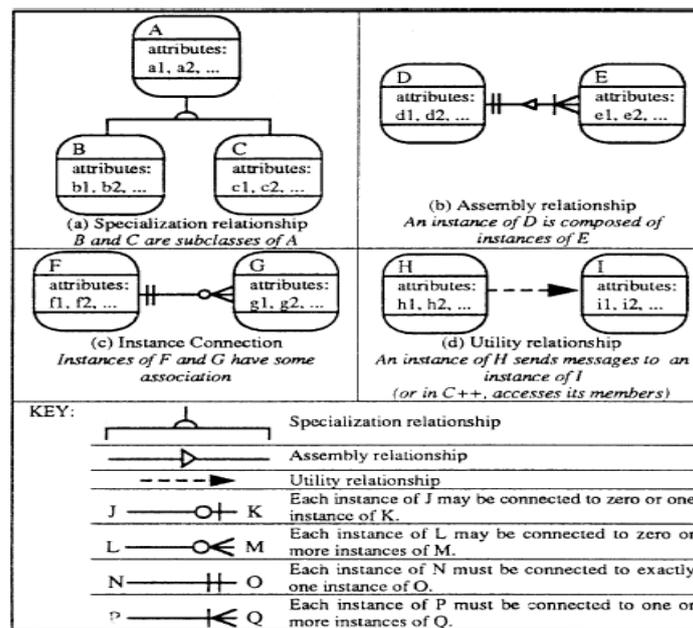


Figure 2. Class and instance relationship

Each node is represented by a concept that can be translated by attributes and/or values associated with that node. The topmost node represents the general concept and the node underneath represents a more specific concept. In this research, a shell-based software has been used. This software supports both methods of knowledge representation. However, the nature of the computer clone of human expert system in MMS makes this frame-based representation more efficient and broad-minded. In a shell software environment called Kappa-PC, the taxonomic process is following a common format as shown in Figure 3 below:

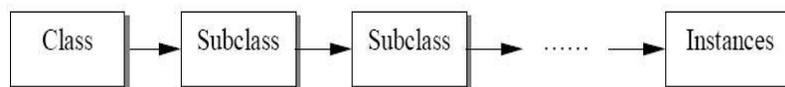


Figure 3. General format of taxonomic process.

In the system applications, the uppermost class was labeled as MMS, which has a broad meaning and includes all the strategies involved in MMS. Furthermore, it is group into nine (9) subclasses: congestion reduction, energy conservation, health and fitness, equity enhancement, livability strategies, parking solutions, rural communities, safety strategies, and affordability. All of these subclasses represent the main objectives in the MMS strategy application. Each of the nine (9) subclasses is divide into three (3) more detailed subclasses, which are part of the main categories of MMS namely better transportation options, incentives to use alternative modes and reduce driving, and land-use management. The final subclasses represent eight (8) geographical areas for each three (3) previous subclasses; large urban, urban, suburban, town, rural, commercial center, residential, and resort. Under each geographical area subclass, there are three (3) instances indicate the most suitable MMS strategies to be implemented according to its hierarchy. Details of the selection process suitable MMS strategies to be implemented in appendix.

3.4. Tools, Shells and Skeletons

There are many tools exist in developing a computer clone of human expert system. Three main categories are divided in the major tools used in practice:

- Programming language

- Programming environment
- An expert system shells

Selection of Kappa PC software is due to suitability in designer mode, which gives the knowledge engineer the possibility to code the knowledge base in a graphical (easily readable and editable) way that follows the latest trends in user interface. It lets the engineer decide what method to use for coding the knowledge, thereby addressing more complex problems. There is an opportunity to evaluate the shell system being built prior to the proposed advanced development, i.e., with access to a series of sample applications, and this has been recommended as a fairly effective tool for development. Experience throughout the study using the same shell system has shown that there is a high degree of confidence in the use of Kappa-PC [4], and this is a useful tool for developing an understanding of expert systems. An important issue was the prototype development process that utilized Kappa-PC as platform in a computer clone of human expert system shell (as the building-tool). Expert system shell was preferred since it offered the advantage of ease of manipulation, increased productivity and a true windowing capability to run on personal computers. Building a computer clone of human expert system shell offers significant advantages. A system can be built to perform a unique task by entering into a shell all the necessary knowledge about a task domain. The inference engine that applies the knowledge to the task at hand is built into the shell. If the program is not very complicated and if an expert has had some training in the use of a shell, the expert can enter the knowledge himself.

3.5. Domain Acquaintance

It is important for a knowledge engineer (KE) to gain a good understanding of the domain to enhance the building of the prototype with respect to its feasibility and evaluation [1]. The first and foremost step for the knowledge engineer is to gain knowledge engineering skill.

3.6. Domain Expert

The domain or area expert is an articulate, knowledgeable person with a reputation for producing good solutions to problems in a particular field. The expert uses tricks and shortcuts to make the search for a solution efficiently, and a computer clone of human expert system models these problem-solving strategies. A person's ability to serve as a domain expert will depend on characteristics such as the ability to explain important knowledge or heuristics, be introspective, be patient, and communicate effectively. There are broad categories of expertise sources to be identified and selected from: textbooks and manuals written by experts and related professional institutions; experts involved in the domain; and research papers from journals and conferences. The advantages of multiple sources of expertise are as follows: bias towards a single view will be avoided; conflicting views manifested by several different experts provide a genuine picture of uncertainty of the subject matter or indicate that further research is required; the knowledge engineer will not be bound or handicapped by availability constraints of any one source of expertise; and completeness of knowledge will be readily achieved.

3.7. Source of the Knowledge Base

The main knowledge was obtained through communication with the transportation experts and engineers who involved directly with the MMS strategy and implementation. The domain experts were selected from experienced MMS planner from several countries in South East Asia. More than 30 transportation experts involved in this project. These experts were chosen from individuals who were currently practicing MMS in their city and some transportation expert from university who had involved in transportation field for many years. On the other hand, the selection of domain experts also critically depending on the expert's availability (time), possess of good communication skills, willingness to participate, and acknowledged as expert by the community or by their peers. Due to time constrains, most of the interview and consultations with the domain experts were done through questionnaire and if knowledge engineer successful to interview the expert, it is done informally and not recorded by tape due to certain reason that expert's not comfortable if the interview recorded by tape. The questionnaire was designed in such a way to covered all nine main objectives in MMS which were obtained previously through different sources from text books and manuals

3.8. Object Representation of E-MMS

The object browser window in Figure 4 represents the top-level hierarchical in the object model developed for the E-MMS domain. The class E-MMS represents the overall prototype that is comprised of nine major subclasses.

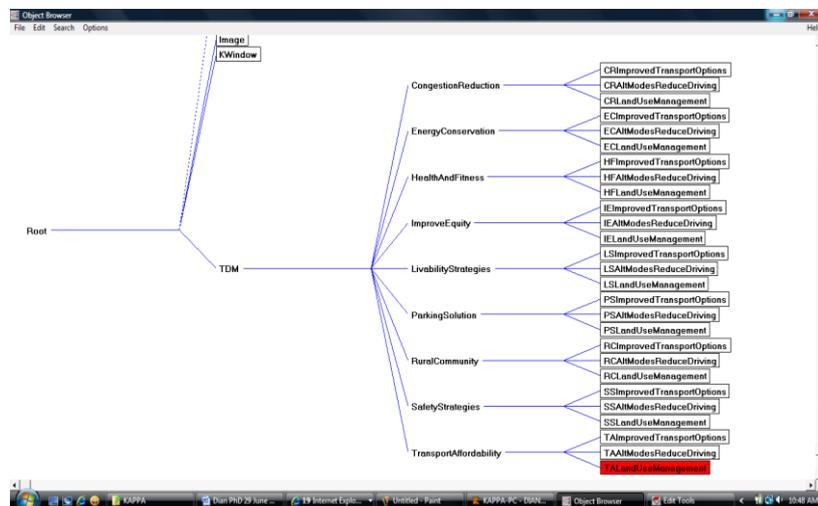


Figure 4. Top-level object hierarchy of the E-MMS.

3.9. User Interface Design and Example of E-MMS Module

Kappa-PC provides powerful tools for creating graphic user interfaces. In addition to session windows, predefined images, custom menus, and dialog windows, it can import Visual Basic (VBX) controls to meet knowledge engineer’s specific requirements. The graphic user interfaces started with general information interface which is the first window invoked after the E-MMS is launched, as shown in Figure 5. It contains information about the E-MMS title, developer, version series number, and development date.



Figure 5. General information interface.

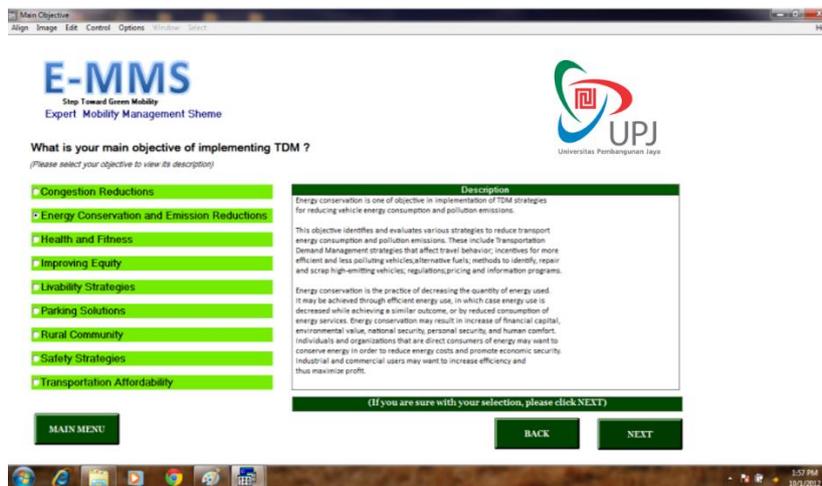


Figure 6. Screen snapshots example of one module in E-MMS

Furthermore, when all instruction in E-MMS has been applied, finally system will give advice strategy summary (Fig. 7) which show the travel impact, benefit and equity if the strategy chosen will be implemented. Based on the travel impact summary, user can easily to identified how effective reduction of trip or total traffic which is stated in the summary using the rating scale; rating from 3 (very beneficial) to -3 (very harmful); 0 indicates no impact or mixed impact on the objective if user implement this strategy. If the user can confirm this strategy is the most suitable strategy, then it is necessary to clicking PRINT button to viewing window spawns a notepad text editor with analysis result (rating scale).

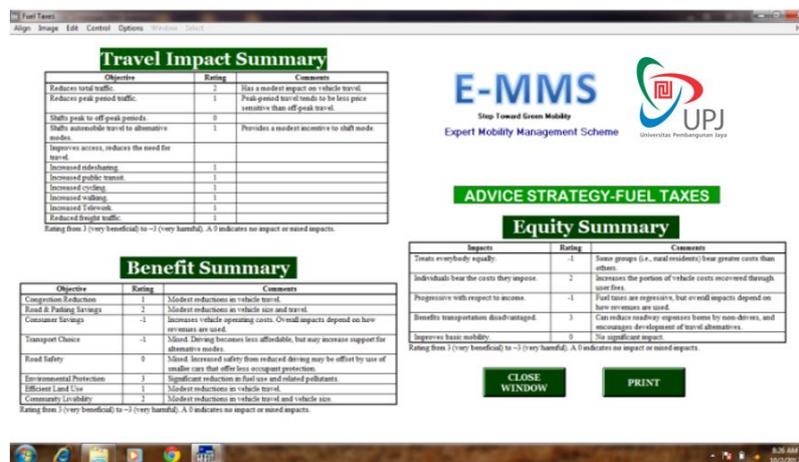


Figure 7. Impact summary interfaces.

4. Verification, Validation and Evaluation (VVE)

The prototype testing or validation is the process of evaluating the performance and utility of the program and revising it as necessary. Testing the prototype also involves looking at the ease of handling the user interface and understanding the explanatory text [1]. The verification starts with learning the behavior of E-MMS under different sub-module in order to studied the consistency and stability of the system. In the E-MMS, there are nine different sub-modules which are dealing with the same specific aims to achieve main goal or objective of MMS strategies. The first scenario was the application of first sub-module under Congestion Reduction and applied to specific aims of Improve Transport Option. When the input was selected then the system will have presented the description of Improved Transport Option in the dialog box. This description should appear as same information when input was selected for second sub-module for Energy Conservation with same specific aims (Improved Transport Option). The results were identical between the different input scenarios. When testing continued to the other

seven sub-modules, the E-MMSA still maintain the consistency. Hence, this reflects high stability and reliability of the developed system. The validation result shows that more than 60 %, or exactly 69 % matched between E-MMS decision and evaluators who are also transport specialist. The result of 69% has been exceeded the level of performance which is expected will be only 50-60 % matched since the strategy is very subjective to evaluate and every single expert either domain expert or evaluator who involved in validation process has different experiences in implementing of MMS strategies. The percentage accuracy in this system is the level of performance that is acceptable to the users is called the acceptable range of performance, and should be specified at some stage of development [1]. It can be specified by a third party, a government agency or the project sponsor. In this case, an acceptable range performance had been specified by a government (DBKL) with range of 50-60% during knowledge acquisition process. This is indicating that the possibility of using the E-MMS as expert system is encouraging. Thus, we can say that the system developed has achieved the purpose that it was designed for. Generally, the flow of the consultation session or advice session between user and the E-MMS system was satisfactory. The user was able to learn every single description in MMS strategy and able to obtain recommendations given by the system. The system also allowed the user to view the impact of result before make decision on the appropriate MMS strategies to be implemented in particular situation based on the input selected. The E-MMS interface was built to accommodate all parameters and variables as stated above and the interface built was considered to be adequate in its design and functioning.

5. Conclusion and Recommendations

5.1. Conclusions

The successful development of an expert system for implementations of MMS demonstrates that the application of a computer clone of human expert system in this domain is promising. Frame-based knowledge representation method in conjunction with the power of object-oriented programming enables the knowledge to be abstracted and represented for the computer to manipulate efficiently and for the knowledge engineer to update the knowledge base with great flexibility. Since the knowledge in this domain is dynamically growing, the E-MMS is by no means complete at this stage.

5.2. Recommendations

The knowledge in MMS strategies are constantly growing and their effectiveness relies on the country itself. The developed E-MMS must also reflect the latest information in this domain. Therefore, it is necessary to periodically assess the new knowledge and loaded to the knowledge base of E-MMS. A newer version of E-MMS may consist of new and updated information and the implementations of MMS strategies and must be reflecting the condition and situation of study area.

6. References

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