OVERVIEW OF EXPERT SYSTEM APPLICATION IN URBAN BUS IN TRANSPORTATION ENGINEERING

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ABSTRACT

The purpose of this paper is to determine the expert system developed from past research. An overview of the expert system indicates that the use of system slightly affects the results. A researcher can make a decision on what system should be conducted by planning a research design. The main components categorised for this paper are first, the knowledge-base which is obtainable inference engine drawn by conclusions from the knowledge-base, the summary from the understanding, and then only the benefits of the system can be determined.
Keywords: expert system; quality of services, bus performance

INTRODUCTION

The expert system is subject to smart computers that basically can solve any intriguing difficulties and transportation engineering problems. Generally, the expert system is about incorporating human expertise into a computer program in order to solve any problems that require a human expert (Spring, 1997).

In order to use the expert system, planning and operational should be identified first (Popović & Jović, 2006). The purpose of planning is to determine the margins of sharing specific transport modes. For the operational purposes, to provide a survey of parameter values is by performing in the existing state or a short-term forecast for these parameters.

For identifying the characteristics of the expert system, Wentworth (1993) conducted a survey regarding the classification by functioning four very broad groups which are traffic management control, traffic impact and safety, highway design and planning, and highway management. All these boards are surveyed according to their type of function.

Definition of Expert System

An expert system is a computer system that emulates or acts in all aspects of the decision-making capabilities of a human expert. Generally, the system contains knowledge-base that accumulates experience and set of rules for applying the knowledge-base to each particular situation described in the program (Rouse, 2005).

Objective to use expert system

An expert system is currently used as a supportive method developed for the best result. This paper currently searches for the knowledge of the building process of an expert system as follows:

1. The knowledge engineer establishes a dialog with the human expert to elicit knowledge.
2. The knowledge engineer codes the knowledge explicitly in the knowledge-base.
3. The expert evaluates the expert system and critiques the knowledge engineer.

Expert system evaluation process

Spring (1997) stated that developing expert system should be done together with the evaluation process. The evaluation process employed for expert systems differs substantially from that used for traditional software projects and is more problematic, mainly because of the nature of problems solved by the expert system.

Three processes should be measured which are verification, validation, and evaluation. Verification is the consistency, completeness, and correctness of the software; hence, for software, it totally determines if the system was built according to specification. Meanwhile, the validation is about the concerned with the quality of the conclusions. Thus, it focuses on the effectiveness of the system. A commonly borrowed phraseology to describe the difference between verification and validation is that verification is concerned with building the system right, whereas validation is concerned with building the right system. Meanwhile, for the evaluation process, the concerned is on the user issues which are user acceptance and system usefulness. Therefore, with all the respects mentioned above, it can be expressed that validation is the cornerstone of the system evaluation process and the most difficult component to accomplish.

Table 1 Overview of Expert System in Transportation for Urban Bus Application

JOURNAL	KNOWLEDGE-BASE SYSTEM	PROBLEM	ADVANTAGE	PROCESS/PROCEDURE
Knowledge-Base Expert Advisory System for Transport Demand Management	**Kappa-PC version 2.4**	Transport Demand Management	Decision support system as well as a teaching tool for junior transportation engineers, planners, private developers, and government officials.	The first step is to create hierarchy from TDM strategies towards specific objectives, main purpose, choice of area, and the final three pieces of advices.
Combining Geographic Information Systems for Transportation and Mixed Integer Linear Programming in Facility Location-Allocation Problems	**TransCAD® (eographic Information System for Transportation (GIS-T))**	To assess the solution quality for location-allocation problems from facilities generated (Location-allocation problems)=location problem	GIS possesses the ability to handle larger problems with more variables and candidates involved, as their routines are based on heuristic methods	The first step includes the Facility Location routine, which identifies the best facility locations (proposing entering new units or closing existing ones, or both), and proceeds to allocate between supply and demand but without considering the full operation for the facilities.
Geospatial Analysis of Road Transport System in Peri-Urban Areas of Ibadan, Nigeria	**Geospatial technology which consists of Global Positioning System (GPS) and Remotely Sensed Images**	Many of the existing roads were without a drainage system, a situation which has serious implication for effective road transport system and quality of life.	Geospatial technology offers a wide range of innovative and cost-effective solutions for environmental sustainability; hence, many countries now appreciate the relevance of geospatial technology in the sustenance of our environment	The data processing techniques adopted include, data evaluation, georeferencing and mosaicking, data sub-setting, feature extraction, terrain modelling, road maps update from satellites images and integration.
Developing a Web-Based Advisory Expert System for Implementing Traffic Calming Strategies	**CALMSYS = Microsoft Visual Basic.NET**	Speeding and nonlocal traffic in residential streets are major safety problems in residential streets. Conventional traffic calming manuals normally deal with only speeding and thru traffic, while traffic calming strategies have the ability and potential to handle wider ranges of traffic safety problems in residential streets. Safety	1) Develop in classifying the strategies and solutions in traffic calming subject, 2) Ability to assist engineers in finding proper traffic calming strategies about traffic safety problems, 3) Can help in handling better and more successfully by computerised system than by human experts due to the presence of many data received, and 4) The capability of VB.NET to build a web-based expert system.	For developing the expert system Microsoft Visual Basic.NET was used. The main advantage of this version over VB 6.0 is the capability of VB.NET to build a web-based expert system. Generally, Visual Basic software is an easy to learn and flexible language that enables developers to code and create GUIs (graphical user interfaces)

Concept of Expert System for Modal Split in Transportation Planning	**EXSYMS (Expert System for Modal Split)**	develop expert system based on experts opinion and experience (transport system demand and transport supply)	1) This expert system could be of use both to experts and less experienced planners who could apply the knowledge contained in this expert system for further improvement, on operational as well as on strategic level, and 2) Determining a framework in which modal split modelling1 is feasible.	The Essential Base was enlarged by correlating PT travel time (tt) with the time spent on the vehicle (t1). In this way, by applying regression analysis, dependence equations of specific transport mode share upon PT travel time (tt) were provided
A multimodal automated fare collection solution for facilitating strategic information technology planning of public transportation in Malaysia	**Automated Fare**	Public transportations must remain sensitive and responsive to the rapidly changing environments and technologies, thus taking an active approach to manage the fare collection and transportation services	1. Reduce maintenance and operational costs, 2. Increase transaction throughput for the travellers, 3. Reduce fraudulence activities Innovations of ticketing and fare options, and 4. Flexible fare pricing.	
RFID-based Ticketing for Public Transport System: Perspective Megacity	**Radio Frequency Identification (RFID)**	Tracking the transit transports and for the public ticketing system. The tracking and ticketing systems using RFID can be merged to solve the prevailing problems.	RFID provides a better system with good in all aspects. RFID tickets currently achieve almost 100% read rate. Thus, RFID is significantly more reliable and leads to a reduction of operation. The RFID tickets provided low cost, easy operation, portability, durability, reliability and being much more user-friendly.	1) The reader will read the RFID tag attached to the rear side of the bus that is denoted as the rear tag, 2) Also the reader being connected to the main server, the data will automatically transfer to the server database, and 3) The screen in the bus will notify the next destination where the bus is going to stop as well the number of passengers sitting on the bus.

Multilevel and Coordinated Self-management in Autonomic Systems based on Service Bus	**Autonomic System**	The existing approaches do not allow to coordinate the activities of multiple autonomic managers based on distributed coordination	First, the responsibility and dependencies of each component may be well defined and easily understandable. Second, the singularity of purpose of each component renders the overall system easier to customise by different policies and to evolve. Third, the focus on a single purpose leads to components that can be implemented differently in several contexts and managed by disparate development teams (e.g.	1) The management processes performed by autonomic managers may scale to a high number of autonomic managers, (2) The opacity of management process details is desired in the management of systems belonging to different organisations, (3) The different management processes require their own customisations performed by experts in many application domains and technologies, and (4) The different self-management processes are highly dynamic or goal-seeking.
A two-factor evaluation of bus delays based on GIS-T database and simulation	**Geographic Information System for Transportation (GIS-T)**	Traffic congestion is an existing part of transport system, though its specific definition and identification is not immediately obvious	1) Simple and convenient interface, 2) Providing the advanced signal control mechanism, 3) Customised results so that the data collection speed can be controlled by user though adjusting the sampling time, and 4)	Four major steps: first of all, the collection of the spatial and attribute data should be done previously, then the transformation is needed to translate the raw data for system input, thirdly, the computer techniques are necessary for visualisation and graphical representation; finally, the multimedia such as the images, video and sound should be connected to the GIS-T database to support the application.

Decision Support System for Transport Demand Management	**KAPPA PC 2.4**	TDM measurement (Supply and Demand	1) Friendly use and it does not require the user to have experience or knowledge on programming to use it. 2) Help young and fresh engineers and planner in their decision making, and 3) Help young and fresh engineers and planner in their decision making	The first step is to create a hierarchy from TDM strategies towards specific objectives, main purpose, choice of area, and the final three pieces of advices.
Impact of IEC 61850-9-2 Standard-Based Process Bus on the Operating Performance of Protection IEDS : Comparative Study	**Intelligent Electronic Devices (IEDs)**	Performance of the Process Bus	1) Reduction in the overall cost of substation protection, automation, and control system since the cost of numerous copper conductor also is reduced 2) the system safer to use and the IEC 61850-9-2 permits wide availability of measurements to individual protection IEDs.	The process level takes care of the data acquisition using instrument transformers. The output of these instrument transformers are sampled, converted to digital representation, and formatted for subsequent transmission through the Process Bus Local Area Network (LAN)

Automated Fare

Introduction

The automated fare collection was introduced by using smart card technology and electronic payment system. Noor (2008) explored the essentials of integrating effective information technology management into the public transportation strategic information technology planning. The planning involves on why it is essential to integrate effective information technology management into the public transportation strategic information technology planning. The reason why the strategic information technology planning is needed is that the system is a core instrument of communication within organisations and externally to both stakeholders and customers.

Function

Basically, the function of automated fares is it eases the seamlessness of multi-modal passengers to travel. The automated fare collection could address many of the key issues, especially in regard to fare collection that is faced by the public transportation agency.

Advantage

With all the motivation and opportunities that drive the multi-modal automated fare collection solution, several rationale benefits from the system are as follows:

1. Reduce maintenance and operational costs
2. Increase transaction throughput for the travellers
3. Reduce fraudulent activities of ticketing and fare option innovation
4. Flexible fare pricing

Other Application of Expert System in Transportation Engineering

Autonomic System

Introduction

The autonomic system introduced by Zouari, EDiop, and Exposito (2014) as multilevel and coordinated self-management system have properties at runtime, according to fluctuations in the environment and changes in users' requirements. The autonomic consists of several autonomic managers (AMs) as the system can manage elements that run in heterogeneous and distant environments. This software is currently used in architectures where the coordination of multiple autonomic allows managers to handle several component-based and service-oriented collaborative software entities.

Function

This system allows the integration of pervasive, distributed, and networked systems, which are a composition of heterogeneous services and software components. Moreover, these systems are developed progressively following a service-oriented architecture (SOA) approach. Then the Enterprise Service Bus (ESB) is used in allowing the integration of pervasive, distributed, and networked systems. Consequently, the ESB may integrate a large number of parallel and concurrent systems.

Advantage

Based on Zouari et al. (2014), autonomic computing allows the self-management of system properties at runtime according to fluctuations in the environment and changes in users' requirements.

Moreover, these distributed systems are being developed more following a service-oriented architecture (SOA) approach and (ESB) is used to allow the integration of pervasive, distributed, and networked systems which are a composition of heterogeneous services and software components.

Mahmoud and Hine (2013) claimed that a data analysis process was carried out in three main stages such as the construction of AHP modelling of user preference, multi-criteria perception evaluation (WPI) and MANOVA. Firstly, users' preferences towards bus quality were derived by using the AHP modelling. AHP is a mathematical-based approach and the analysis of a typical AHP data-set is mainly carried out in eight steps and detailed as follows (Saaty 1996; Saaty & Vargas 2000):

Geographic Information System for Transportation (GIS-T)

Introduction

Zhang and Ren (2010) developed GIS as a computer-based system in which the system could manage the objects and their information with their spatial characteristics. Basically, GSI-T is a geographical information system for transportation created by combining the advantages of both GIS and TIS for geographic information to store, visualise, plan, and analyse transportation information.

Problem
The study aims to evaluate bus delays that are based on some factors which are traffic congestion, passenger's waiting time, and the bus line interaction research.

Function
For this study, the GIS-T was provided with detailed database information to support simulations. A digital map was coordinated to the system as a background map. The background map contained information on the block, road, railway, water area, and green area. Then, all the bus lines and bus stations were located on the digital map with the coordinates. Basically, the database of GIS-T consists of shapefiles that store the location and background information such as roads and bus stations. Personal geodatabase stores relation factors information, such as passengers' number and bus velocity. The primary bus transportation information is stored in TIS database and it consists of bus transportation structure and related information. The whole bus transportation network structure is based on a microscopic model. The location of bus stations and bus line was geo-coded. After that, the bus transportation structure in the TIS database was transformed into a digital map.

Advantage
The advantages of this software include the simple software and convenient interface. It is also a direct representation where the network is constructed on supported background pictures. Then, by providing the advanced signal control mechanism, it makes the simulations of crossroads intersection closer to reality. Other than that, the software usually customises the results so that the data collection speed can be controlled by the user through adjusting the sampling time. Besides, the software can be a seamless interface which the network constructed in VISUM would be imported into VISSIM to simulate. Meanwhile, the simulated VISSIM network ought to be transferred into VISUM to get a detailed graphical representation of cobweb graphs. In addition, the urban traffic simulation accuracy is well improved because of the innovative pedestrian simulation.

System Dynamics (SD)

Introduction
Developed by Abbas (1990), System Dynamics (SD) is a methodology of wide applicability and pioneered the use of system concepts and computer simulation for the analysis of complex problems. This system has become a modelling style that has been used by many different disciplines.

Function
This system provides a framework structure through which large-scale system can be easily accommodated. Other than that, the socio-economic and demographic forecasts are obtained with the use of separate modelling techniques. Then, the SD models also can easily utilise available data which are mainly required to initialise the model for a run. Besides that, by using SD for transportation modelling, the traditional sub-models are linked to each other and other subsystems simultaneously, rather than step by step. In addition, results of SD transport model are derived from the dynamic, casual, and feedback interactions of the structural components of the model.

Advantage

Case-Based Reasoning/Rule Based Reasoning

Introduction
The Case-Based Reasoning (CBR) can be defined as the program that acts as a solution to unsolved problems based on pre-existing solutions of a similar nature (CBR - Case Based Reasoning, 2014)

On the other hand, CBR is also known as brilliant techniques which can solve the human problem and new problems that can be solved by recalling and adapting the solutions of similar past problems. CBR is also one of the famous and active research areas due to its adoption by many companies (Michael M. Richter, 2013).

Rule-based reasoning (RBR) is used as a way to store and manipulate knowledge to interpret information in a useful way. RBC is also known as a simple pattern that matches patterns in the data (BusinessDictionary, 2014).

Function
CBR functions as Crew Scheduling From Planning, Crew Scheduling, Crew Attendance Management and Weekends Shift (Liu, Ma, Guan, Song, & Fu, 2012).

Advantage
CBR and RBR give some benefits including representing the rules neutrality that represents a method with a high level of comprehensibility. Then, the modularity which reflects a rule with discrete knowledge unit can be inserted into or removed from the knowledge-base. Other than that, it provides a compact representation of general knowledge (Prentzas & Hatzilygeroudis, 2007).

Comparison

Generally, Rule-Based Reasoning (RBR) and Case-Based Reasoning (CBR) emerge as two important complementary and reasoning methodologies in artificial intelligence (AI) especially in problem-solving. For RBR, it requires the domain model to elicit and explicit, while CBR is different as it does not require an explicit model. In addition, CBR is faster and easier when compared to RBR in terms of constructing a rule-base equivalent (Knowledge Engineering, 2007).

Benefits of the expert system

Overall, the expert system has its own benefits. The benefits are listed as follows:

- Increased availability
- Reduced cost
- Reduced danger
- Performance
- Multiple expertise
- Increased reliability
- Explanation
- Fast response
- Steady, unemotional, and complete responses at all times
- Intelligent tutor
- Intelligent database

Conclusion

The review of the expert system for this study expressed the importance of applying the modern technology into the research design. In analysing the transportation engineering, the most proper system had to be introduced during the research study. The system played an important role that affected the results achievement. Several systems may be used; however, not all the systems had appropriate criteria focused on the research study.

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