



## THE APPLICATION OF EXPERT SYSTEM: A REVIEW OF RESEARCH AND APPLICATIONS

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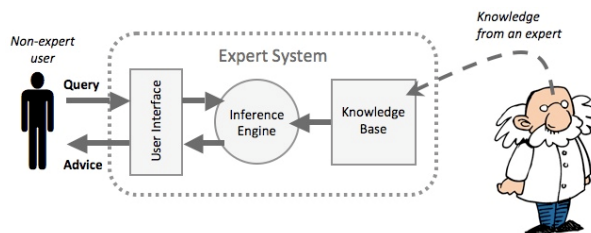
### ABSTRACT

The development of Artificial Intelligent (AI) technology system can be a wide scope; for an instant, there are rule-based expert system, frame-based expert system, fuzzy logic, neural network, genetic algorithm, etc. The remarkable achievement applications of AI has been reported in different disciplines including field of medicals, militaries, chemistry, engineering, manufacturing, management, and others. Its' discoveries and contributions through of AI study since the early 1970s were be significant step to enhance better performance of human work activities and probably replaced by these technologies. Today, there a lot of intelligent machine is available in everywhere such as airport gate scanner, movie theater counter ticket, vending machine, ATM machine, washing machine, etc. Expert system has been used widely in many areas and industries. This paper is described the current research and development of expert system.

**Keywords:** artificial intelligence, expert system review.

### INTRODUCTION

The discovery and development of expert systems recorded since in the early 1970s until today. The unique characteristic of the expert system is an explanation capability to review its own reasoning and explain its decisions (Hetem, 2000). It was built by extracting knowledge from human experts (Tan & Kher, 2012) as shown in Figure. 1 (Tan, 2007), to be applied in a computer program for knowledge processing so that it can deal with quantitative and qualitative data. Compared to other conventional program that require sequences of step prescribed called algorithm, expert system more intelligent as human being that allow inexact reasoning and can deal with incomplete data.



**Figure-1.** Simple diagram of expert system (Photo reprinted from (Tan, 2007).

Expert system programming can be categorized based of the particular subject area and it purpose of applications, as such type of diagnosis (Tan *et al.*, 2012; Tan *et al.*, 2013), repair, instruction, interpretation, prediction (Moorkherjee and Bhattacharyya, 2001), design and planning, simulation (Negnevitsky, 2002), reengineering (Asgharizadeh *et al.*, 2011), control, classification or identification and others many. Each type of expert system programming development would apply different rules, code, sequence of algorithm, interactive

method between user and program etc. These categories are not rigid because some cases of application may exhibit characteristics of more than one category as refer to Table 1.

The main objective of the development of an expert fault diagnosis system is to achieve an integrated diagnostic procedure for air-conditioning development. The research was done in a subsidiary of the largest automotive parts manufacturing group in Malaysia. The developed system is to diagnose problems in the product development process in the vehicle air-conditioning manufacturing company. The developed ES will trace the error and defect in the various phases in the development processes. The developed ES is able to shorten the product development time and increase the efficiency in the decision making process.

### RESEARCH ON EXPERT SYSTEM

An expert systems technology is to provide a mechanism for building the institutional or corporate memory of the firm. That is expert system are being used to preserve or document knowledge so that one's knowledge and experiential learning would not be lost once that individual retires or leaves the firm (Liebowitz, 1995). Therefore, the application of expert system knowledge in different field of discipline has been done and experimentally success by quite a lot of researchers. There are a few hundred or maybe thousand studies and development of an expert system for various different fields like medicals, militaries, chemistry, engineering, manufacturing, management, etc. The statistic data for the subject research of AI from year 1996s until 2012s as can refer in Table-2 and Figure-2 shown that there are positively increment number of researches. This data prove that more researchers or academicians from worldwide countries have highly concerned and actively involved in the studying areas of the AI. The Malaysian



academicians and researcher collaboration with the industrial sectors for the current last 10 years indicates the improved of ranking and percentage of number of researches. Compared to the 140 countries, the Malaysia in year 2000 is only in the rank of 60 and the rank improves to 18 in the year 2012. The benefits and contributions from development of AI, especially the expert system development program in any discipline of study become significant. One of the reasons the application of expert system is to provide better alternative solutions and assist the companies to struggle among the world competitive market challenges. In terms of the optimization whole process activities for product

development, its hope to prevent the losses or the wastes source of materials, producing times, labor, facilities and utilities invested by a company to manufacture a product. In addition, the company source of capital rolling can be enhanced therefore better profit will be generated. The researcher contribution in their journal, articles, conference papers and thesis writing, study field of expert system as can be searched in various areas of study. This paper only discussed several numbers of an expert system study in seven disciplines; there are engineering, manufacturing, medicals, management, military, education & training.

**Table-1.** Category of an expert system and its application.

No.	Category	Problem addressed	Applications Program (Examples)	Reference
1.	Diagnosis	Recommend remedies / treatment to illnesses, trouble-shoot technical machine problem	<b>SHYSTER-MYCIN</b> : a legal expert system to diagnosis and treatment of meningitis and bacteremia infections	O'Collaghan, 2003
			<b>ONCOCIN &amp; ONCO-HELP</b> – 1980s : diagnosis of the general cancer diseases	Saritas et al., 2013
			<b>DEXs</b> : Identifying the treatment accurately by diagnosing the diseases.	Patra et al., 2010
			Diagnosis of industry piping manufacturing process	Tan and Kher, 2012
		Diagnosis of automatic wire bonding machine	Tan, 2007	
2.	Repair	Suggest the planning schedule structure to repair of item and maintenance works	<b>ESPCRM</b> : for personal computer repair and maintenance	Leng and teng, 1992
3.	Instruction	As training program that evaluate users ability with current knowledge base or monitor progress	<b>HSPEXP</b> : to assist less experienced modelers with calibration of a watershed model	Liebowitz, 1995
4.	Interpretation	To analyze data input and determine its significance (compare with knowledge base)	<b>Hepaxpert</b> - 1989: To allows precise and exhaustive interpretations of hepatitis serology test results	Rudgier et al., 2010
5.	Prediction	As method to guess or make assumption the possible outcome based data record.	<b>DEREK</b> : Predicts a variety of types of toxicology	Syed-Abdullah et al., 2011
		Recognition of CAD feature	<b>STAR</b> : Predicts carcinogenicity	
			Design of a Feature Recognition System for CAD/CAM Integration	Tan et al., 2013
7.	Forecasting	Gas price forecasting	Integration of GMDH neural network with GA and Rule-based Expert System	Abrishami and Varahrami, 2012
8.	Design and planning	To develop and decide solution in shorten time, sometime act as human experts	<b>COMEX</b> : to collect data about the costs of products, services and customers for planning and control function	Grahovac and Devedzic, 2010
			<b>CAKES-ISTS</b> : for planning an Internet-based stock trading system	Lee and Lee, 2012
9.	Monitoring	Comparing observations to plan vulnerabilities	<b>VES</b> : To analyze vibration in condition monitoring of fixed plant	Ebersbach and Peng, 2008
10.	Control	Interpreting, predicting, repairing, and monitoring system behaviors	<b>KBESs</b> :- industrial applications of real-time knowledge based expert systems for process control.	Stanley, 1991
11.	Monitoring control	To monitor operations and control functions that particularly important in decision making	<b>StruxureWare Power Monitoring Expert 7</b> : To collects and organizes data gathered from facility's electrical network and presents it in comprehensive	Moridis et al., 2013
12.	Classification/ identification	To classify or identify the objectives in the system based on differences features or attributes	<b>DENDROID</b> : to analyzing and classifying code structures in Android malware families	Tangil et al., 2014
13.	Discovery	To aid a user getting to, setting up or otherwise exploring the system	<b>SeTES</b> : to assist in the discovery and recovery of Unconventional Gas Resources (UGS)	Moridis et al., 2013
14.	Debugging	To provide incremental solutions for complex problems	<b>SIPDES</b> : To simulate Program Debugger Using an Expert System	Doukidis and Paul, 1991
15.	Selection	To select the suitable machining tool	To select the suitable carbide tool for CNC machine	Tan et al., 2012



**Table-2.** A ranking in the top five of a country founded on the total research on AI topics (ScImago Lab, 2014).

Rank	Country	Number of documents	
	Year 1996-2012	Percentage (%)	
1	United States	23,558	17.94
2	China	11,902	9.06
3	United Kingdom	9,030	6.88
4	Japan	6,341	4.83
5	Spain	6,104	4.65
30	Malaysia	848	0.65
Total countries = 140			
Total documents = 131340			



**Figure-2.** The total research of the AI from 2000-2012 for the Malaysia country (ScImago Lab, 2014).

### Engineering & Manufacturing

The impact of computer technologies application of the engineering branch such as mechanical, electrical, Automotive, locomotive, chemical and others branch could be a tough subject to be discussed. Products from the current engineering industries as we can find in everywhere make our life become much easier and comfortable, for the instant a vehicle that shortens our travelling period, remote control enables us to operate the machine for long distance, etc. Behind these product engineering processes, certain process, perhaps inefficient to be performed and handled by conventional way. Therefore, an expert system implies into the engineering and manufacturing process can provide greatest assistance for operational workers during perform and deal the critical and important tasks. Furthermore, accurate result analysis of each engineering parts or process able to be obtained from expert system that can prevent any losses for the company.

### Medical

Technologies in medical treatment are important as well as during pre-treatment of medical consultation, diagnosis disease until the actual treatment by a specialist or doctor. Not many medical practitioners who have enough expertise and experience to consult patients about diagnosis and treatment a certain high-risk diseases especially in most developing countries like South of

Asian, African and third world countries. Furthermore, patients need to wait in longer period before diseases has been diagnosis by specialist and when the treatment is stated, it may already late and patient could be suffered for the whole life or in certain worse case mortality of patients cannot be avoided. Computer technologies such as expert system can solve the above problems with the aim to conduct the earlier diagnosis diseases for patients, identify disease symptom and provide immediate accurate response to save patient life (Cabrera and Edye, 2010). In addition, the chance percentages to cure that disease turn to positive which mean the current practice for patient to consult specialist before treatment become more effective.

### Management

Expert system build for the usage of different application and different group of decision makers each level in the organization, there are managers, accountant, financial analysis, consultant, strategic planners etc. In developing expert system, management teams might have difficulties during strategic plan consist of sourcing expert advisors, budget, time constraint, other management support and contribution, skill etc. (Shariat *et al.*, 2013). Soufi *et al.* (2013) studied that expert system as importance and provide accommodation to the management to investigate the different aspect of assumption and optimal solution even though in complex case where the management problem normally solved by expertise which took more longer time for solving. Due to community demand and modern business culture nowadays, development of expert system for the application for data and information management in organization became significant role. Furthermore, company managers have an authority to access the information should engaged with the technologies such as expert system for them able to manage their management resources which more systematic, improve accountability and traceability of information system management. An expert system as programmed to facilitate in decision making in management and organization toward the high performance, it program also show that the management in its decision (Shariat *et al.*, 2013)

### Military

The technologies of artificial intelligence for the most military program and hardware are wide and varied which due to robustness, reliability and durability. It showed the improvement to the military communication security, operation, control and maintenance, training areas etc. Liao (2008) studied that the expert system as significant to facilitate decision support in the command and control process ability by a military commander due to expensive and complexity real situation in the military program training. The potential of expert system can solve many problems for the military and some AI application had demonstrated their utility such as a device tool to find bombs and mines, and search different radar. The AI application in the military field which available in current technology for instant the CALO (Cognitive Assistant that



Learns and Organizes) and PPAML (Probabilistic Programming for Advancing Machine Learning) were financed by U.S. Advanced Research Projects Agency of the Pentagon. PPAML is AI program to make accessible and effective of machine learning capability for a wide variety of information program and military weapons (Keller, 2013).

### Education & Training

Currently education learning process and training aid tools among students are well developed by advanced technology. Back to era after the Independent Day of Malaysia in 1957, education facilities and accommodation for children to study in the classroom was not like today. Mostly at the countryside areas, all teaching course provided in conventional method where less or no interaction in the learning process between teachers and pupils. Teachers would teach by chalk-talk method and pupils were just listening and takes note. Therefore, Nwigbo and Agbo (2013) has introduced expert system is very useful to facilitate teaching and learning process. Moreover, expert system can act as intelligent tutor and perhaps tutor and students are unnecessary anymore to meet in the same tutorial classroom. These processes of teaching include the training become dynamic and intelligent as stated by Hossein and Maryam (2012). Today, the technology invention makes a possibility to enhance the educational method so both educators and students become interested through the way of learning process. From the level of primary school until university level, application of expert system offers many advantages to support academic process. As example, compare the traditional way for student to get the advice about courses selection in the university or college, development prototyping student advising expert system proved and showed that automated advising as equivalent as human advisor about 93% (Al Ahmar, 2005; Al Ahmar, 2012). That is mean expert system is successful implemented during educational process and promising better teaching environment for students especially.

### STATE OF THE ART EXPERT SYSTEM FRAMEWORK

Selection of the expert system framework becomes the important factor for successful expert system project. Norton (1986) examined that the impact of particular framework on virtually every phase of an expert system project through the Bayesian Theory. Various characteristics need to be considered by system designers when evaluating an expert system framework. These are different aspects of knowledge acquisition, inference, knowledge representation, and explanation, knowledge engineering, and knowledge utilization depends on different tools applied. The impact of expert system technology by viewing of framework construction can be categories into six factors the technology itself; market realities; personal, organizational, and societal values; and policy choices (Chen, 2002). The framework of the successful implementation of each category of expert

system is based on the influences both the user perceptions and the speed of its diffusion among the user group have been discussed by Bradley and Hauser (1995).

### CONCLUSIONS

Modern businesses, academicians, scientists, engineers, manufacturers or individual were recommended to compile resources and expertise data which significantly will benefit other people. For companies, it could be the master storage the knowledge and operation expertise in keeping survival the operation of the company and eliminate a problem hiring or replacing human experts. The output of these researches will benefit any type of manufacturing industry by the optimization of product development in early stage design.

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