



UNIVERSITI MALAYA

Faculty Of Computer Science
and Information Technology

WID2001

Knowledge Representation and Reasoning

Group Assignment Report

Semester II, Session 2022/2023

Criminal Law Expert System (Rule-Based)

Group : 1 - 4

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Table of content

Abstract.....	3
Introduction.....	3
Objectives.....	3
Gantt Chart.....	4
ES architecture.....	6
a. Knowledge Base (Rule-based).....	6
b. Inference Engine.....	6
c. User Interface.....	7
Hardware & Software Used.....	8
Findings: SWOT analysis.....	9
Conclusion.....	10
Acknowledgements.....	11
References.....	11
Appendices.....	12
- Criminal Law Expert System link.....	12
- User Manual.....	12
- Decision Tree.....	18
- Group members & E-portfolio's link.....	19
- Slide.....	19

Abstract

This paper explores the possibility of expert systems on enhancing access to legal knowledge, particularly for individuals without legal training. The complexity of the legal system often presents challenges for non-professionals, hindering their understanding and decision-making processes. To address this, expert systems have emerged as valuable tools that offer broader accessibility, instant responses, and user-friendly interfaces. This study focuses on the development of a rule-based criminal law expert system within the Malaysian context. By utilising the knowledge base and inference engine, the system aims to provide accurate legal advice and recommendations based on specific scenarios. Through this research, we aim to highlight the importance of expert systems in supplementing legal expertise, enhancing educational experiences, and promoting efficiency in accessing legal knowledge.

Introduction

For people without legal training, the legal system's complexity frequently makes it scary and perplexing. Expert systems help with these issues by facilitating access to crucial legal knowledge and increasing decision-making skills. It can be difficult for anyone to comprehend Malaysia's complicated criminal rules, so we need a cutting-edge expert system that can swiftly negotiate these convoluted networks. The system has to include an extensive database jam-packed with data on every facet of criminal offences law applicable within Malaysian boundaries, the inference engine uses this information to draw conclusions, such as advising them whether their actions are lawful or recommending potential future actions based on various scenarios.

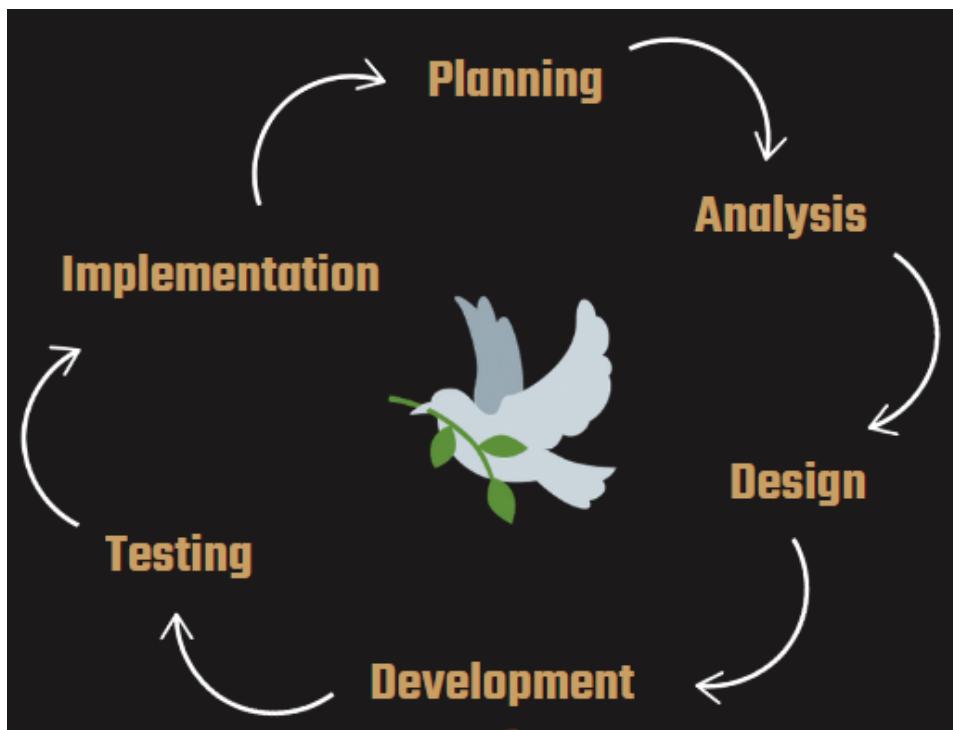
Objectives

1. To ensure that individuals seeking legal guidance or information can access the system at their convenience and receive instant responses 24/7.
2. To ensure that the expert system is accessible to a wider range of users, including non-professionals, legal students, and researchers with the user-friendly interfaces.
3. To establish a rule-based system that operates on predetermined rules and principles that ensures consistent and reliable responses, providing users with accurate information and legal analysis.
4. To provide a platform for anyone interested in criminal law, including legal students and researchers, to enhance their learning experience.
5. To provide valuable resources for preliminary research, fact-checking, and serve as a starting point for legal analysis.
6. To offer quick and accurate answers to common legal questions. By providing an expert system that can efficiently address frequently asked legal queries, it saves time for both professionals and non-professionals in obtaining relevant information and initial legal insights.

Gantt Chart

	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
Form a group								
Decide the domain								
Discussion for the specific topic								
Research								
Abstract Submission								
Expert System Decision Tree								
Find Human Expert								
Testing								
Expert System Completion								
Interview the Human Expert								
Write the Report								
Presentation & Report Submission								

ES Life Cycle



Planning Stage:

- Define the project goals and objectives, including the desired functionality of the punishment finder.
- Identify human experts and target users, and involve them in the planning process.
- Determine the resources, timeline, and budget for the project.
- Conduct a feasibility study to assess the viability of developing the expert system.

Analysis Stage:

- Gather requirements by consulting legal experts, studying relevant laws and regulations, and understanding the criminal justice system.
- Identify the types of crimes, associated laws, and possible punishments to be considered in the system.
- Analyse the decision-making process and knowledge required to determine appropriate punishments.

Design Stage:

- Design the overall system architecture and structure, considering the knowledge representation and inference mechanisms.
- Define the user interface, ensuring it is intuitive and user-friendly for legal professionals and other potential users.
- Specify the data sources required, such as legal databases or case law repositories, to support the decision-making process.

Development Stage:

- Implement the expert system using ES Builder.
- Develop the knowledge base, which includes rules and facts that represent legal knowledge and decision-making criteria.
- Design and implement the inference engine to process user inputs, apply rules, and derive appropriate punishments. Inference engine used was forward chaining.

Testing Stage:

- Conduct thorough testing of the expert system to ensure its correctness and reliability.
- Test the system with various scenarios and edge cases, including different crimes, legal scenarios, and punishment outcomes.
- Validate the accuracy of the system's decisions against known legal cases and rulings.
- Address any identified issues or bugs, and refine the knowledge base and inference mechanisms as needed.

Implementation Stage:

- Prepare the expert system for deployment in the target environment.
- Package the system into a user-friendly form, such as a desktop application or a web-based interface.
- Consider security and access control measures to protect sensitive legal information.
- Provide documentation and training materials to assist users in understanding and effectively using the system.

ES architecture

a. Knowledge Base (Rule-based)

Our Rule-based Criminal Law Expert System's knowledge base is based on the Laws of Malaysia Act 574, **Penal Code**. As the limitations of members and time, we only focused on the 5 Chapters, which were about Property, Religion, Public Tranquility, Terrorism and Human Body. The decision tree with attributes, values and conclusions is created according to the understanding of Penal Code.

Besides, to make sure our knowledge base is accurate, we also interviewed the domain expert, Dr. Haezreena Begum Binti Abdul Hamid from the Faculty of Law, UM. Dr. Haezreena tested our expert system to ensure the accuracy of the knowledge base rules. She also provides some suggestions for us to ensure the reliability of the system. For example, she emphasised the difference between the words “**shall**”, “**may**” and “**can**” in the Penal Code. As we are using the ES-Builder Web to create the expert system, the knowledge base is stored in the **MySQL** online database.

The knowledge base is collections of the rules of the penal code law. It is structured in **IF-AND-THEN** format.

IF <antecedent> AND <antecedent> THEN <consequent>

Example for Knowledge Base Rules :

Expert System - Criminal Law Expert System by KW L			
#	Rule	Notes	Image
1	<p>IF what is the case related? property AND is defendant intentionally or purposefully taking possession? yes AND is the defendant take actions? yes and success AND the objects are taken out of the consent of the authorities? yes AND what is the type of property? movable AND did the defendant put victim in fear? no AND is the defendant prepare to cause death or hurt? yes THEN the Penalty is Imprisonment: <= 10y + fine/ whipping .</p>	<p>Penal Code Act 574 Chapter XVI - Offences Against Property Section 382 Theft after preparation made for causing death or hurt in order to commit theft</p>	
2	<p>IF what is the case related? property AND is defendant intentionally or purposefully taking possession? yes AND is defendant take actions? yes and success AND the objects are taken out of the consent of the authorities? yes AND what is the type of property? movable AND did the defendant put victim in fear? no AND is the defendant prepare to cause death or hurt? no AND is the event occurred in dwelling house? yes AND is the defendant reoffending? yes THEN the Penalty is Imprisonment: <>10y + fine/ whipping.</p>	<p>Penal Code Act 574 Chapter XVI - Offences Against Property Section 380 Theft in dwelling house</p>	
3	<p>IF what is the case related? property AND is defendant intentionally or purposefully taking possession? yes AND is defendant take actions? yes and success AND the objects are taken out of the consent of the authorities? yes AND what is the type of property? movable AND did the defendant put victim in fear? no AND is the defendant prepare to cause death or hurt? no AND is the event occurred in dwelling house? yes AND is the defendant reoffending? no THEN the Penalty is Imprisonment: <<10y + fine.</p>	<p>Penal Code Act 574 Chapter XVI - Offences Against Property Section 380 Theft in dwelling house</p>	
4	<p>IF what is the case related? property AND is defendant intentionally or purposefully taking possession? yes AND is defendant take actions? yes and success AND the objects are taken out of the consent of the authorities? yes AND what is the type of property? movable AND did the defendant put victim in fear? no AND is the defendant prepare to cause death or hurt? no AND is the event occurred in dwelling house? no AND is the defendant stealing a motor vehicle? yes AND is the defendant reoffending? yes THEN the Penalty is Imprisonment: 1y - 7y + fine/ whipping.</p>	<p>Penal Code Act 574 Chapter XVI - Offences Against Property Section 379, 379A, 382A Punishment for theft of a motor vehicle</p>	

b. Inference Engine

ES-Builder Web and our ES system uses forward chaining in their inference engine. Forward chaining is a reasoning method used in inference engines, which are components of artificial intelligence systems that perform automated reasoning and decision-making tasks. Forward chaining is particularly employed in rule-based systems or expert systems.

In forward chaining, the inference engine starts with the available facts or data and applies a set of rules to derive new conclusions or facts. It uses a data-driven approach, where it iteratively combines the available information to infer new knowledge. The process continues until no further conclusions can be drawn or until a specific goal or condition is met.

c. User Interface

The user interface is predefined by the ES-Builder Web using simple HTTP and CSS. The ESBuilder also provided the link to the expert system website, so it will be web-based and can be accessed from anywhere with internet access.

The target user of this expert system is both professionals and non-professionals. Therefore, we need to keep our expert system user interface as simple as possible so that the one who visits the website, especially for those non-professionals, will not feel lost. The user interface provided by ES-Builder Web is very easy and understandable. What we need to do is just make sure we use simple English words when asking for input.

In the user interface provided, there are several components, which are:

- a. Attribute - the question that asks input from the users.
- b. Attribute Note - the explanation or elaboration of the attribute.
- c. Attribute Image
- d. Value - the possible answer, input or response of the attribute
- e. Value Note - the explanation of the response
- f. Value Image
- g. Decision History - Show all the previous selections that link to the previous attribute.

Example and Explanation for User Interface:

This screenshot shows a decision history for a criminal law expert system. The main text area displays a series of questions and their corresponding answers, each annotated with arrows indicating its type:

- "The objects are taken out of the consent of the authorities?" → Attribute
- "(Authorities include owner, occupiers and person has authority.)" → Attribute Note (Explanation)
- "• Defendant fraudulently or dishonestly induces the person" → Value
- "• Yes" → Value
- "• No" → Value
- "i. You get the consent" → Value Note (Explanation)
- "ii. You don't know who is the owner/ occupier when get the property" → Value Note (Explanation)
- "iii. You know the owner/ occupier but you get the property when (s)he is not at the site or you are trying to give it back to the owner/ occupier in the future." → Value Note (Explanation)
- "• Till now don't know who is owner/ occupier..." → Value

Below this, a "Decision History" section is shown, also with annotations:

- "What is the case related?" → Attribute
- "Is defendant intentionally or purposefully taking possession?" → Value
- "Is defendant take actions?" → Value
- "Tip: Click on an attribute link above to return to that decision..." → Decision History

At the bottom left, a "Link to return" is indicated. On the right side, there is an "Attribute Image" pointing to a photograph of a dark surface with the handwritten text "WHAT DO YOU MEAN ?".

This screenshot shows another decision history for a criminal law expert system. The main text area displays a series of questions and their corresponding answers, each annotated with arrows indicating its type:

- "What is the case related?" → Attribute
- "• Public Tranquility" → Value
- "• Human Body" → Value
- "• Religion" → Value
- "• Property" → Value Image
- "• Terrorism" → Value

At the bottom left, a "Link to return" is indicated. On the right side, there is an "Attribute Image" pointing to a photograph of a gavel and a speech bubble.

Hardware & Software Used

The **Expert System Shell** is the software module that contains a structured skeleton of an empty state knowledge base with the suitable knowledge representation facilities, built-in inference engine and user interface. The Expert System Shell is the main choice to build the criminal law expert system prototype as it already provides a framework for the developers. The expert system can be easily created by simply adding the knowledge base and rules to the particular framework.

Among the variety of the Expert System Shell currently in the market, we chose the **ES-Builder Web** to create our own expert system prototype. As an introduction to the ES-Builder Web, it is a free educational tool designed for students to help develop expert systems skills. The very first reason for us to choose it as our solutions for prototype creation is the function of web integration. It will automatically generate a url to the expert system and we can easily showcase our system by sending the link generated. The web pages (User Interface) are auto generated with simple HTML and CSS. As we decided to create a rule-based criminal law expert system, ES-Builder is really a good choice as the rule-based knowledge base can be developed using the decision tree. The decision tree consists of Attributes(characteristics of possible conclusions), Value(Response to Attributes) and the Conclusion(final decision). Besides, the ES-Builder Web also has the ability to create backups for the knowledge base. This is very important as when the knowledge base contains more and more rules, it is very risky without any backups as we cannot restore whenever the error occurred.

For the hardware, we just completed our expert system with our own devices. This includes our laptops and personal computers.

Findings: SWOT analysis

Strength	Weaknesses
<p>Accuracy: The expert system provides accurate and consistent interpretations of criminal laws, ensuring the legal decisions and recommendations are based on a thorough understanding of the law. The accuracy of the expert system is guaranteed by interviewing and asking the opinion from the human expert.</p> <p>Accessibility: As the ES-Builder Web provides web integration, the expert system can be easily accessed by everyone, including legal professionals, people seeking legal guidance and individuals who are interested in the law and legal field. The expert system provides widespread access to legal knowledge and expertise.</p> <p>Standardisation: The rule-based expert system prototype is created and relied on the predefined rules. Therefore, it can promote consistency in legal decision-making, reducing the decision-making process to be affected by human bias.</p> <p>Security and Privacy: As we use the ES-Builder Web to create our own expert system, the Expert System Shell itself provides the security and privacy factors. The ES-Builder Web provides the function to backup the expert system, so we can restore the expert system whenever any error occurs. Besides, the website uses various measures such as secure communication protocols (HTTPS), online MySQL database and so on to protect the website.</p>	<p>Limited Scope: First, we selected the law and legal domain, and specifically chose criminal law as our topic. However, as we only have 5 people in a group, we only focus on 5 chapters in the criminal law. Besides, in the real life scenario, different laws or acts are somehow related to each other, and the legal expert needs to consider different situation case-by-case basics. However, our expert system only focuses on criminal law, so the legal expert needs to do further research when it is out of scope. The rule-based system also relies on the predefined rules only, which may not encompass every nuance of complex criminal cases. The expert system prototype may oversimplify or miss specific circumstances that require more nuanced legal analysis.</p> <p>Lack of Contextual Understanding: In the real life scenario, the legal expert needs to interpret the information while considering the social culture or defendants' personal factors that could influence legal outcomes. However, the prototype built only uses the predefined rules and may struggle to interpret legal information in a broader context.</p> <p>Knowledge Maintenance: To make sure the expert system works accurately, the developers need to regularly update and do maintenance which is very time-consuming and resource-intensive.</p> <p>Dependency on Input Quality: The accuracy and effectiveness of the criminal law expert system is very much dependent on the quality and accuracy of the input data and the predefined rules. If the data is inaccurate or outdated, the system will lead to incorrect legal interpretations and recommendations.</p> <p>Slow Processing Time: As we are using the shell, the processing time is much dependent on the shell. When we have more attributes and values, the processing time also becomes slower and slower.</p>

Opportunities	Threats
<p>Automation of Legal Processes: Legal professionals can focus on more complicated and strategic duties by automating time-consuming tasks, resulting in enhanced productivity and the ability to handle a larger caseload.</p> <p>Enhanced Legal Decision Support: The expert system can help legal practitioners by offering relevant legal information, precedents, and alternative arguments, enhancing their decision-making abilities and boosting the quality of legal outcomes.</p> <p>Collaboration and Knowledge Sharing: The expert system can provide useful insights and alternative views by using the pooled expertise and experience of legal professionals, resulting in more robust legal analysis and decision-making.</p>	<p>Legal and Ethical Concerns: The use of an expert system in legal decision-making may raise legal and ethical concerns, such as accountability, transparency, and the potential for biased outcomes. Clear guidelines and oversight mechanisms must be in place to address these concerns.</p> <p>Resistance to Adoption: Some legal experts may be resistant to adopt technology-driven systems in legal practice. Overcoming this resistance and promoting the benefits of the expert system may pose a challenge.</p> <p>Complexity of Legal System: The criminal laws and legal processes are very complex and ever-evolving. It is very challenging to capture and encode all the relevant rules and exceptions accurately within the expert system.</p>

Conclusion

Our groups have developed a rule-based criminal law expert system prototype with ES-Builder Web that focused on 5 chapters in the Penal Code, which are:

- a. Chapter XVII - OFFENCES AGAINST PROPERTY
- b. Chapter XV- OFFENCES RELATING TO RELIGION
- c. Chapter VIII - OFFENCES AGAINST THE PUBLIC TRANQUILLITY
- d. Chapter XV - OFFENCES RELATING TO TERRORISM
- e. Chapter XVI - OFFENCES AGAINST THE HUMAN BODY

The expert system prototype was created successfully with the law human expert, Dr. Haezreena Begum Binti Abdul Hamid from the Faculty of Law, UM. In conclusion, it is possible and there is a need to create an expert system for criminal law which can be a great tool for the experts to reduce their workloads and also for others to study the criminal law knowledge and rules.

Acknowledgements

We are thankful to Dr. Rohana Binti Mahmud., our KRR lecturer and Dr. Haezreena Begum Binti Abdul Hamid, the human legal expert from the Faculty of Law, UM for their kind suggestions and help.

References

Bibliography: Penal Code (act 574) (as at 1st August 2002), 2002, International Law Book Services, Kuala Lumpur, Malaysia, 222 pp. Abstract/Citation: Penal Code of Malaysia.

Jayalath, L. (2021, June 12). Creating an expert system with ES-builder.

<https://lasithmanaram.medium.com/creating-an-expert-system-with-es-builder-acf4a9f993f9>

Appendices

- **Criminal Law Expert System link**
<http://www.mcgoo.com.au/esbuilder/viewer/viewES.php?es=c8d3d44eb6c3dbc82ef2c953c8d55387>
- **User Manual**
<https://drive.google.com/file/d/1gXISuVSUHpZxzXaz7JYtG6OarZAVBlfl/view>

User Manual



Welcome To Our
Criminal Law
Expert System
Manual

Table Of Content

[About Expert System](#)

[How to access the Expert System](#)

[Navigating ES Builder website](#)

[Answering the Question Given](#)

[The conclusion at the end](#)



About **Criminal Law Expert System**

Introducing our Criminal Law Expert System, powered by ES Builder. This system accurately determines punishments for five crime sections: Property, Religion, Public Tranquility, Terrorism, and Human Body. It streamlines decision-making with a comprehensive knowledge base, enabling swift and reliable judgments. Achieve efficient and consistent justice with our advanced solution.

How to access **Expert System**

The Website Link

The website link is as follows:

[http://www.mcgoo.com.au/esbuilder/viewer/viewES.php?
es=c8d3d44eb6c3dbc82ef2c953c8d55387](http://www.mcgoo.com.au/esbuilder/viewer/viewES.php?es=c8d3d44eb6c3dbc82ef2c953c8d55387)

How the Website Look Like



From There We Can Start the Expert System

The user can start to explore the expert system by clicking the 'Guilty? Innocent? Let's see.....'



Navigating the Expert System

What is the case related?

- [Public Tranquility](#)



- [Religion](#)



- [Terrorism](#)

[Return to the Criminal Law Expert System Expert System Title Page](#)

What to select?

The Expert System work by choices based system. Users will be able to select the choices that apply to their case. The system will present questions or situations to identify the crime and punishment.

Answering the Questions Given

Is defendant intentionally or purposefully taking possession?

(Even when defendant himself think the action is wrong.)

- Yes
- No

Decision History:

What is the case related?	Property
---------------------------	----------

Tip: Click on an attribute link above to return to that decision...

Questions form

Some of the questions will be asking a yes or no. Some will give situations and you will need to select them.

The decision history will be shown as below.

Decision History:

What is the case related?	Property
---------------------------	----------

Is defendant intentionally or purposefully taking possession?	Yes
---	-----

Tip: Click on an attribute link above to return to that decision...

The user can go back to the previous question by clicking the link in the decision history.

The Conclusion

ES-Builder Web

Expert System - Criminal Law Expert System by KW L

Based on the responses you have made:
The Penalty is Imprisonment: >=1y, <= 10y + whipping + fine

Conclusion Notes:
Penal Code Act 574
CHAPTER XXIII - Attempts to commit offences
Section 511
Punishment for attempting to commit offences punishable with imprisonment
Chapter XVI - Offences Against Property
Section 420
Cheating and dishonestly inducing delivery of property

Expert System Rule:
IF what is the case related? property
AND is defendant intentionally or purposefully taking possession? yes
AND is defendant take actions? yes but fall or not yet done
AND the objects to be taken are out of the consent of the authorities? defendant fraudulently or dishonestly induces the person
AND is the defendant induces delivery of property? yes
THEN the Penalty is Imprisonment: >=1y, <= 10y + whipping + fine.

[Return to the Criminal Law Expert System Expert System Title Page](#)

ES-Builder Web ©2013 McGoo Software Provided free for personal and academic use. [ES-Builder Web Help](#) [Privacy Policy](#)



Conclusion

The final conclusion includes the Penalty, Notes and the Expert System Rules.

- Decision Tree

https://drive.google.com/drive/folders/1WnAGnP3vIT3fnWE6r70gzLHwN_hj0Agr?usp=sharing

This Google Drive contains the images of the decision tree. We separate the images of the decision tree so that it will not become too long. We separated the images according

to the Chapter in Criminal Law which is Property, Affecting Human Body, Public Tranquility, Terrorism and Religion.

- **Group members & E-portfolio's link**

Name	Roles	E-portfolio's link
Lai Ke Wei	Leader	https://laikewei.b4a.app/
Nur Irdina Binti Sukarno	Evaluator/ Presenter	Nur Irdina Sukarno's e-portfolio
Reem Moumen Mohammed Idres	End User	https://sites.google.com/view/reemeportfolio-s2128921/expert-systems
Iwan bin Amri	Programmer	https://sites.google.com/view/krr-iwan-e-portfolio-s2132443/home
Nor Aniq Haqym bin Nor Azman	Knowledge Engineer	https://sites.google.com/view/aniq-e-portfolio?usp=sharing

- **Slide**

https://www.canva.com/design/DAFkTjP4pak/w13TEZmBqNwywhhQWxRDLQ/edit?utm_content=DAFkTjP4pak&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

10th. May 2023.

Salam Sejahtera,

Dear Prof. Dr. / Assoc. Prof. Dr. / Dr. Haezreena Begum Binti Abdul Hamid

Re: An appointment as the 'Domain Expert' for a Group Project of the Course WID2001 - Knowledge Representation and Reasoning, under the Department of Artificial Intelligence, Faculty of Computer Science & Information Technology, Universiti Malaya.

The above matter is referred.

For your information, the students of the **WIX2001** course are currently assigned to develop a mini **expert system (ES)** of a specific domain area as part of their course assessment (30% marks), which require them to do a 'real' knowledge engineering process with the human expert.

Therefore, we're really appreciate if Prof. Dr. / Assoc. Prof. Dr. / Dr. is able to help the students' project by sharing your knowledge and expertise in the development of the proposed ES prototype. The student will contact you directly and please help to endorse your participation with them.

The prototype can always be extended as an application system or for any further development and we welcome any future research collaboration.

Thank you for your kind help and best wishes.

Yours faithfully,

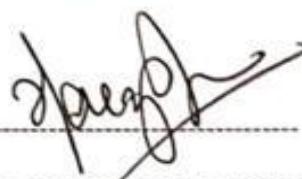

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Acceptance of participation as the Domain Expert:

Signature: 

Name & affiliation: _____

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