CERTIFICATION OF APPROVAL

Depression Consultation Expert System

By

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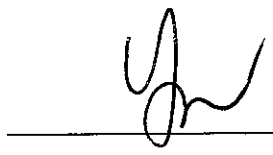
Approved by,



(Vivian Yong Suet Peng)

UNIVERISTI TEKNOLOGI PETRONAS
TRONOH, PERAK
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CERTIFICATION OF ORIGINALITY

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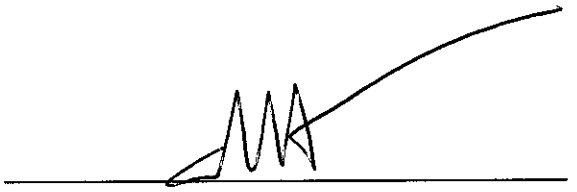

NGUYEN THI MINH ANH

ABSTRACT

Depression Consultation Expert System (DECES) is a web-based Diagnosis and Counseling system for depression cases based on knowledge from human expert. Given the shortage of psychiatrists, the refusal of patients on face-to-face consultation due to shyness, appointment hassles, time & cost of each treatment, and a considerable increase in numbers of depressive subjects, there is a definite sense of urgency in the development of this system. The objectives of the project are to understand the underlying concepts of AI in medicine in general and psychology in particular, and to develop DECES through research on diagnostic expert system, its construction techniques and approaches. The methodology used is expert system development life cycle with prototyping. The development begins with knowledge acquisition, then design of the knowledge base and inference methods. Application of this methodology allows the prototype to be evaluated and refined by professionals in stages to verify its credibility, reliability and clinical acceptability. The system is able to guide its users to a diagnosis process of identifying their depression levels and causes and getting self-help without the intervention of psychiatrists. The proposed system captures the expertise, which empowers patients with the ability to help themselves in depression treatment quickly, at any convenient place and time. With the increase recognition of the seriousness of depression and the importance to reduce it critically, the future depression expert system appears to be promising and optimistic. This paradigm shift makes depression consultation expert system an emerging and ever-evolving one that can be and should be productively explored.

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CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Artificial Intelligent (AI), or the use of computer technology to replicate human intelligence, was introduced by John McCarthy during a conference at Dartmouth College in 1956 [1]. The main aim of AI is to build computers and programs that capture the expertise in diverse areas as science, medicine, business, engineering and education to assist decision makers in solving real-world problems [2]. In 1965, the success of DENDRAL, a computer program acting as an expert chemist in recognizing molecular structures of unknown compounds developed at Stanford University, opened the era for Expert System, also called Knowledge-Based System [3]. Expert System, one of the most prominent subsets of AI, mimics the way humans actually approach a given problem by articulating the rules that are thought to govern an expert's strategies.

Among many fields in which Expert System is involved, medicine holds a large domain. A 1986 survey conducted by Waterman [4] showed that the majority (30%) of applications were in the field of medicine. This is due to the diagnostic nature of the applications and the relative ease of developing such a system. From the very first blood disease diagnosis expert system (MYCIN) built in the early 1970s till today online advanced diagnosis system, expert systems in medical domain have gone through a long way of continuous assistance to doctors and specialists in decision making process.

All clinical decisions are complex, but compared to other aspects of health care, psychology or mental disorders are the hardest in diagnosis and treatment as they lies in an abstract area [5]. Together with the speedy growth of the world industry, more and more mental illnesses appear to harm human stability and demand for mental expert systems therefore increases. This project named **Depression Consultation Expert**

System (DECES) is expected to act as an online computerized center that consults patients on their depressive conditions based on expert knowledge and experience. It captures input of patient symptoms, categorizes their specific depressive types and provides guidelines or self-help methods for improvement and healing.

The rapid advent of World Wide Web (WWW) and information technology are creating possibility to develop more intelligent systems that help decision makers in general and patients in medical fields in particular to solve their problems fast and efficiently. Like Ed Feigenbaum, researcher on DENDRAL at Stanford University, once claimed: 'In the knowledge lies the power' [6], Expert System is believed to possess such a power.

1.2 PROBLEM STATEMENT

1.2.1 Depression – A severe danger to human health

Depression is the largest non-fatal disease burden, affecting 121 million of people globally each year [7]. The US National Comorbidity Survey conducted at Harvard Medical School on adolescents and young in 1998 found depression to be in the order of 15% [8]. In 2001, Haarasilta et al. confirmed the prevalence of depression in young adult (20-24 years old) population is approximately 10% [9]. Depression is currently considered a major risk factor for deliberate self-harm and suicidal behavior. In a study of suicidal ideation among 1,678 undergraduate Australian University students, it was found that 62% reported suicidal ideation and 6.6% had had one or more attempts [10]. Depression also leads to extensive disability worldwide and the problem is predicted to increase to the second most common cause of global disability by 2020 [11].

In Malaysia, the National Morbidity and Health Survey carried out in 1996 revealed that 11 per cent of those between 19 and 59 suffered from depression. In 2001, the percentage had risen to 18.8 per cent. According to Bernama.com on Oct 9, Malaysia has an alarming rate of seven suicides a day, based on statistics in 2005, or 2,004 patients committed suicide last year, fuelled by depression and other mental

disorders [12]. Table 1.0 shows Malaysia extrapolated prevalence on depression is much higher than that of other countries in Southeastern Asia when taking population into account.

Table 1.0 Depression in Southeastern Asia (Extrapolated Statistics)

Country	Extrapolated Prevalence	Population Estimated used
Indonesia	12,638,006	238,452,952[2]
Laos	321,610	6,068,117[2]
Malaysia	1,246,691	23,522,482[2]
Philippines	4,570,810	86,241,697[2]
Singapore	230,756	4,353,893[2]
Thailand	3,437,872	64,865,523[2]
Vietnam	4,381,128	82,662,800[2]

(Sources: http://www.wrongdiagnosis.com/d/depression/stats-country.htm)

1.2.2 Refusal of depressive cases on psychological consultation

The problem of depression would not have become so severe if those who are involved in such a mental condition sought for counselors, psychologists or any other professional services for help. Malaysia itself is currently having 85 psychiatrists, 56 counselors at 27 hospitals nationwide ready to treat all types of mental disorders [13]. Globally, there are a considerable number of hospitals specialized in psychological field that recruit more and more well-trained psychiatrists per year to meet the anticipating increase in demand. However, recent community services have confirmed that the vast majority of people are unlikely to access counselors and get help. Aalto Sataelae et al. in 2001 found only one-third of their subjects with a current disorder reported contacting psychiatric services and only 16% continued this contact [14]. Similarly, only half of the subjects with panic disorder search for consultation [15]. A study by Phillips et al in 1999 [16], who conducted a 20-month survey of referrals to a mental health care service, highlighted that only four in ten people with a diagnosable behavior ever seek help from a health professional. By this time, symptoms are likely to have worsened, and take more time

and cost to treat. All the evidences clearly show the current behaviors are not effective in lowering the prevalence of depression.

One of the main reasons for the refusal of depressed patients in consultation is the social stigma attached to being diagnosed by a doctor, counselor or other health professional. A study by Copper in 2001 showed that 70% of participants avoided attendance in face to face programs due to this stigma [17]. They do not feel like discussing or telling others what they may feel is a sensitive and personal issue, which is normally the cause of depression. Another reason is patients' realization on the fact that making an appointment with a psychiatrist, queuing for their turns and traveling all the way to a traditional mental health care institution bring a lot of hassle and tiredness. Moreover the treatment normally drags for a long time with frequent checks that are hard to follow. The third reason is the high fee for professionals in this field and might not be affordable to certain people. They would prefer to spend such an amount on other than some 'invisible' sickness without a confirmation for a successful recovery. The forth very common reason among depressive cases is that patients do not feel the urge or essential need to go for a psychological treatment. They find it too serious to even have a visit to a counselor and tend to believe they could themselves get over their depression after some time. They are not aware that an unattended depression would never be completely healed and would be worsen by time. There is a need for a system that could solve all the above problems

1.2.3 Proven positive influences of online self-help systems on depression sufferers

In the 39th Hawaii International Conference on System Sciences 2006, the positive influences of online self-help systems were highlighted. According to the analysis result, people are more likely to continue after they have had a chance to secretly test self-help online for guidance due to its anonymity [18]. Glasgow et al. in 2004 confirmed that Interactive Behavioral Change Technologies are valuable adjuncts to clinical behavior-counseling [19]. It is stated that online consultation systems provide speed, convenience, widespread access, privacy, interactivity, and other benefits that are hard to achieve by

physical psychological centers. This makes computer and the Internet perfect mediums supporting and motivating depressed patients. Solid evidence on the advantages of these systems was shown through the work Christensen et al. over 2909 subjects in 2004. He found that anxiety and depression scores decreased significantly as individuals progressed through five assessment modules in the Internet MoodGYM self-help program [20].

1.2.4 Significance of Depression Consultation Expert System

The discussed severity of depression harming human health and huge patient refusal of psychological professionals emphasize the need and importance of the availability of a self-help online system specialized in depression. It is expected such a system would influence behavior of potential sufferers who are not seeking, or taking too long to get help for their condition. Expert System with all its useful characteristics could act as a computerized questionnaire to discover the causes behind each depressive case. Patients would have a chance to express themselves to the system without feeling afraid since their personal information is not disclosed to any outsiders. They would be more comfortable to take their own time answering all detailed questions sincerely and openly while sitting in their house with food and drink. In this way, the analysis result would be more accurate and the process is fast and effective. The solution or guidance to improve patients' mental conditions would be immediately given to system users as soon as they finish their assessment. The method of gathering input from patients and providing recommendation is called consultation. A significant advantage of this type of system from user perspective is that it helps user feel satisfied that somehow they could solve their own problems by putting themselves in a self-help treatment and being healed. The tendency would go to the level where users have the urge to seek for more information online about their mental illnesses [21].

DECES is built to assist patients in the war against depression. Such a system, in which expertise serves as a foundation, hopefully would move in the positive direction of owering depression scores in the future despite continuous challenges in its development.

1.3 OBJECTIVES AND SCOPE OF STUDY

1.3.1 Objectives

The four main objectives of this project are as followed:

1. To study and understand concepts of AI in general and in the field of mental disorders in particular.
2. To do research on depression diagnosis including its symptoms, causes, effects and treatment, and online mental consultation.
3. To examine and test rule based Expert System approach in building a useful web-based expert system.
4. To develop DECES which focuses on diagnosis patient depressive conditions and provides self-help recommendations to improve or heal depression. The aim is to capture expertise and make it available to non-expert so they could use it to solve their own problem at the good cost and the right time efficiently.

1.3.2 Scope of Study

The foundation of DECES is available and updated expert knowledge in the field of depression. Information gathered includes all depressive causes, symptoms, categorized types, consequences and methods of recovery. The system mimics the way a psychiatrist would diagnose patient conditions and consult on the possible treatments.

The tool to develop such a system is Exsys CORVID or Knowledge Based Expert System software that is now widely used in many fields, one of which is medicine. The approach chosen is rule based one (IF-THEN statement) that divide knowledge into decision trees and tables.

1.3.3 Feasibility of the Project within the Scope and Time Frame

This project focuses on depression, one of the currently urgent psychological issues worldwide. Since depression has caught great attention of all professionals in the field, many related books and journals can be found both online and in libraries. UTP library provides a number of resources that helped the information gathering process and the access to international e-libraries like IEEE and other trusted sources. In terms of expertise, UTP experienced counselors as well as master students doing research on other medical expert systems are always available for support and guidance. Well-qualified doctors and psychologists in Malaysia and Vietnam hospitals are also cooperative in providing help on checking the validity of DESES knowledge base. The software used by the project called Exsys CORVID can be used in UTP Post Graduate lab.

CHAPTER 2
LITERATURE REVIEW AND THEORY

2.1 MEDICAL CONSULTATION EXPERT SYSTEMS

Known as a branch of AI, Expert Systems offer a way of capturing and encoding expert knowledge to emulate the way people think. Throughout the years, these systems have been developed in various fields ranging from geology and electronics to medicine and education. In the early 1970's, AI introduced intelligent programs designed to simulate clinical decision making process of diagnosis in several medical specialties, including MYCIN in antimicrobial therapy, ANNA in digitalis therapy, MEDICO in chorioretinal diseases, and PIP in internal diseases.

MYCIN is one of the most influential and widely quoted expert systems [22]. Its inference engine was based on backward chaining. In order to prove a query, backward chaining chooses a rule whose conclusion part matches the query and the search to prove the rule's premises continues in a recursive manner. MYCIN rules had confidence factors, which are numeric values indicating uncertainty about applicability, associated to them. Eliminating MYCIN's domain specific knowledge gave birth to expert system shell EMYCIN. PUFF is one of the systems developed by EMYCIN for identifying lung disorders and suggesting treatment. It was accepted by majority in the medical community. MYCIN is therefore referred to as a typical example of first generation expert systems.

The technology of MYCIN is categorized as specific problem- solving design. In 1981 during SAMS/SCM Conference on Computers in Ambulatory Medicine, EXPERT [23] intelligent system was introduced as a move from specific medical consultation systems to generalized frameworks of organizing expertise in a higher level of reasoning. An EXPERT consultation model consists of findings, hypotheses, and decision rules. Findings are the patient's history, symptoms, signs, and lab results elicited through true – false or numerical- range questions. Hypotheses are conclusions including diagnostic and prognostic decision categories, therapy recommendations, and intermediate hypotheses about pathophysiological states, expected causes of illness, or typical aggregates for findings. A measure of uncertainty can be associated with a hypothesis during the reasoning process to characterize the incompleteness or ambiguity of the clinical situation. There are three types of rules for describing logical relationships among findings and hypotheses: finding-to-finding rules (FF), finding-to-hypothesis rules (FH), hypothesis- to-hypothesis rules (HH). The FF rules are used to specify the sequencing of questions in a fashion consistent with medical practice by truth value of findings. FH

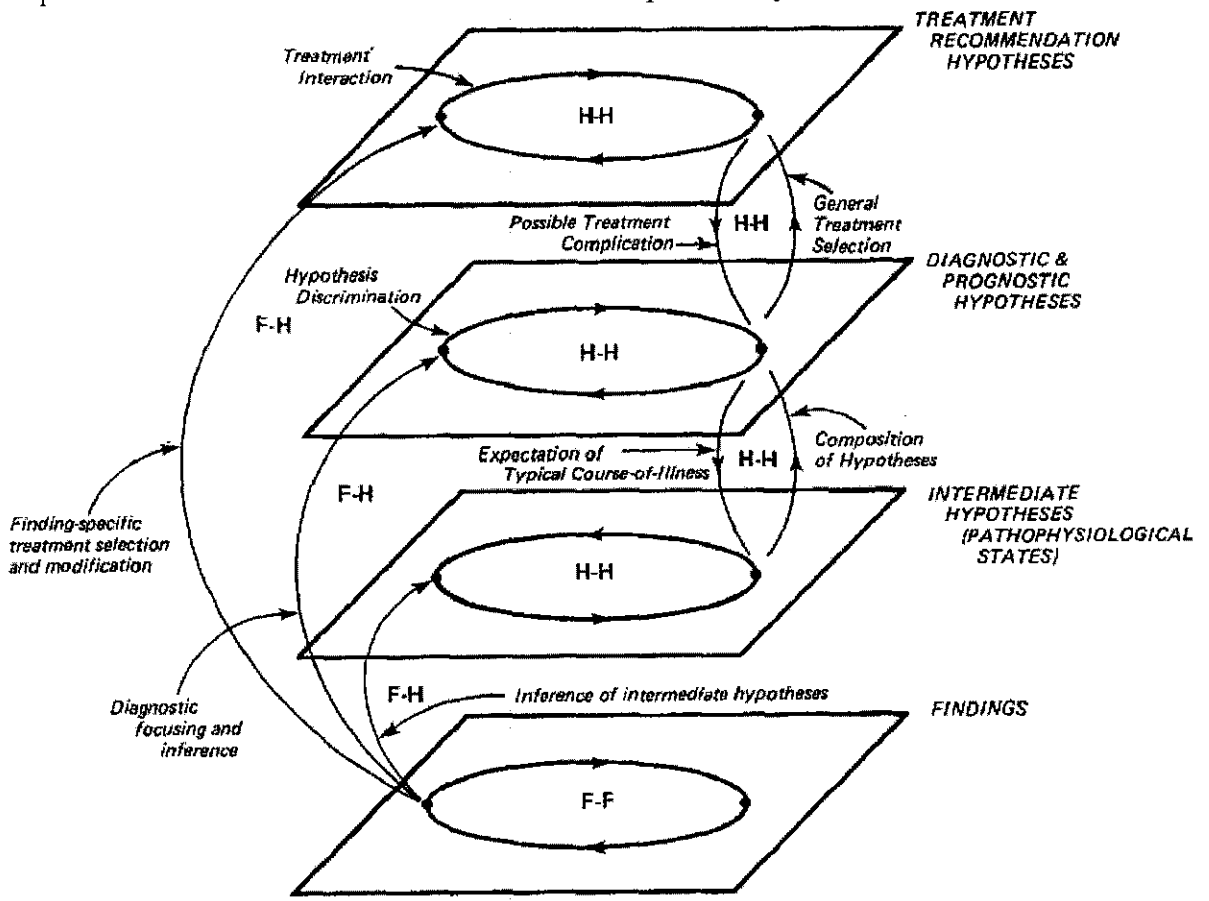


Figure 2.0: The use of 3 types of EXPERT rules

:: D. Gelernter and J. Gelernter. (1984). 'Expert systems and diagnostic monitors in psychiatry'.IEEE.45-4

rules are logical combinations of findings that indicate confidence in the confirmation or denial of hypotheses. The HH rules allow the model builder to identify inferences among hypotheses and treatment selections. Figure 2.0 shows the use of 3 types of EXPERT rules

With its high-level designing model, EXPERT was used extensively in the development of several medical consultation models in biomedical modeling. Its birth gave rise to the field of medical knowledge engineering, which concerned with acquiring expertise and choosing appropriate computer representation to build a knowledge base to solve medical problems.

2.2 MENTAL CONSULTATION EXPERT SYSTEMS

Even though a number of medical expert systems have been developed to address problems in health care, there have been considerably fewer applications to date for psychiatric practice.

One of the expert system models explored for the psychiatric clinic is the online diagnostic monitor (ODM), an interactive model designed to be used by the clinician during the course of patient interviews [24]. ODM can operate in "data mode," in which it "passively" accepts information in any order deemed appropriate by the clinician. In the ODM, each diagnosable disease is associated with a particular set of manifestations, and the inference scheme treats information in such a way that any element may be entered either as a datum or hypothesis. This scheme reduces the amount of data entry required and enables the clinician to exert more control over the flow of interaction. However, although the proposed benefits of the ODM design make it an attractive model, it has been embodied only in a small prototype system which, to date, has not been tested in a clinical setting.

Another mental expert system prototype, PSYXPERT, was developed to aid psychiatrists in the diagnosis of mental disorders [25]. Written in Prolog, this small research prototype has been tested by psychiatrists using cases from the Diagnostic and Statistical Manual-

3rd edition (DMS 111) Case Book of the American Psychiatric Association (a companion reference which gives illustrative examples for each diagnosis) and found to be accurate. However, in several actual cases, it has not performed as well as expected, coming to significantly different conclusions than the attending clinician. Creators of this system agree that considerable enhancements are necessary.

One of the main reasons for some lack of user acceptance for mental consultation expert systems was the small integration of such systems into clinical environment for a higher level of application. This led researchers to explore a different approach from what was introduced by MYCIN. OVERSEER, [26] was the first version of knowledge-based system designed to monitor treatment of psychiatric patients in real time that is specialized in psychopharmacology. It diagnoses any of 3 mental disorders including bipolar disorder, schizophrenia, and major depression, and then gives advice on drug therapy. Unlike other psychiatric diagnosis system, OVERSEER does not gather data under question-answer format to get patient input but depends on the existence of an accurate and consistent hospital database. Its main form of interaction with user is through alert messages generated by means of production rules. The rule base is organized into a separate module that can be modified independently of the control and inference modules. This is important in clinical situation where new knowledge often forces changes in existing procedures and practices. In its prototype form, OVERSEER runs on a Sun 3/50 workstation and was tested on subsets representing 1200 patients days of actual patient, laboratory and pharmacy records. The result showed its valuable quality assurance functionality as a 'clinical supervisor'.

Subsequent expansion and modification of OVERSEER prototype led to the development of a new expert system called Clinical Evaluation and Monitoring System (CEMS) [27], which was installed at a large psychiatric hospital in Harford, Connecticut in 1995. CEMS functions support 3 modules: (1) Patient Outcome Assessment, (2) Diagnostic Checklists, and (3) Pharmacotherapy Guidelines. It therefore addresses essential elements of the clinical process – assessment, diagnosis, and treatment, which are also consultation system process. CMS generates alerts by comparing information in its knowledge base

(about medications, diagnoses, treatment protocols) to the clinical data in hospital information system without any input from user. The advantage of the system is that it can identify non-standard treatment and diagnostic events and assure appropriate documentation and review of test results.

At the Family Therapy Unit of Springfield Hospital in London, a practical application of a psychiatric diagnosis expert system was effectively used [28]. Family Therapy Expert System was written in the Arity dialect of Prolog which runs on an IBM compatible PC. The methodological assumption underpinning the system is that certain identifiable types of psychological problems have their root from relationships between family members, rather than in the personalities of any particular family members considered as atomic individuals. Within this general holistic approach, more specific therapeutic approaches or models of treatment can be discerned. Both the system's principal expert system and its mini sub-system reason are in a backward chaining manner. The former incorporates the calculation of confidence factors (according to the standard approach), assigning a different weighting to each particular theoretical model depending upon the answer to each question that has been input by the user. The mini sub-system attributes relative status to its rules via their ordering, rather than via any assignment of confidence factors. Since, in keeping with traditional expert system design, the knowledge bases comprise a separate part of the system, it is a straight forward matter to introduce new theoretical models into the system, as well as to update existing ones. Furthermore, since the principal system contains two separate knowledge bases, one containing the rules governing the applicability of each model and the other containing the rules governing the appraisal of the therapist's own performance, and since the sub-system also contains its own separate knowledge base, containing the rules governing the Consistency Test, it is easy to modify one aspect of the system without worrying about its ramifications for the others. This modular aspect of the system facilitates ease of maintenance and subsequent development.

2.3 DEPRESSION CONSULTATION EXPERT SYSTEM

Depression is one of many psychological problems, which is now among the highest causes of suicide and disability [7]. Acknowledging the importance of depressive disorder, a few expert systems have been developed that narrow the scope of mental diagnosis to specialize in depression treatment.

The two best known expert systems built for depression consultation are HEADMED [29] and BLUEBOX [30]. Both systems are highly interactive, questioning the user about the patient's history and the nature and severity of the symptoms and then generating a treatment recommendation, including choice of drug, and information on dosage, administration, side effects, and hazards of the medication.

HEADMED was developed using the knowledge-engineering tool EMYCIN. Although EMYCIN proved to be an extremely useful tool for developing HEADMED knowledge-base and decision-making structures, its interactive interface proved much too tedious for clinical users. Clinicians were at times required to respond to over 50 questions before HEADMED generated a treatment recommendation. Furthermore, its dialogue was unable to adjust to the user's level of expertise, asking the same questions of both a medical student and an experienced internist.

Like HEADMED, BLUEBOX is an expert system that advises physicians on selection of appropriate pharmacological therapy for depressed patients. It was developed in a clinical setting (a hospital psychiatric ward) by a team of clinicians (medical students) who also used EMYCIN. The rules incorporated into BLUEBOX knowledge base enabled it to "reason" about the type of depression, evaluate the suicidal risk, and propose a management plan. In informal comparisons against discharge summaries of former patients, the advice offered by BLUEBOX was found to be accurate and consistent. Hospital staffs were uniformly positive about the usefulness of the system as a teaching, research, and reference tool. Although BLUEBOX is still at the level of a research prototype, its successful development by a group of nonprogrammers illustrates the

power and importance of knowledge engineering tools such as EMYCIN. At the same time, however, its reliance on EMYCIN's interactive interface makes it subject to the same problems encountered by HEADMED.

There is an obvious need for more reliable and effective Expert Systems in Depression Consultation that would contribute to the enhancement of human health in general and human psychological condition in particular. With the increasing recognition of the importance of reducing and healing depressive disorder, future development of such systems appears to be promising and optimistic. While debates are still on about the clinical acceptance of diagnosis expert system, the available evidence [31] shows the strong impact of medical diagnosis/ consultation expert system in delivering quality and improvement of human health.

CHAPTER 3
METHODOLOGY

3.1 PROCEDURE IDENTIFICATION

System Development Life Cycle (SDLC) introduced in 1996 is an effective methodology in building a useful expert system. DECES uses SDLC (Figure 3.0) as its step - by - step approach in solving the problems.

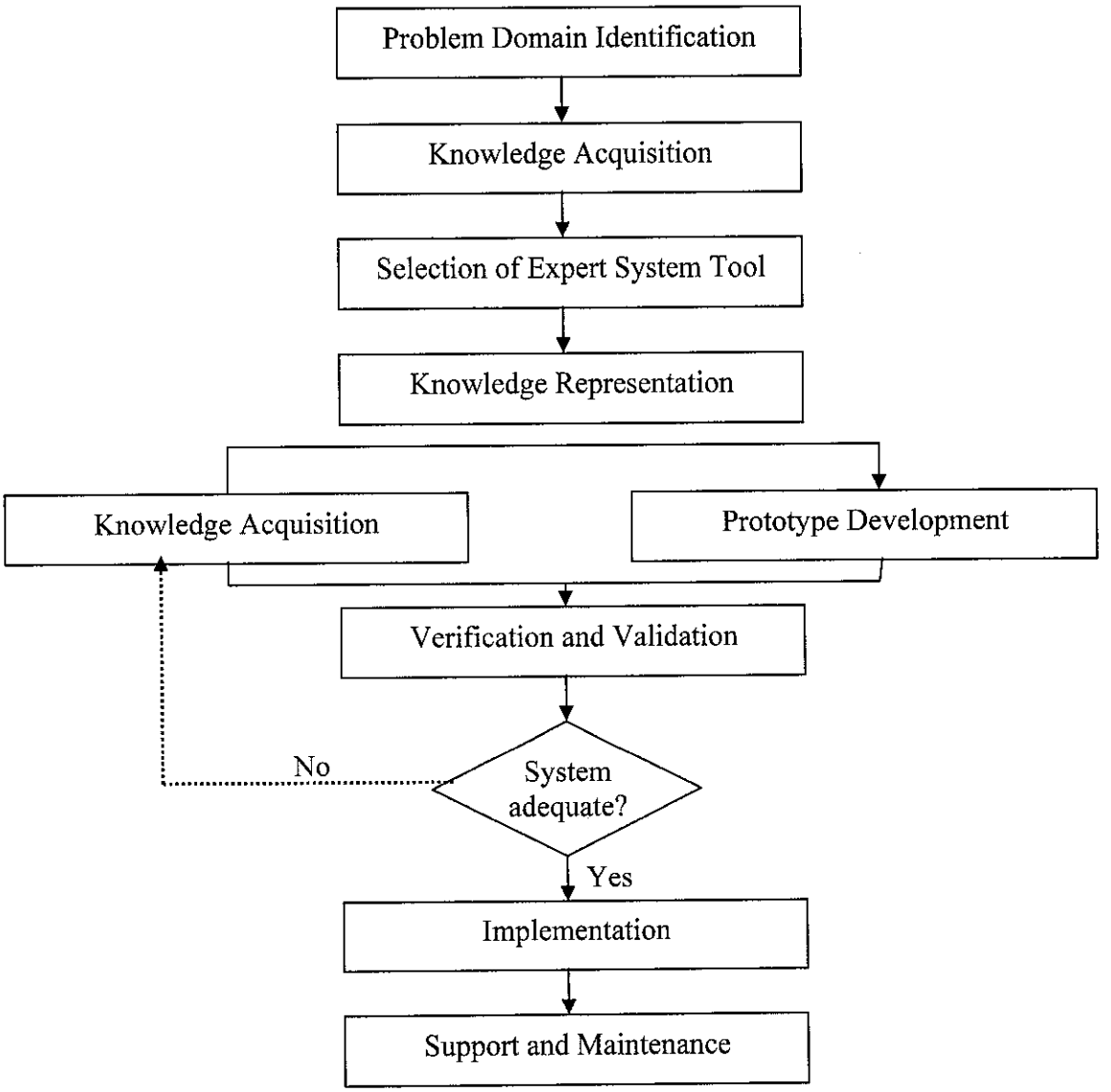


Figure 3.0: Expert System Development Life Cycle (Awad, 1996, pg.97)

3.1.1 Problem Domain Identification

As being stated in Introduction part, the main problem studied is the refusal of depressive cases on psychological consultation, which leads to a considerably increase in self-harm activities, suicide cases, and extensive disability both in and outside Malaysia. This is due to the following reasons

- Discomfort when being diagnosed and asked personal questions by a psychiatrist
- Hassle and tiredness in making appointment and meet psychiatrist in person
- High cost of psychological consultation/treatment
- Unawareness of the need to turn to a professional upon any sign of depression and the seriousness of the issue.

There are currently limited depression consultation expert systems worldwide and none in Asia continent to help solving the above problems. Therefore, the development of DECES is highly justified

3.1.2 Knowledge Acquisition

DECES knowledge acquisition process is shown in Figure 3.1.

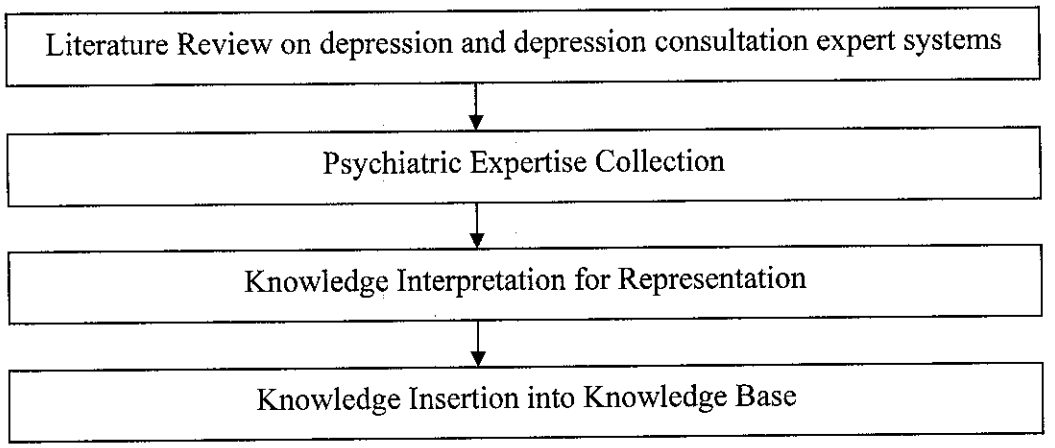


Figure 3.1: DECES Knowledge Acquisition Flowchart

The project literature review with its purpose of identifying, discussing and evaluating Expert Systems built in the field of depression not only provides a summary of previous work but also draws a context to connect to the future development. It proves the importance of the issue which has long been studied and acts as the base for the continuing of more updated versions. It underlines the knowledge gathered from previous developers and researchers, shows the disadvantages to avoid and the advantages to capture in the progress of system improvement with additional features.

Internet is one of the huge information sources where useful knowledge on depression can be found quickly. It is important, though, to identify the right 'qualified' websites as there are a considerable number of 'junk' sites providing false information or very subjective ideas that can not be taken as facts. Well-written books on psychology in general and depression in particular also contribute to the knowledge acquisition process. As knowledge on depression including causes, types, symptoms, and treatment is explored, similarities and differences appear that require combination as well as filtering for what could be put into the DECES knowledge base. The comparison of cases leads to the selection of most suitable knowledge that represents depression in two dimensions:

- Analysis on five (5) levels of depression
- Analysis on nine (9) major causes of depression

3.1.2.1 Understanding different levels of depression

Depression can be analyzed from many aspects. The most common way is to categorize depression into five types, namely major depressive disorder, dysthymia, seasonal affective disorder, postpartum depression, and bipolar disorder [31]. However, it would be a redundancy if DECES did the same thing in dividing depression into the above types as there have been many successful systems built on this basis. A new approach of depression severity analysis shown in the project represents five different levels, which are: Gold, Lost of Sparkles, Blues, Grey, and Black [32]. The general explanation for each level is as followed:

- Gold level

  People at this level live out the full potential color, variety and creativity that is possible to them. Confidence, energy, interest, and a feeling of self-worth are what they have most of the time. Their world appears to be bright and interesting, clear and acute. Not many people manage to reach this high level

- Lost of Sparkles level

  Most of the people would be at this level of liveliness, where they might be very successful, but life is a little muted, less vivid, more routine than what you expect it to be. They are not depressed. However, they might not enjoy life to its fullest because of many factors that limit your pleasure, immediacy, satisfaction and inner confidence

- Blue level

  Everyone gets blues now and again. They might have depression that lasts a few days, or even only a few hours. This is temporary loss of energy, motivation, interest, care for yourself and others because they are feeling down

- Grey level

  People at this level are definitely depressed. They might have lost their will and interest to keep fighting, but they have not lost their sense of hope altogether

- Black level

  This is the most serious level of depression whereby a number of physical characteristics become prominent and there is a feeling of being taken over by an irresistible process of emptiness. Lost of appetite, weight, hope makes it difficult for people at this level to contemplate a future at all.

There are effective self-help treatments that are recommended for patients at each of this level, except for Black level which required an immediate doctor consultation to prevent any possibility of suicidal. The DECES differentiate patients of each level based on more than thirty predefined symptoms.

3.1.2.2 Understanding different causes of depression

There are just as many causes of depression as any other type of psychological disorders. With the scope that puts the limit on the age of patients above 22, causes have been narrowed down as they cast out teenagers' conflicts and problems. The DECES takes into account nine main causes of depression that are most commonly seen in patients and suggests clear self-help advice on tackling them in the fastest way. In general, a person who is depressed is one of the following cases:

- A woman who just gave birth
- One who is unemployed or just lost his/her job
- One who is bored or stressed at work
- One who just lost someone/something he/she loved
- One who is in a relationship crisis
- One who has family problems
- One who is getting old and has physical changes
- One who is simply bored of his/her life as a whole
- One who is always very lonely

Solving a problem from the root is the strategy of this approach where causes are identified and treatments are given.

The expertise gathered is organized under the decision flowchart that goes on both parallel and serial base. This type of representation helps the insertion of knowledge into the knowledge base easier, faster and more correct. Acquiring knowledge from experts (psychiatrist and internet depression database) and revising the system throughout the whole process of prototype development is required for any modification and updated being made in time. It is almost impossible to touch knowledge acquisition only once because findings and new techniques tend to appear along the way, especially in psychology field where abstract knowledge can unpredictably change just as human nature.

3.1.3 Knowledge Representation

The knowledge collected from knowledge acquisition stage is displayed in the form of decision flowcharts, which offer a clear and logical way of interpreting data that would lead to certain results (Figure 3.2)

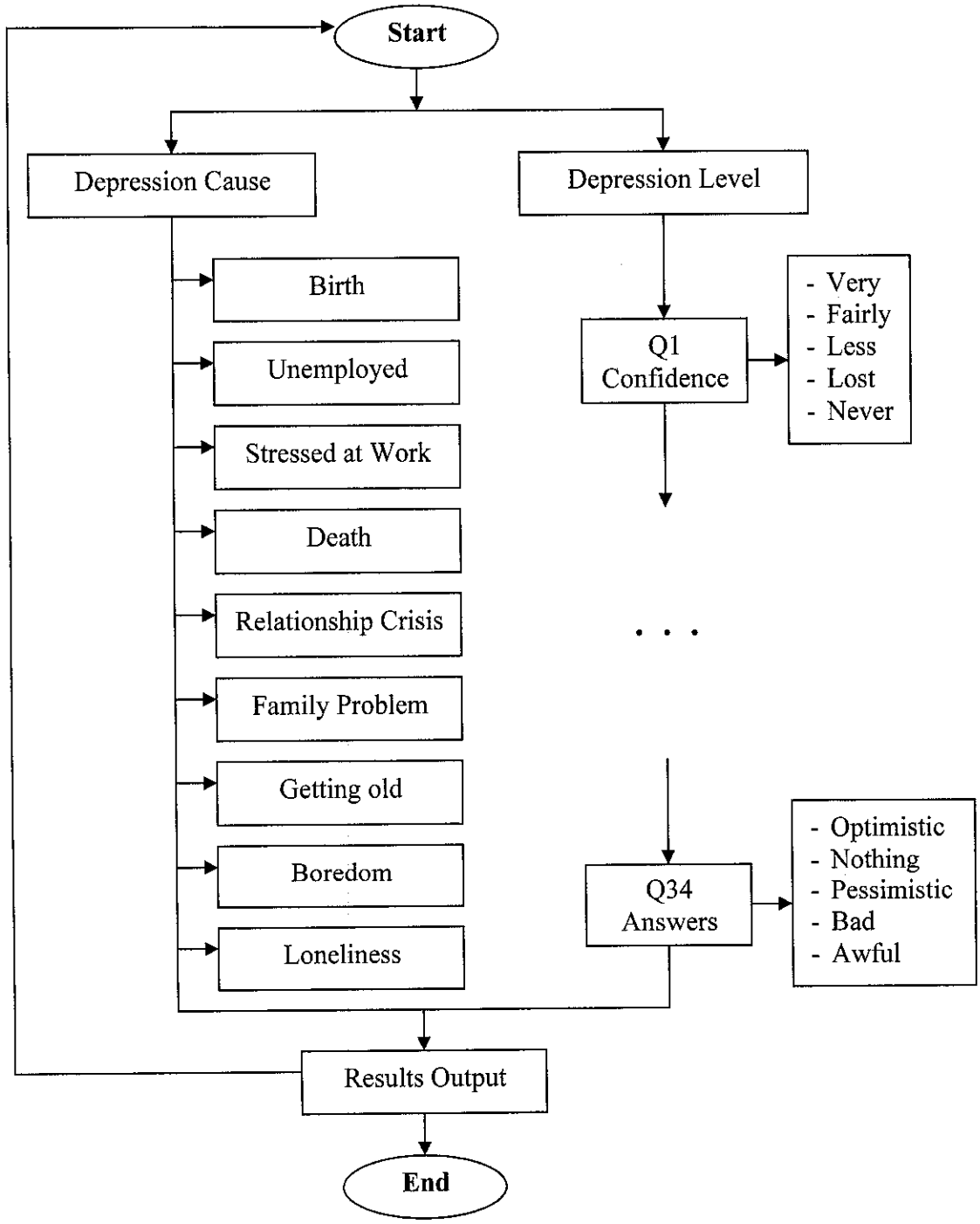


Figure 3.2: DECES Decision Flowchart

As shown in Figure 3.2, the DECES is divided into two independent sub-categories: depression cause and depression level. Under depression cause there are nine parallel options that would lead to a direct result. On the other hand, there is a serial of 34 questions to be attended one by one under depression level. The completion of these questions would ultimately lead to a result. The system would end or restart to go back to the first choice of either one of the two categories based on user's selection.

Based on the flowchart, knowledge is extracted and inserted into a knowledge base under **production rules**. These rules represent knowledge in condition- action pairs: IF this condition (premise) occurs, THEN some action (result) will be taken. For example:

IF: State the cause of your depression and get help
AND: You are a mother who just delivered a baby
THEN: score1: Confidence = 1000

In Exsys CORVID, premises as well as results are called variables. A variable contains the following characteristics:

Name — The name of a variable. E.g. confidence, enjoyment, answers...

Type — A variable can be Static, Dynamic, Continuous, Collection or Confidence. DECES implements 2 most popular types of variable which are Static for premises and Confidence for results.

- **Static Variables**
  These are variables with a fixed set of possible values. They can be represented in radio buttons or check boxes which are very convenient and simple for user to select their options. DECES includes all static variables for depression symptoms and causes.
- **Confidence Variables**
  These variables are used to calculate the likelihood or confidence of particular item being an appropriate solution or recommendation

of the system. DECES uses them to get the total scores of each patient based on the selected symptoms answered in each question to determine their depression level.

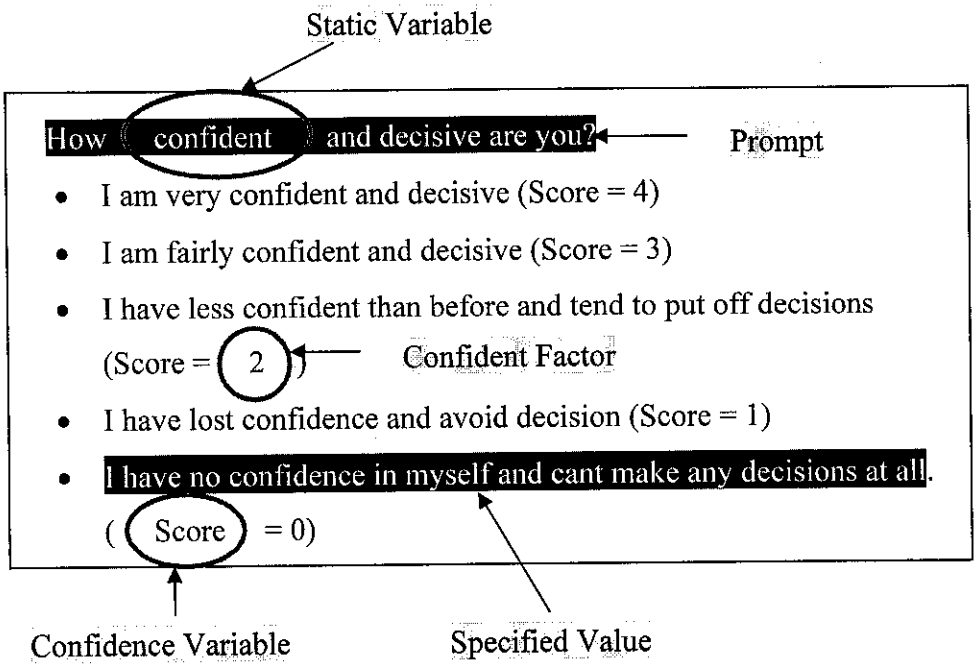
Prompt — The query presented to the user when asking user for input or in displaying results. In other words, it displays the questions before options for answers are shown.

Specified Values — Static variables have multiple values to be inserted by knowledge engineers. For example, the static variable Confidence in question 1 has 5 values:

1. Very
2. Fairly
3. Less
4. Lost
5. Never

Confidence Factors — These factors are associated with specified values of a variable. They have the numerical values like 1, 2, 3... and are summed up at the end to display predefined results. In DECES, there are 5 options for answer at every question. These options' confidence factors valued from 0 to 5.

Example

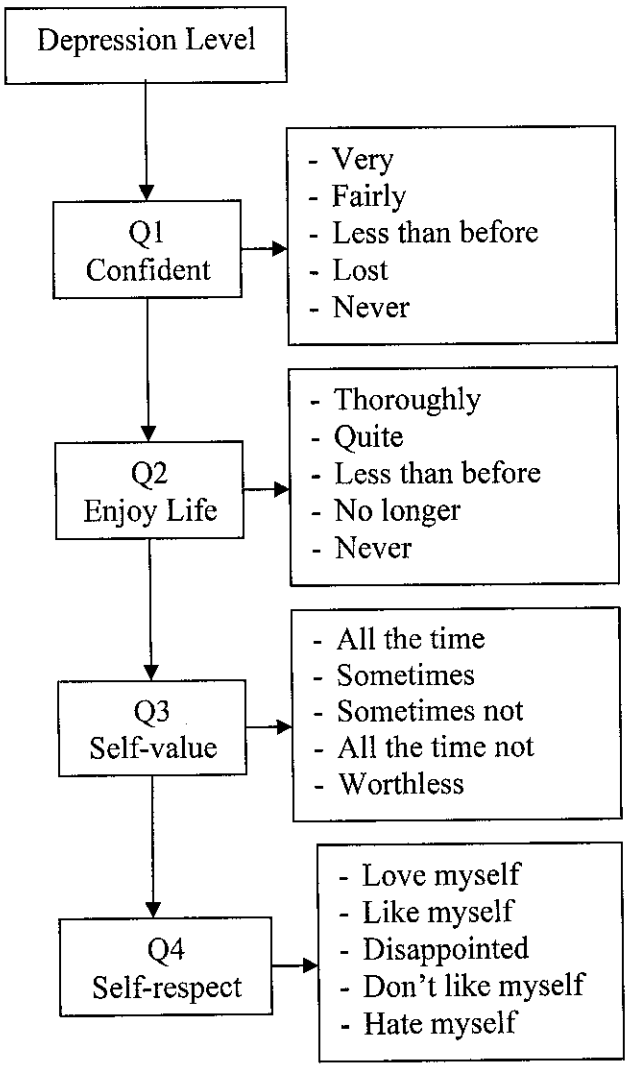


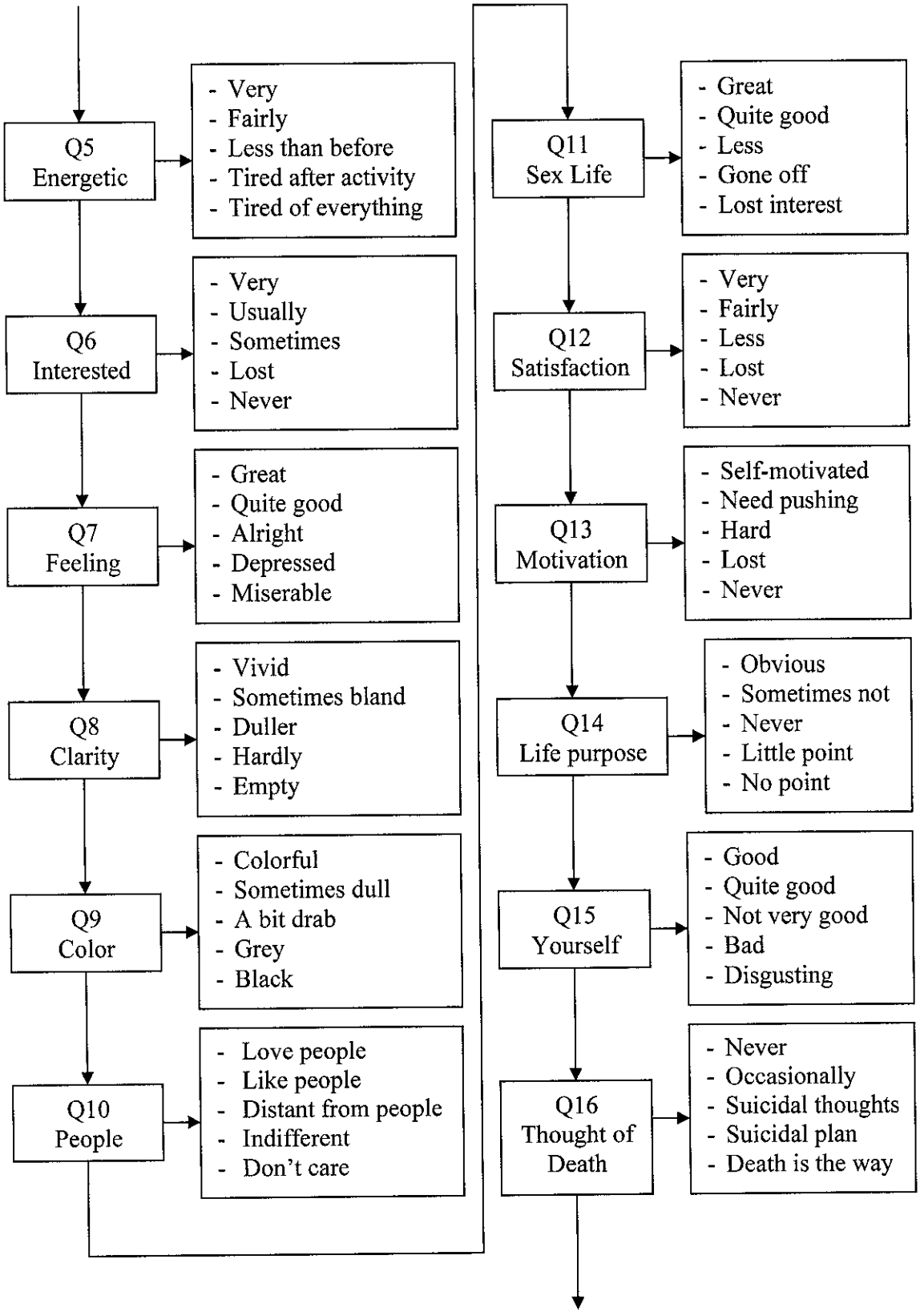
3.1.4 Prototype Development

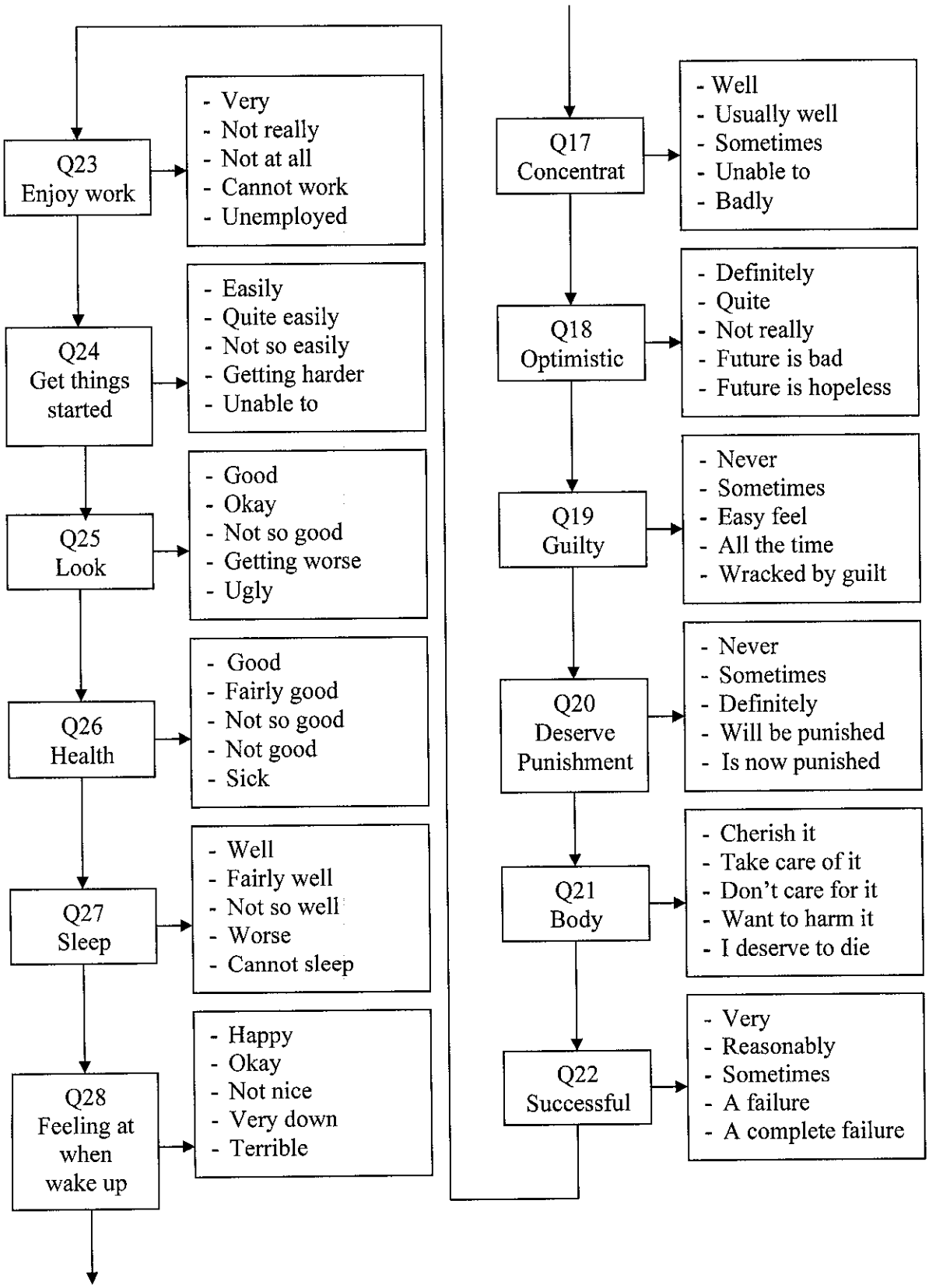
The organized knowledge is coded into framework of the development tool to build a working prototype. At this stage, knowledge base and inference engine are established. Prototyping helps to verify the system's integrity and reliability.

3.1.4.1 DECES Knowledge Formalization

Figure 3.3 shows the flowchart for Depression Level sub-category. The chosen knowledge on level of depression is organized into a total of 34 questions under 34 static variables, each of which carries 5 specified values. These characteristics on depressive cases have been chosen from hundreds for most common generalization.




Q5
Energetic
- Very
- Fairly
- Less than before
- Tired after activity
- Tired of everything
Q6
Interested
- Very
- Usually
- Sometimes
- Lost
- Never
Q7
Feeling
- Great
- Quite good
- Alright
- Depressed
- Miserable
Q8
Clarity
- Vivid
- Sometimes bland
- Duller
- Hardly
- Empty
Q9
Color
- Colorful
- Sometimes dull
- A bit drab
- Grey
- Black
Q10
People
- Love people
- Like people
- Distant from people
- Indifferent
- Don't care
Q11
Sex Life
- Great
- Quite good
- Less
- Gone off
- Lost interest
Q12
Satisfaction
- Very
- Fairly
- Less
- Lost
- Never
Q13
Motivation
- Self-motivated
- Need pushing
- Hard
- Lost
- Never
Q14
Life purpose
- Obvious
- Sometimes not
- Never
- Little point
- No point
Q15
Yourself
- Good
- Quite good
- Not very good
- Bad
- Disgusting
Q16
Thought of
Death
- Never
- Occasionally
- Suicidal thoughts
- Suicidal plan
- Death is the way


Q23
Enjoy work
- Very
- Not really
- Not at all
- Cannot work
- Unemployed
Q24
Get things started
- Easily
- Quite easily
- Not so easily
- Getting harder
- Unable to
Q25
Look
- Good
- Okay
- Not so good
- Getting worse
- Ugly
Q26
Health
- Good
- Fairly good
- Not so good
- Not good
- Sick
Q27
Sleep
- Well
- Fairly well
- Not so well
- Worse
- Cannot sleep
Q28
Feeling at when wake up
- Happy
- Okay
- Not nice
- Very down
- Terrible
Q17
Concentrat
- Well
- Usually well
- Sometimes
- Unable to
- Badly
Q18
Optimistic
- Definitely
- Quite
- Not really
- Future is bad
- Future is hopeless
Q19
Guilty
- Never
- Sometimes
- Easy feel
- All the time
- Wracked by guilt
Q20
Deserve Punishment
- Never
- Sometimes
- Definitely
- Will be punished
- Is now punished
Q21
Body
- Cherish it
- Take care of it
- Don't care for it
- Want to harm it
- I deserve to die
Q22
Successful
- Very
- Reasonably
- Sometimes
- A failure
- A complete failure

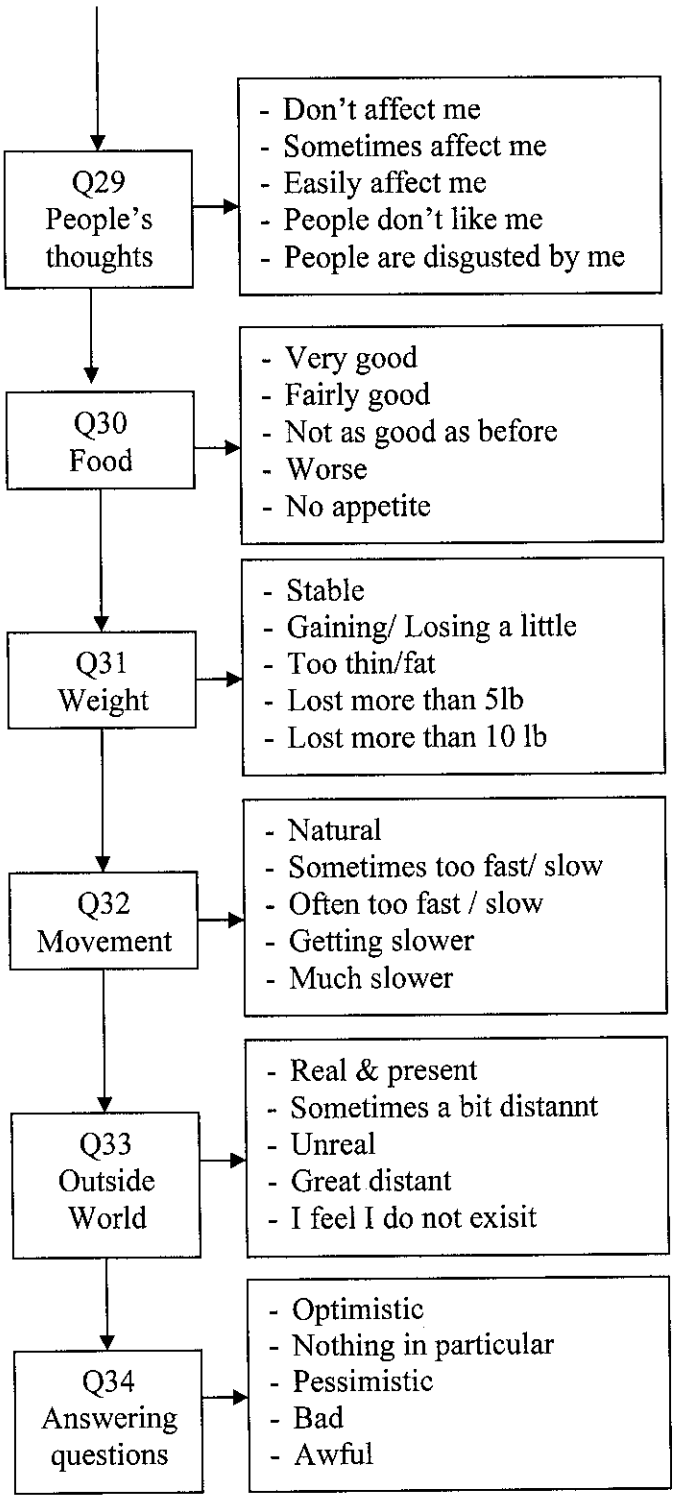


Figure 3.3: DECES - Depression Level flowchart

Answers to 34 chosen questions above can be categorized into 5 different groups according to the pattern of their similarity as the following:

- Group 1

Option	Confident Factor
Very /Thoroughly	4
Fairly / Quite / Not really	3
Less than before	2
Lost / No longer / Gone off	1
Never	0

Example

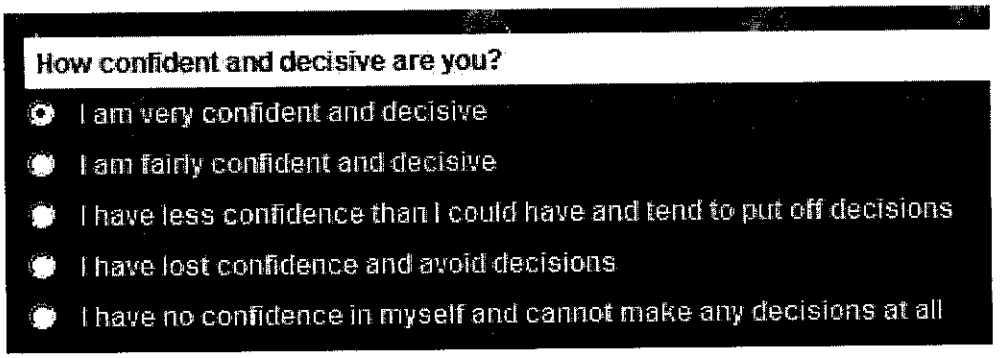


Figure 3.4: Group 1 question sample

- Group 2

Option	Confident Factor
Great / Good / Optimistic	4
Quite good / Okay	3
Not so good / Pessimistic	2
Bad / Very down	1
Terrible / Disgusting / Sick / Ugly / Unable	0

Example

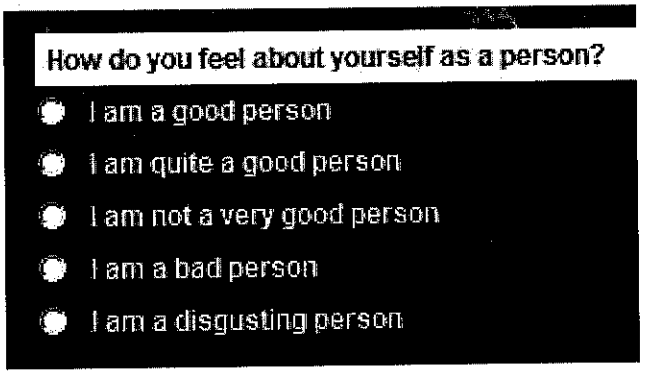


Figure 3.5: Group 2 question sample

Group 3

Option	Confident Factor
All the time	4
Usually	3
Sometimes	2
All the time not / Little point	1
Never / No point / Unable	0

Example

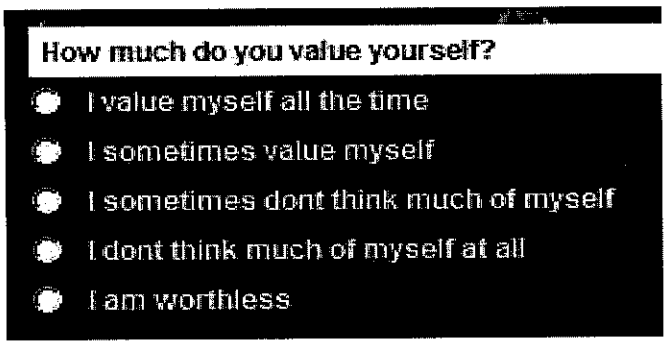


Figure 3.6: Group 3 question sample

- Group 4

Option	Confident Factor
Love / Cherish	4
Like / Take good care	3
Disappointed / Distant / Less care	2
Don't like / Indifferent	1
Hate / Don't care / Think of death	0

Example

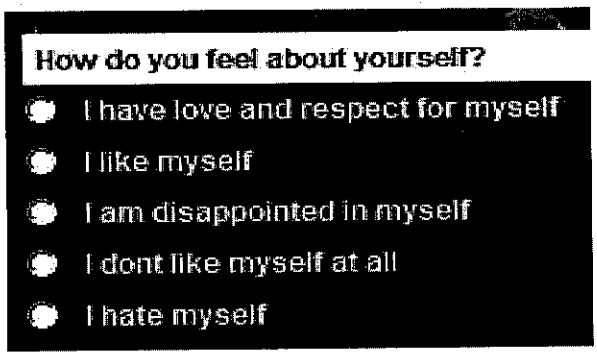


Figure 3.7 Group 4 question sample

- Group 5

Option	Confident Factor
Colorful/ Real / Vivid	4
Dull/ Distant / Bland	3
Drab /Unreal	2
Grey /Great distant	1
Black / No existence / Empty	0

Example

Figure 3.8 Group 5 question sample

3.1.4.2 Logic Block

In Exsys CORVID, Logic blocks are made up of IF-THEN production rules that can be defined by tree diagrams. This has been proven the most effective way to describe the heuristics for the decision-making process. In DECES, there are 36 logic blocks all together representing declarative knowledge of depressive cases.

The very first logic block named 'First screen' determines the result of user's choice in selecting between the option of testing depressive level and that of checking the cause of depression. The tree diagram of this block is shown in Figure 3.9 below. Each line in the tree is a node. There are a total of 397 nodes in DECES

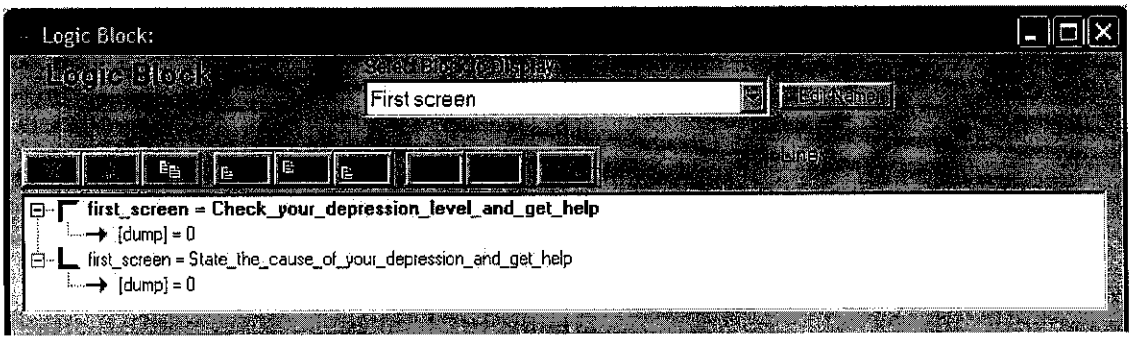


Figure 3.9: First screen Logic Block

The following 34 Logic Blocks contain rules that indicate the calculation of confidence factors for 34 questions on Depression Level. The example of 'Body' Logic Block is blow:

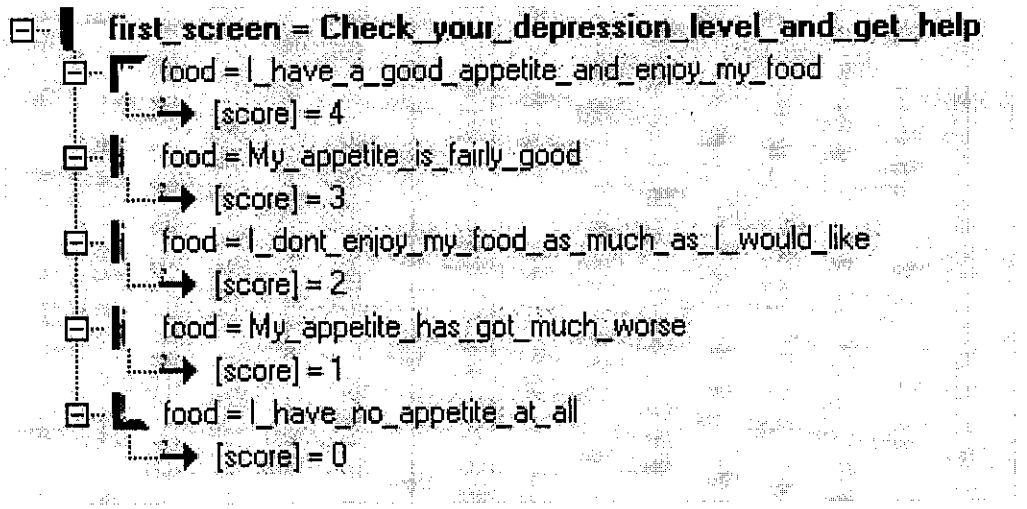


Figure 3.10: Body Logic Block

As the user goes from one question to another until the end, confident factors will be totaled up and results will be determined based on the final confident level. In the above example, a score is given only if 2 conditions are satisfied:

IF:

first_screen = Check_your_depression_level_and_get_help

AND:

Food = I_have_a_good_appetite_and_enjoy_my_food

THEN:

[score] = 4

This is because to reach the second condition of user's choice on 5 answering option, there must be a selection on depression level test at the first screen. The 5 rules that lead to 5 scores are equivalent. This particular structure helps the Logic Block be clear and easy to construct.

The last Logic Block indicates the choice on 9 causes of depression. Exsys CORVID provides Rule View window that displays the IF-THEN rule currently being worked on. It is more convenient to use this tool in maintaining and verifying the system.

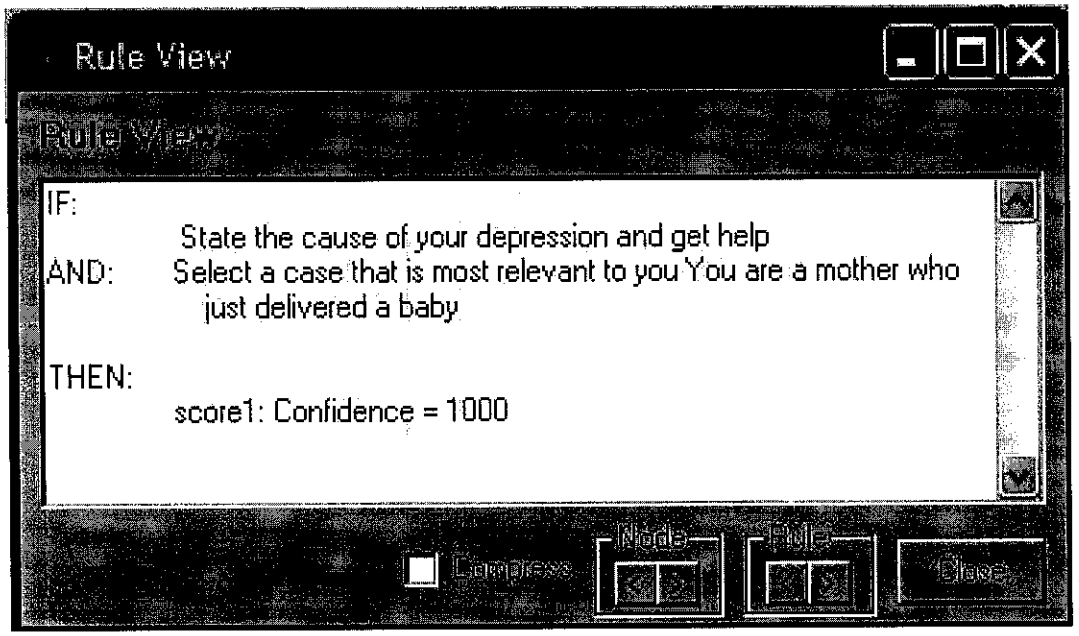


Figure 3.11: Rule View window for Cause Logic Block

3.1.4.3 Command Block

If Logic Block tells the system what things to do, Command Block gives instruction on when to do those things. In DECES, Command Block controls the procedural flow and displays the results accordingly, using 'test rules'. For example, the result 'Gold Level' is displayed when the total meet the test of confident value between 110 and 126. There are 5 result screens for 5 depression levels, and 9 other screens showing the self-helps for 9 different causes of depression.

The following shows the 14 Commands in DECES:

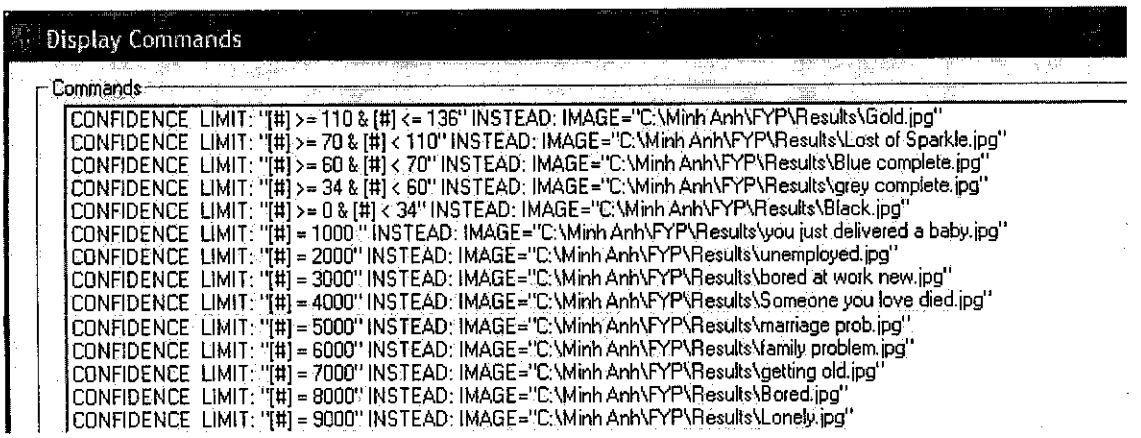


Figure 3.12: DECES Display Commands Window

3.1.4.4 Forward Chaining Versus Backward Chaining

Our system uses **forward chaining approach**. The system is more data-driven to get the results. It starts with the available information, which is symptom selected by the user, and draws the conclusion. The rules are tested in the order that they occur sequentially. In the case diagnosis system in general and of DECES in particular, forward chaining is a faster and more applicable approach as the information (knowledge on depression) is already available at the beginning and the main task is to use the logic in the production rules to analyze it. Its drawback would be the must to go through all the questions without and intermediate answer for a particular question. One advantage of Forward Chaining approach is its straight-forward characteristic. Another one would be the fact that developers can define the sequence of the questions according to their preference. This helps DECES to run smoothly and achieve its objectives of coming out the results for 2 categories in depression levels and causes.

Another approach provided in Exsys CORVID is backward chaining. It is goal-driven as it specifies the conclusion (goal) at the beginning, and then determines what is it needed to meet the goal. It goes the opposite direction in comparison with forward chaining. Systems used this approach would ask specific questions that fulfill the conclusion and keep track of the sequence of questions itself. This takes more time than in forward chaining approach.

3.1.4.5 User Interface

User interface was developed on the structure given by Exsys CORVID software. The graphical design tool is Photoshop CS which allows photo and text editing creatively.

The first screen (Title screen) welcomes user into the system and give a brief explanation on DECES as well as guidance on how to use the system. It includes two choices indicated by 2 radio button for user to select between part one (depression level diagnosis) and part two (depression causes and treatment).

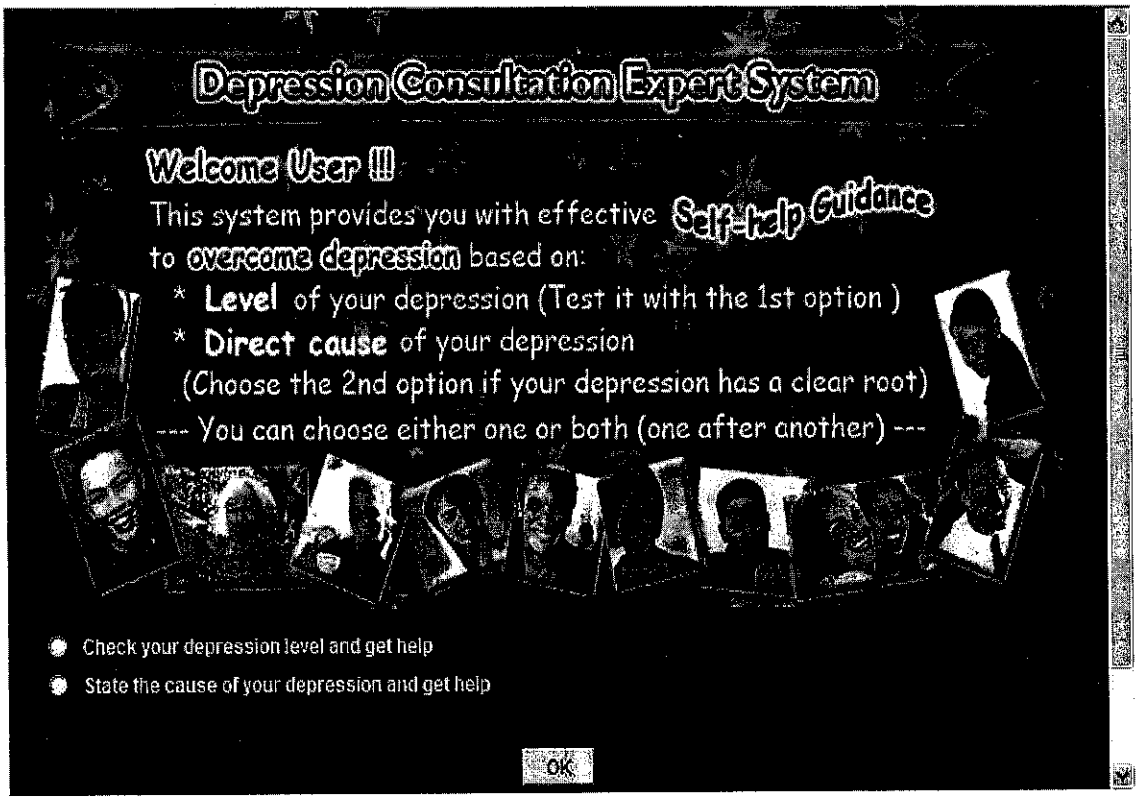


Figure 3.13: DECES Title screen

By selecting the first radio button, user would enter part 1 which contains a sequence of 34 questions to diagnose depression level. Each question has 5 options represented by 5 radio buttons.

The sample question is as follows

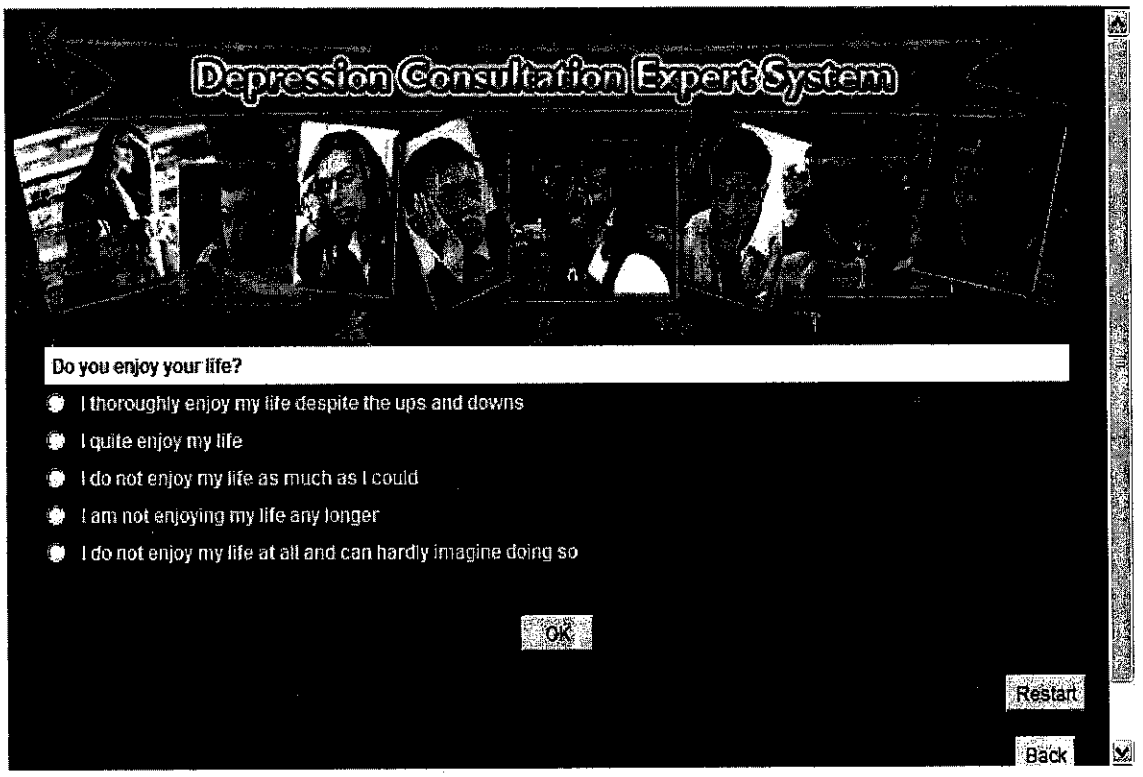


Figure 3.14: DECES question 2 screen

After answering 34 questions result screen would appear with the level of depression the system managed to generate according to total confident values. User would know their level as well as self-help treatment to improve their condition.

Figure 3.15 shows the result screen for Lost of Sparkles level

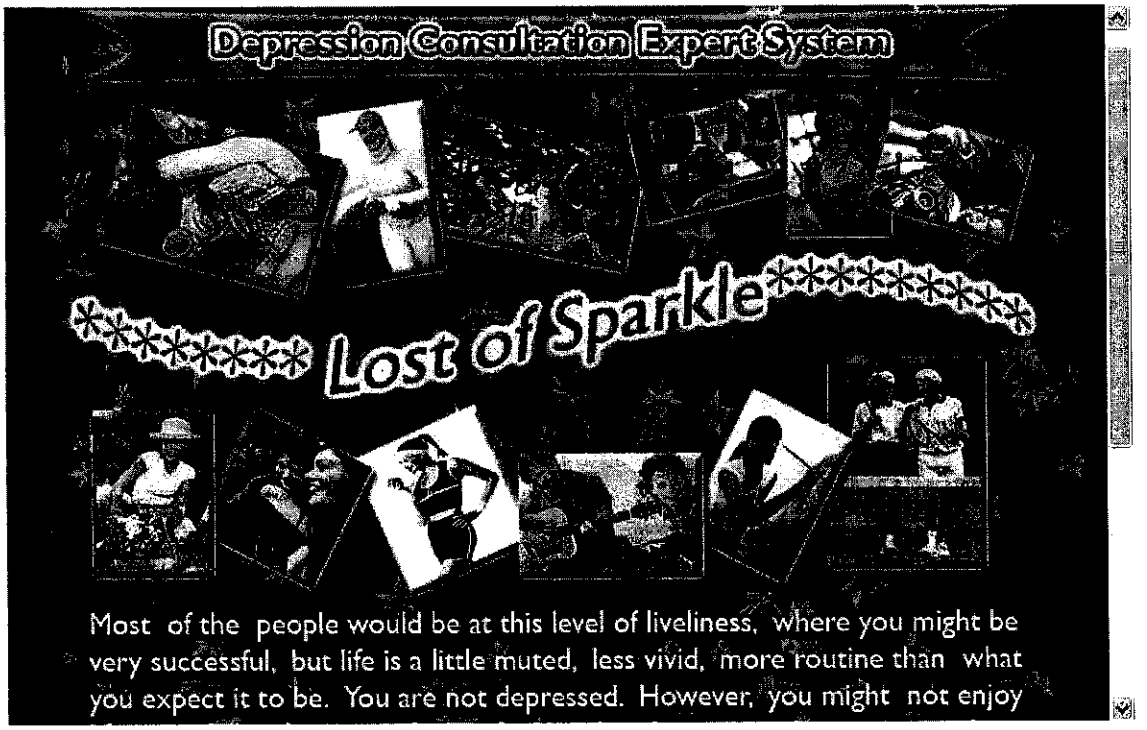


Figure 3.15: DECES result screen for Lost of Sparkle Level

By selecting the second radio button in the title screen, user would enter part two in which they need to select the condition that is most suitable for them as their cause of depression.

The screen for part two is shown below:

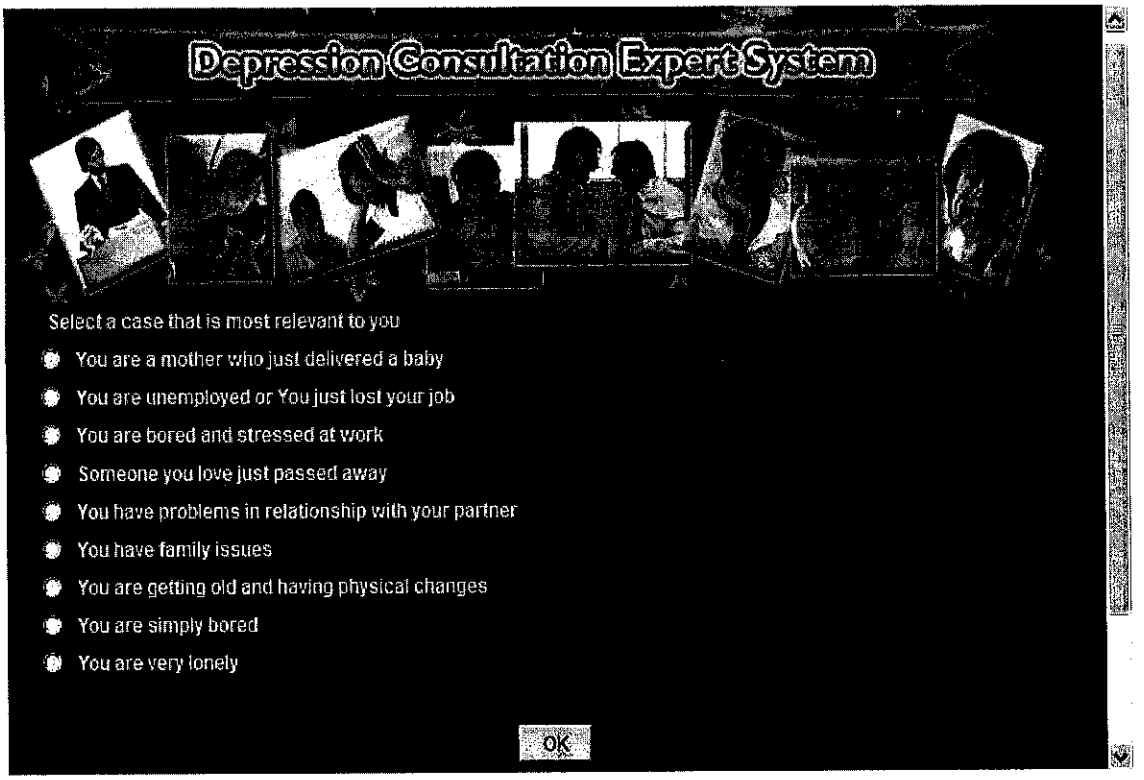


Figure 3.16: DECES depression causes screen

After choosing one option, the result screen will be displayed in which self help on how to overcome depression caused by this particular condition.

Figure 3.17 shows the result screen for the condition of unemployment or loss of job

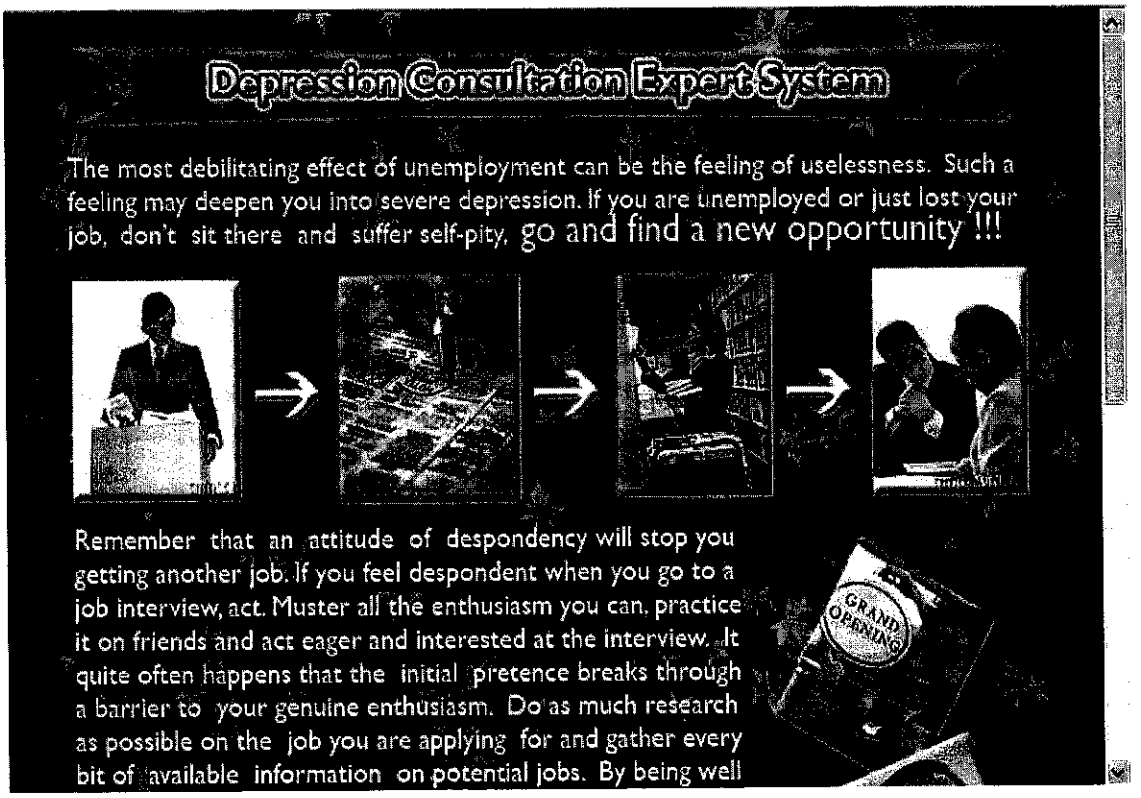


Figure 3.17: DECES result screen for unemployment condition

3.1.5 Validation and Verification - Black-box Testing

Validation and verification of the DESES is carried out throughout the entire development process to ensure the accuracy of the knowledge base as well as the functionality of the prototype. Exsys CORVID does not require any programming codes except for IF- THEN statements which narrows down the testing process to only input-output relationship evaluation. This means the system would be tested on inputs keyed in by users and the corresponding outputs which are expected to be correct. Black-box testing is chosen for this purpose. Any discrepancies between the system output and expected output indicate a problem with the prototype. Changes are then made to fix the problem and the system is tested again until the prototype is credible and acceptable. DECES can only be launched for usage at the competition stage.

Another attempt in testing the prototype is to verify the ease of use provided by the system as well as the validation in results. Three main groups of testers include:

- Psychiatrists
- Counselors
- Depressed individuals

Test cases for DECES are prepared by developer and executed on depressive individuals (mostly students) to examine realistically the performance of the system. Testing is conducted in careful manner, where all the cases cover certain possible combinations of input values. The base of the test is the logical completeness as well as consistency of the DECES.

Test cases are also provided by psychiatrists and UTP counselors to have a different look from recorded and professional angles. This coverage of sources in such a testing plan allows DECES to meet its objectives of completing a helpful tool for depression consultation and self-help treatment. Comprehensive testing with different user groups further enhances DECES's credibility and quality

3.2 TOOL REQUIRED

3.2.1 Hardware

- Processing speed : 1.73GHz
- RAM : 512MB
- Hard Disk space : 40GB

3.2.2 Software

- Operating System : Windows XP Home Edition
- Development Tool : Exsys CORVID Version 3.1.2
- Graphical Tool : Photoshop CS

CHAPTER 4
RESULTS AND DISCUSSION

4.1 SYSTEM FUNCTIONALITY TESTING

100 Questionnaires (Appendix) were distributed to users of 4 groups (students, lecturers, psychiatrists, and counselors) to gather comments on system functionality and ease-of-use. A total of 6 questions surveying user's opinions are as follows:

1) Is it easy to follow the flow of the system?
2) Are the questions on depression symptoms and causes appropriate and understandable?
3) Are the explanations in the results understandable?
4) Are you overall comfortable using the system?
5) Is the diagnosis made by the system useful for education and health-care purposes?
6) Would you recommend the system to others?

The structured answers for these questions require users to choose between 1 and 5 (1: strongly disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, and 5: strongly agree). The result of the survey is shown in the diagram in Figure 4.0.

According to the diagram, users generally agree on the effectiveness and ease-of-use of the system. 95% evaluate the system as easy to follow, and more than 90% are satisfied with the understandable content of the questions and results displayed. There are a few that have neutral answer and less than 6% are not totally comfortable using the system due to the reason of 'too many questions'. It is agreed that DECES is useful for education and health care purposes as well as a good recommendation for other depressive cases. With the help of Exsys CORVID convenient development tools, the system functionality reaches the expected standard of easy to use and making no logical errors.

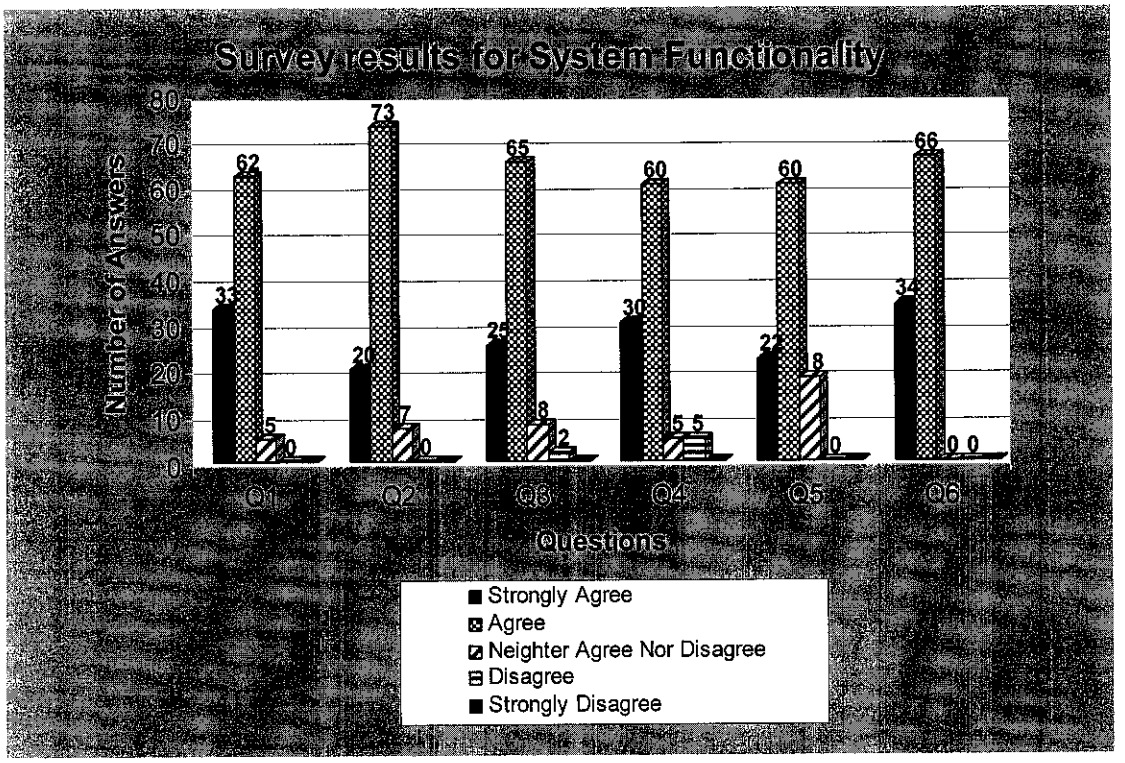


Figure 4.0: System Functionality Survey Results

4.2 RESULT VALIDATION TESTING

It is essential for DECES to be tested under real cases to make sure the validity of the given results. Psychiatrists and counselors were consulted to give out test cases on their previous depressive patients. The professionals are

1. **Dr. Vu Thi Chin**

   She is a pediatrician having the advantage of an "Interne des hopitaux de Hanoi". Over more than 30 years of her medical career, she has concentrated her study on child and mother relationship and followed the course of the mental development of a child from his/her early age. She has published 2 books named "Mother and child" (2d edition 2005) and "The psychopathology of the child" (2d edition: 2005) in which she analyzed root causes of adolescence's depression and other psychological disorders related to childhood and family harmony.

2. **Ms. Maznah Bt Rosli**

   Student counselor in Student Support Services Unit of University Technology PETRONAS (UTP). She has been one of the few counselors for UTP students since the very beginning of the university opening. Her professional training and experience in counseling help her to analyze many cases quickly and accurately. Understanding different psychological paths encountered by depressive patients, she tackles problems and give effective advice that contributes to the happy atmosphere and reduces depression level around the campus. As one of the students mentioned before, 'she gives great help as she can see through us and motivate us'.

3. **Mr. Idham B Ghani**

   Career Counselor in Career Advisory Unit of University Technology PETRONAS. His daily job is not only to give guidance and motivation to graduating student in getting jobs but also to calm those freshies down from stress and anxiety. The worries for future brings all sorts of depression, either minor or major, to students and Mr. Idham's task is to lead them the way out and make them more optimistic in their new paths.

Two parts of the DECES were tested separately based on their different natures. The first part on 'Depression Level' which provides a set of 34 questions for diagnosis had the results examined to ensure the symptoms and the level of depression match according to expert data source. The second part 'Depression Cause and Treatment' were tested in terms of the correct recommendation on patient self-help. The professionals determined if the advice given by DECES is helpful and clinically acceptable.

4.2.1 DECES Part 1 (Depression Level) Testing

There are different categorizing methods for depression levels as a result of a psychological diagnosis. Based on patient symptoms, doctors can conclude the condition in terms of depression types, lengths, seriousness, and many more. After the explanation and discussion on the method used by DECES in dividing depression into 5 levels,

compromising decisions were made for an effective testing process. The professionals would based on the clinical results and categorize the subjects (patients) into one of the five levels predefined by the system before using it. The diagnosis from experts would be compared with the results the system generates after answering a complete set of 34 questions for this part. The experts would also check the treatment recommendation to ensure the validity of the advice suggested by DECES.

There are two types of subject provided by the professionals:

1. The past subject with data recorded in patient history
2. The current subject with data being gathered and can take the test directly on the system.

The following shows the process of result analyzing:

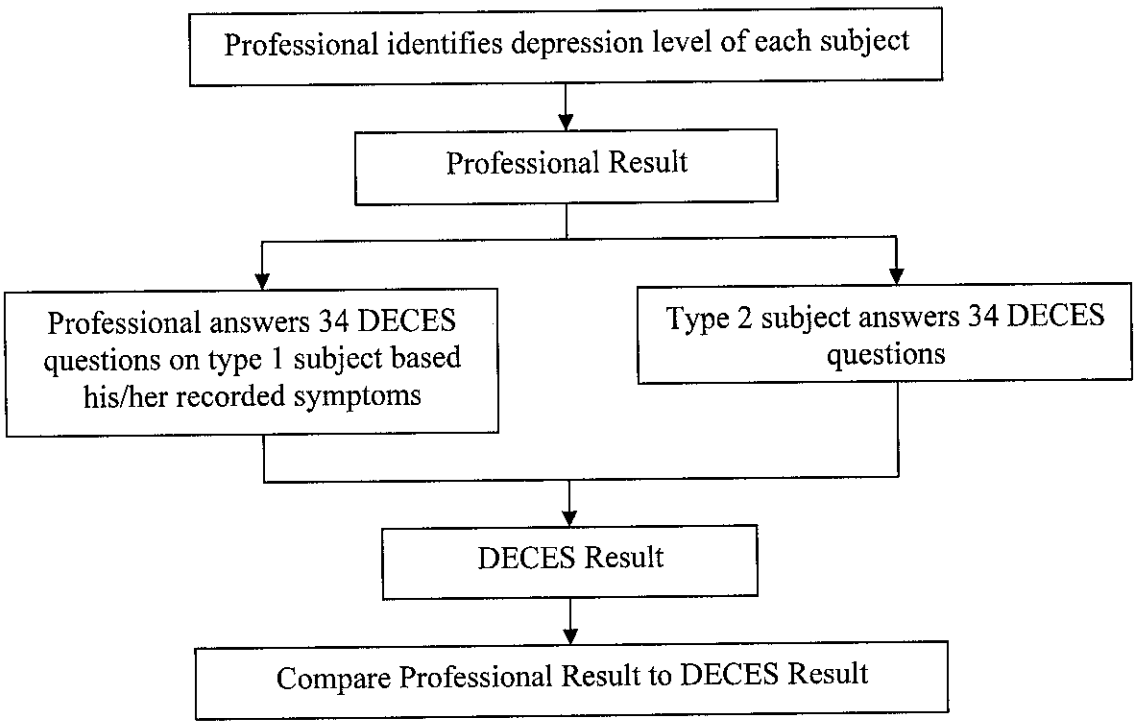


Figure 4.1: DECES Result analysis flowchart

There are a total of 20 subjects being tested:

- 8 subjects under Dr. Vu Thi Chin (C)
- 8 subjects under Ms. Maznah Bt Rosli (M)

- 4 subjects under Mr. Idham B Ghani (I)

Table 4.0 represents the data gathered after testing 20 of the above subjects. In the table, 5 depression levels are numbered from 0 to 4. 0: Black, 1: Grey, 2: Blues, 3: Lost of Sparkle, and 4: Gold level. For each level, the total confident factor ranges are: 0- 33 (level 0), 34 - 59 (level 1), 60 – 69 (level 2), 70 - 109 (level 3), and 110 -136 (level 4).

Table 4.0: Results on 20-subject testing

No	Prof.	Age	Subject Type	Sex	Prof. Result	Total Conf. Factor	DECES Result
1	C	44	1	F	1	41	1
2	C	55	1	F	0	32	0
3	C	29	1	F	2	59	1
4	C	43	2	M	1	48	1
5	C	36	2	F	1	56	1
6	C	30	1	F	0	27	0
7	C	28	2	M	2	66	2
8	C	33	1	F	2	63	2
9	M	23	1	F	0	28	0
10	M	19	1	F	2	73	3
11	M	20	1	F	1	55	1
12	M	18	1	M	0	32	0
13	M	23	2	M	2	64	2
14	M	24	2	M	1	49	1
15	M	18	1	F	0	26	0
16	M	21	2	F	2	72	3
17	I	22	1	F	1	58	1
18	I	21	1	M	2	65	2
19	I	23	1	M	3	69	2
20	I	20	2	F	2	66	2

According to the above table, there are more type 1 subjects (13 cases) than type 2 (7 cases). Subject names are confidential due to privacy issue. The age range is widely considered from 18 to 55. This proves that depression can happen to anyone despite their age differences. An 18 year-old girl who just entered university might be just as miserable as a 55 year-old lady who just started her retirement. The difference is in their reasons and levels of expression. There are more females (11 girls) than males (9 guys). This reflects the general trend from professionals' statistics. According to Ms. Maznah, there are more females who came to her for consultation because they have more problems to feel depressed about. Especially for young girls at the age from 18 to 24, all sorts of relationship problems affect them a great deal and push them into a face of distance from people. Girls tend to be more sensitive with the environment and less adaptable to changes and harshness of difficult situations. For female adults, Dr. Chin mentioned that family issues such as relationship with husband, mother in law, child-care were the main reasons that lead to their serious level of depression. When analyzing about male cases, Mr. Idham referred to certain cases that instead of having troubles communicating with people, they feel too overwhelming of success in social events and multiple relationships that it reaches a point where those things make them depressed and lose purpose in life. They kept running after something abstract.

One more point that can be extracted from the table is that most patients who come for counseling are in severe levels of depression. Those with minor blues or lost of sparkles normally underestimate their conditions or feel there is no urge to have any type of treatment since they are not totally miserable. This is not advisable because unattended discomfort or reduction of energy would gradually lead to a more serious condition. It is better to check whenever patients start to feel down, less confident, less energetic and have blur outlook. This would prevent depression from getting worse and save time and effort for heavy medication.

Among 20 cases, there are 4 cases in which DECES generated depression level one stage lower or higher than what was diagnosed by professionals. In other words, 80% of the

cases tested provided a correct result. Figure 4.2 shows the comparison of levels from two sources clearly.

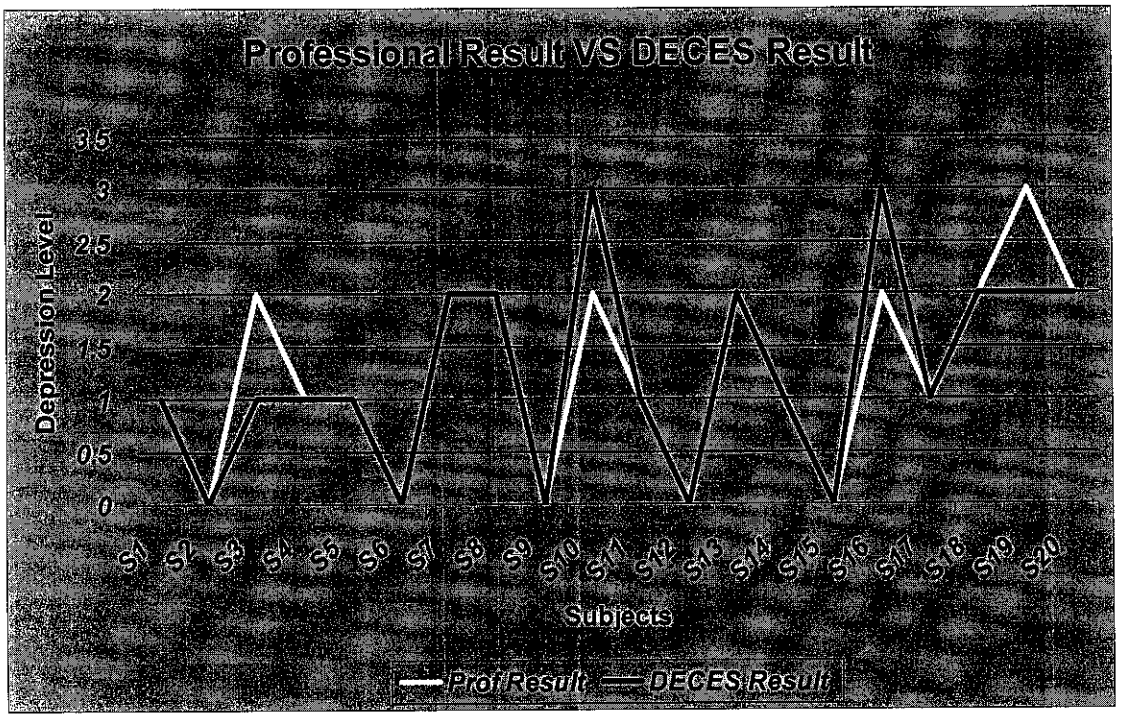


Figure 4.2: DECES Result in comparison with Professional Result on depression level

Overall the two graphs match. At the point where there are differences between the level indicated by professionals and that by DECES, the gap is only 1 level. In details:

- Subject 3: Professional result is Grey Level while DECES one is Blues. This can be explained by confident value of 59, which is very near 60, the Grey Level.
- Subject 10 & 16: Professional result is Blues while DECES one is Lost of Sparkles. Actually, these two levels somehow have certain similar characteristics. Blues is a more severe case of Lost of Sparkles. However, subjects in one of these levels could change to the other one easily due to its close relationships. Moreover 72 and 73 are the two values that are near the border of these 2 levels
- Subject 19: In this case Professional result is Blues while DECES one is Grey. There is a big difference between Blues and Grey but the subject has reached the highest level of blues (confident value: 69). Therefore, DECES indicates it as Grey.

There would always be some percentage of differences between Professional diagnosis and Depression System results due to calculation based on ranges. Considering the thin line separating different levels of depression, it is hard to indicate a certain answer when the confident values are near to the edge. There is no absolute solution for this condition. However, future adjustment can be made to the questionnaire to reduce the possibility of results reaching near the critical number between 2 neighbor levels.

The self-help advice provided by the system on each level of depression was approved by the professional as useful and clinically acceptable.

4.2.2 DECES Part 2 (Depression Cause) Testing

After examine the causes stated in part two of DECES, professionals found it reasonable to include all these 9 initiation of depression. However, it is suggested that more causes might be put into consideration as depression could come from different angle. The causes used in DECES are the most applicable ones. They are especially useful for patients in Grey depression level.

The self-help steps for each cause were commented as direct and understandable. Those are the standard steps that a patient should take to avoid depression getting worse and gradually reduce its severity. Of course, there are many other ways to heal depression. DECES suggested one of the best ways.

4.3 PROJECT LIMITATIONS

A few limitations encountered in the process of project development are as follows:

1. DECES was built using licensed Exsys CORVID software that allows an unlimited number of nodes from Electrical & Electronic Postgraduate Department. However, due to the time constraint in the availability of the software for student usage (2 weeks for full development), no adjustment could be made upon completion. This created difficulty in enhancing or editing the system even though the deadline for the project was still 3 weeks ahead.
2. DECES testing period must depend on the fixed completion time (the given 2-week period) of the system. Therefore, it had approximately only 2 weeks for results gathering and expert approaching and consultation. Moreover, availability of psychiatrists and counselors are limited in short-time notice. The system could have been tested more given a longer period of result gathering and discussion
3. DECES user interface was constructed using built-in functionalities and features that are fixed in Exsys CORVID. These tools limit a more customized and creative design for the system interface. Therefore, question and result screens are not interactively coded as compared to other software.

CHAPTER 5
CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

DECES was developed to emulate expertise in psychological area that leads to a proper diagnosis of depression cases. The system's careful interpretation of depression levels and causes as well as comprehensive step-by-step advice not only facilitate patients in identifying their depression severity but also empower them with the ability to help themselves to get better.

The system's reliability, credibility, and efficiency have been examined based on detailed design, strict rule-based development, continuous prototypes evaluation and validity tests right up to the final stage.

DECES represents a user-friendly and easy-to-understand user interface that enhances its usability and interaction with users. It is simple yet very clear that eliminates the avoidance of patients using the system due to lack of familiarity with system functions.

DECES attempts to enhance the diagnosis, timeliness, and quality of depression consultation without taking over the task of professionals. FEDES uses heuristics to build its knowledge base that have been validated by human experts for an effective usage.

DECES underlined the concept of AI under the use of expert system with rule-based knowledge representation to support decision-making process. It helps the project to meet its objectives and shows the important of computer as an irreplaceable aid for medical field in general and diagnosis in particular. The study has lead to significant impact on the depression consultation and counseling.

Considering the scarcity of psychiatrists and the increase of depressive cases due to society complication, the necessity of diagnosis and the refusal of patients in going for counseling sessions, the development of DECES is justified. DECES provides an effective and efficient gateway to an easier solution to the problems through convenient, speedy, and cheap medical medium in the knowledge age.

5.2 RECOMMENDATIONS

Future enhancements can be made to DECES as follows:

1. 34-questionnaire can be divided into 4 or 5 categories (each category would contain 7 to 8 questions of the same focus) so that users can have a choice on answering all 34 questions or only certain categories and still get the result on level of depression. This requires enhancement in Logic and Command Block to ensure the correctness in confident factor calculation in the new method.
2. With the self-help treatment provided at the results, patients are expected to follow to reduce their depression level gradually. The system could add on functions on tracking patient's improvement on weekly or monthly basis by letting them revisit the system with a user name and password. In this way, the system can identify cases that have little improvement after certain periods of treatment and update or modify step-by-step advice accordingly.
3. The system could be made for mobile device access like PDAs as this would help them take the test and get help at any time and wherever they want. Also, with the tracking function suggested above, it would be easier to manage their profile and condition without geographical limitation.
4. More surveys on user interface preference and suggestions for a widely accepted design that satisfy different groups of users.
5. Continuous updates on new symptoms and causes of depression as well as level separation standard to make sure the system is always up-to-date to solve problems that pop up in newer conditions.

6. There is a choice to transfer the knowledge base of DECES to a free-software to make it independent from software policy and easier for future adjustment in case Exsys CORVID license is expired and cannot be given in time.

REFERENCES

[1] Hand DJ. (1985). *Artificial Intelligence and Psychiatry*. New York: Cambridge University Press.

[2] Chris Nikolopoulos. (1997). *Expert System*. New York: Marcel Dekker, Inc.

[3] Cornelious T. Leondes. (2002). *Expert System: The technology of Knowledge management and decision making for the 21st Century*. San Diego, CA: Academic Press.

[4] Waterman, D. A. (1986). *A guide to Expert Systems*. Addison- Wesley.

[5] Ohayon MM. (1993). *Utilization of expert systems in psychiatry*. Can .I Psychiatry 38:203-211.

[6] Buchanan, B. and Feigenbaum, E. (1978). 'DENDRAL and Meta-DENTRAL: Their applications dimension'. *Artif. Intel.*11, 5-24.

[7] World Health Organization. (2003). *Mental Health Resources. Depression.* <http://www.who.int/mental_health/management/depression/definition/en/> (Accessed 12 March 2006).

[8] Kessler, R.C., and Walters, E.E. (1998). 'Epidemiology of DSM-III-R major depression and minor depression among adolescents and young adults in the National Comorbidity Survey'. *Depression & Anxiety*. Department of Health Care Policy 7(1): 3-14 Harvard Medical School, Boston.

[9] Haarasilta, L., Marttunen, M., Kaprio, J. and Aro, H. (2001). 'The 12-month prevalence and characteristics of major depressive episode in a representative

nationwide sample of adolescents and young Adults'. P*sychological Medicine.* 31(7):1169-79.

[10] Schweitzer, R., Klayich, M. and McLean, J. (1995). 'Suicidal ideation and behaviors among university students in Australia'. *Australian & New Zealand Journal of Psychiatry. 29(3):473-9*

[11] Andrews G., Sanderson, K., Slade, T. and Issakidis, C. (2000*). Why does the burden of disease persist? Relating the burden of anxiety and depression to effectiveness of treatment.* Bulletin of the World Health Organisation. 78(4): 446-452.

[12] Bermata.com. (2005). <http://www.wfmh.org/documents/malaysiareport.doc> (Accessed 15 March 2006)

[13] Aalto-Setaelae, T., Marttunen, M., Tuulio-Henriksson, A., Poikolainen, K. and Loennqvist, J. (2001). 'One-month prevalence of depression and other DSM-IV disorders among young adults'. *Psychological Medicine.* Vol 31(5): 791-801.

[14] Katerndahl, D.A. (1996). 'Panic attacks and panic disorder'. [Review] [56 refs] *Journal of Family Practice.* 43(3):275-82.

[15] Phillips, L., Yung, A.R., Hearn, N., McFarlane, C., Hallgren, M. and McGorry, P.D. (1999). 'Preventative mental health care: accessing the target population'. *Australian & New Zealand Journal of Psychiatry.* 33(6):912-7.

[16] Cooper, G.A. (2001). 'Online assistance for problemgamblers: An examination of participant characteristics and the role of stigma'. *Dissertation Abstracts International Section A: Humanities and Social Sciences.* 62 (4-A): 1334.

[17] Gordana Culjak and Mark Spranca. (2006). *Internet Improves Health Outcomes in Depression.* IEEE Engineering in medicine and biology.

[18] Glasgow, R.E., Sheana, S.S., Piette, J.D. and Steiner, J.F. (2004). 'Intereactive Behaviour Change Technology. A partial Solution to the Competing Demands of Primary Care'. *American Journal of Preventive Medicine.* 27(2S) 80-87

[19] Christensen, H., Griffiths, K.M. and Korten, A. (2002). 'Web-based Cognitive Behavior Therapy: Analysis of Site Usage and Changes in Depression and Anxiety Scores'. *Journal of Medical Internet Research.* 4(1):e3.

[20] Taylor, H. (1999). *Explosive growth of "cyberchondriacs" continues.* <http://www.harrisinteractive.com/harris_poll/index.asp?PID=117>. (Accessed 17 March 2006)

[21] Shortliffe, E. (1976). Computer *Based Medical Consultations: MYCIN.* Elsevier.

[22] Casimir A. Kulikowski. (1983). *Expert Medical Consultation System.* Plenum Publishing Corporation.

[23] D. Gelernter and J. Gelernter. (1984). 'Expert systems and diagnostic monitors in psychiatry'.*Proc. Eight Annu. Symp. Comput. Appl. Med. Care,* New York.IEEE.45-48.

[24] M. Overby. (1987)'PSYXPERT: An expert system prototype for aiding psychiatrists in the diagnosis of psychotic disorders'. *Compur. Bid. Med.*6(17) 383-393

[25] Joseph D. Bronzino. (1989). *OVERSEER: A Prototype Expert System for Monitoring Drug Treatment in Psychiatric Clinic.* IEEE Transactions on Biomedical Engineering. 36(5) 533-540

[26] Abraham Kandel. (1991). *Fuzzy Expert System.* Florida: CRC Press, Inc.

[27] A Z TOMIAK. (1992). *A Family Therapy Expert System: A Practical Application of Expert Systems in the area of Psychological Diagnosis.* IEEE Intelligent Decision Support System and Medicine 2/1-215

[28] R. E. Brooks and J. F. Heiser. (1979). 'Transferability of rule-based control structure to a new knowledge domain'. *Proc. Third Annu. Symp.Compu. Appl. Med. Care.* IEEE. 56-63.D.

[29] Servan-Schreiber. (1986). 'Artificial intelligence and psychiatry'. *J.Nervous Mental Disorders.* 174(4). 191-202

[30] Coiera, Enrico. (1997-2003). Chapter 25- Clinical Decision Support Systems. .E.Coiera's Guide to Health Informatics 2nd Edition, United Kingdom, Arnold Publishers

[31] Depression.Com. *Understanding Depression: Depression –Related Mood Disorders* <http://www.depression.com/types_of_depression.html> (Accessed 17 July 2006)

[32] Dr. Richard Gillett. (1997). *Overcoming Depression- A practical self-help guide to prevention and treatment.* British Holistic Medical Association.

APPENDIX

Depression Consultation Expert System (DECES)

System Functionality Questionnaire

Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree
1	2	3	4	5

Referring to the scale above, circle the extend to which you agree with the following statements:

1.	The system flow is easy to follow	1	2	3	4	5
2.	The questions on depression symptoms and causes are appropriate and understandable	1	2	3	4	5
3.	The explanations in the results are understandable	1	2	3	4	5
4.	Overall I am comfortable using the system	1	2	3	4	5
5.	The diagnosis made by the system is useful for education and healthcare purposes	1	2	3	4	5
6.	I would recommend the system to others	1	2	3	4	5