SKIN CARE ROUTINE DECISION SUPPORT SYSTEM USING FUZZY LOGIC

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DEDICATION

I specially dedicate my appreciation to my parent for supporting me from the first day I'm stepping my feet in UMP and until now. Not forgotten to my project's supervisor, Madam Dr. Noorhuzaimi @ Karimah Binti Mohd Noor for willingness to guide me from the beginning this project been developed.

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Thesis submitted in fulfillment of the requirements
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ABSTRAK

Penyelidikan ini mengenai Sistem Sokongan Keputusan Rutin Penjagaan Kulit menggunakan logik kabur yang merupakan penjagaan kulit pada masa kini adalah isu penting kepada semua orang bukan sahaja untuk wanita tetapi lelaki juga. Walau bagaimanapun, walaupun isu ini penting tetapi masih ramai yang tidak mempedulikannya dan tidak tahu sama ada produk penjagaan kulit digunakan, sesuai dengan jenis kulit mereka atau tidak. Bagi penyelesaian, sistem sokongan keputusan rutin penjagaan kulit dengan menggunakan logik kabur adalah sistem yang dapat meramalkan gejala kulit empat jenis kulit seperti kulit biasa, kulit berminyak, kulit kombinasi dan kulit kering. Sistem ini akan mengesahkan jenis kulit dengan menggunakan satu set peraturan skor yang akan dimasukkan oleh pengguna berdasarkan umur, jantina, jam tidur dan keadaan kulit, maka input pengguna, akan diproses untuk menentukan jenis kulit berdasarkan kadar maksimum. Sistem sebelum ini, Sistem Sokongan Rutin Penjagaan Kulit (SCRSS), di mana sistem yang mengesan kulit dalam nilai julat keadaan kulit tidak benar-benar tepat pada julat standard dan juga beberapa gejala teras ciri yang menunjukkan jenis kulit tidak termasuk, sukar bagi pengguna yang mempunyai pelbagai jenis gejala kulit yang tidak termasuk dalam sistem. Kajian ini bertujuan untuk mengatasi masalah ini dengan menggunakan logik kabur dalam Sistem Sokongan Keputusan Rutin Penjagaan Kulit (SCRDSS). Oleh yang demikian, satu sistem telah dibangunkan bagi menyelesaikan masalah pengguna dalam menentukan rutin penjagaan kulit. Sistem Sokongan Keputusan Rutin Penjagaan Kulit (SCRDSS) menggunakan kaedah logik kabur dengan menggunakan rangka kerja sokongan keputusan. Ujian pengetahuan pengguna telah dijalankan ke atas SCRDSS yang telah ditambah baik ini. Ujian dilakukan ke atas 15 responden di mana hanya 80% responden memberi maklum balas. Keputusan ujian menunjukkan kadar peningkatan pengetahuan pengguna berkaitan kulit dan rutin penjagaan kulit iaitu sebanyak 20% berbanding pengetahuan pengguna sebelum menggunakan sistem ini. Ini menunjukkan bahawa sistem yang dicadangkan memberi manfaat kepada pengguna awam dalam menjaga kulit mereka. Namun penilaian ke atas peraturan yang dihasilkan tidak dapat dinilai memandangkan kekangan masa untuk merujuk kepada pakar kecantikan.

ABSTRACT

This research about Skin Care Routine Decision Support System using Fuzzy Logic which is skin care nowadays is important issues to everyone not only for women but men also. However, although this issue important but still many people not concerns about it and doesn't know whether the skin care products used, match with their skin type or not. As for solution, skin care routine decision support system using fuzzy logic is a system that able to determine the skin symptom of four skin types such as normal skin, oily skin, combination skin and dry skin. This system will diagnosis skin type by using a set of score rules that will be entered by the user based on age, gender, sleep time and skin condition, then the user input, will be processed to determine skin type based on maximum rate. The previous system, the Skin Care Routine Support System (SCRSS), where the system that detects the skin in the range of skin condition is not exactly accurate in the standard range and also some of the core features of the feature that indicate skin type is not included, it is difficult for users who have various types of skin symptoms that are not included in the system. This research has developed to aims to overcome this problem by using fuzzy logic in the Skin Care Routine Decision Support System (SCRDSS). As a result, a system has been developed to solve the user's problem in determining skin care routines. The Skin Care Routine Decision Support System (SCRDSS) used fuzzy logic method using a decision support framework. Test results, obtained from public respondents to determine their skin symptoms based on respondents' inputs in the Skin Care Routine Decision Support System (SCRDSS). User knowledge testing has been carried out on this improved SCRDSS. The test was conducted on 15 respondents where only 80% respondents responded. The test results show the increased rate of skin-related consumer knowledge and skin care routine that is 20% compared to user knowledge before using this system. This suggests that the proposed system benefits public users in keeping their skin. However, the assessment of the resulting rules cannot be evaluated given the time constraints to referring to a beauty expert.

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LIST OF ABBREVIATIONS

DND	Distribution Network Design
DSS	Decision Support System
FIS	Fuzzy Inferential System
HTTP	HyperText Transfer Protocol
MySQL	My Structured Query Language
PHP	Hypertext Preprocessor
PSM	Projek Sarjana Muda
SCRDSS	Skin Care Routine Decision Support System
SCRSS	Skin Care Routine Support System
UMP	Universiti Malaysia Pahang

CHAPTER 1

INTRODUCTION

1.1   Introduction

Skin Care Routine Decision Support System is a system that can determine the skin symptoms of four skin type such as normal skin, oily skin, combination skin and dry skin which based on the skin conditions and the rules that has represent into percentage. Besides that, its provide the information of skin care routines, include with the information of what should use and avoid ingredients in the product based on skin type and also the information of how to pamper the skin. This is cause, it would difficult for user to describe the skin symptoms because of do not have dip knowledge about skin symptoms. Before doing skin care or choosing cosmetics, it would be nice to know the skin symptoms first. So that, it would be easy to maintain healthy skin if user follow every routines that need to be considered based on skin symptoms.

This research proposed of using fuzzy logic method in Skin Care Routine Decision Support System to diagnosis skin symptoms, identify the skin care routine and the chemical ingredients use in the product where the ingredients suitable with the skin or not. Other than that, the information of skin care routines, which from step by step routines are provided for user to take care the skin. Talk about skin care routines, some people become lazy to do facial skin because of too many step to follow. Actually, not too many if user have enough knowledge about skin symptoms and think what good for skin it might be good for them.

As we know, skin care routine is the most important thing need to take care carefully, but nowadays, people become more attracted to the an element that call cosmetic. In the daily life, especially for women and teenager are often used cosmetic and it is becoming a trend for most people. As mentioned by the expert dermatologist,

that some Asians tend to overdo the usage such as like the whitening ritual. For approximately users, they randomly picked products to be used without thoroughly exploring the usefulness and the negative outcomes of the usage.

Moreover, its important to study the ingredients because they need to understand for each ingredients that contain in one cosmetic are good enough to apply onto users' skin. As frequently, before the people start to make for decision so first the new products should be analyzed, before it going to promotion or get ready for launch event to make sure the products not dangerous to the users' skin.

Therefore, by developing a decision support system that focus on rules, it may help the user to determine the skin symptoms. After user inserts the all information inside the support system, result of skin symptoms will display from system and the user can know what suitable ingredients user should use to skin. This decision support system can help in solving this problem.

1.2   Problem Statement

Fatin Farhana (2016) has proposed a system for helping public to use correct skin care routine. The system that has been developed able to detect the range of skin type by using the symptoms. However, the outputs produced are not given the accurate to the percentage value. The percentage value is generated from mostly frequent symptom for each skin type. This is because, the system for detected of maximum percentage value for dullness skin was not accurate to the standard range and also some of skin condition categories for determine skin symptoms are not included. Besides, it's hard for user that has different categories of skin symptoms which is not including in the system.

Moreover, users use support system because want to know about skin symptoms but when user wants to make decision, there are not enough categories to choose. So, the system still not achieves and can make user not satisfied with this system. This research analyses the set of the rules for the next implement system and existing one. A new method approach based on fuzzy logic to provide the rules and added several of

skin condition categories for each skin symptoms rules for user satisfactions, based on thesis paper.

1.3   Objective

Skin Care Routine Support System has been developed by using method decision support system (DSS). For this research, fuzzy logic used to set the new rules based on percentage value skin condition categories. Thus, the rules created based on the high percentage value that chosen in the categories. To ensure this can be achieve successfully several objective needs to be meets. There are three objectives that has been determined. The objectives are:

i)   To identify the skin symptoms based on percentage value in skin conditions and the information of skin care routine.

ii) To develop the skin care routine decision support system using fuzzy logic.

iii) To evaluate fuzzy logic based on user comparison user knowledge.

1.4   Scope

i)   The study is to determine the skin symptoms of four skin symptoms such as normal skin, oily skin, combination skin and dry skin.

ii) The information of skin care routine, what should use and avoid ingredients has in used product and also how to pamper the skin.

iii) The knowledge of public respondent measured by using goggle survey form before and after using the support system.

iv) The rules construct based on skin conditions categories.

1.5   Thesis Organization

This research consists six chapters which are Introduction, Literature Review, Methodology, Implementation and Testing, Result and Discussion and Conclusion.

Chapter 1 discusses on the introduction of research presents the main idea of research thesis Skin Care Routine Decision Support System using Fuzzy Logic. In addition, this chapter, discussed is more on to introduction that included problem statement, objectives, scope and significance of this research.

In Chapter 2, discussed a detailed literature review about this research is presented. This chapter brief the comparison between existing system support system, advantages and disadvantages and also the programming languages used. This chapter contains related works or tasks that have been done previously by the researchers and developers of skin care routine decision support system.

Chapter 3 is discussed on methodology used for this research where the concepts of fuzzy logic approach in solving problem of the system. The chapter also discuss factors determination, fuzzy rules, context diagram, and flowchart diagram.

Chapter 4 discuss on the implementation and testing. The discussion will begin with development setup, data and rules preparation, development software and tools used for implementation phase and last user requirement specifications.

In Chapter 5 discuss on result and discussion of the system. This chapter brief on result of user, usability testing and respondent's knowledge before and after using the system. The comparison result will show on graph.

Lastly, Chapter 6 discuss about the conclusion. The conclusion is the last chapter that will conclude all content of the research including the perfect limitation and future research idea that can improve the performance of Skin Care Routine Decision Support System using Fuzzy Logic.

CHAPTER 2

LITERATURE REVIEW

2.1   Introduction

This chapter focuses on information and research about existing support system that found in the literature related to the chosen project. Besides, this chapter also briefly describes about the review on existing method, technology, tools and techniques used that in related decision support system. The discussion based on current support system that exist, their advantages and disadvantages and also problems with current system.

So, to get a successful research, the existing support system data are collected from various resources such as internet, web page, articles, journals and etc. All related techniques; methods and tools that used from the support system discussed and compared detailed by this chapter.

2.2   Decision Support System (DSS)

DSS are a model-based a set of procedures for processing data and judgments to assist a manager in user decision. DSS can combine the use of models or analytical techniques with data access functions, emphasise flexibility and adaptability to respect changes in the decision context.

2.2.1   Important of DSS

An information system that can supports business or organizational decision-making activities is know as DSS. Besides, with DSS helping people to make decision about complications that may be suddenly changing and not easily specified in advance,

got uncertain information and data not really accurate such as decision problems like unstructured and semi-structured. Other than that, decision support system have planning levels of an organization (usually mid and higher management), operation and also can serve the management. Either fully computerized or human-powered, or a combination of both that decision support systems can be.

DSS is a based computer system that has by objective aiding humans in the decision making process by integrating multiple source information or knowledge, this is why they are called knowledge-based systems Juan Ram´on Castro and Figueroa (2016). Constituted of a variety of techniques from the fields of artificial intelligence, information science and cognitive psychology is the main core for systems. Moreover, DSS aims at helping a human not only to take a risky decision because it capable of developing multiple task but also take control of tasks like monitor the certain of activities, the data management and others automatic tasks.

DSS are a specific class of computerized information system that supports business and organizational decision-making activities. Decision support system is include on knowledge based systems which is more knowlegde can be learn by using DSS. The conccept of an interactive software-based system that intended to help decision makers compile useful information from raw data, documents, personal knowledge, or business models to identify and solve problems and make decisions properly designed Decision Support System.

In decision support system, there are a lot of termed that already defines by some author and the term needs to follows. Example of the term such as first DSS aimed at the less structured, upper level managers typically face problem need to underspecified, combine traditional data access and retrieval functions use of model or analytic techniques, focuses on factor to use easily by non-computer-proficient people in an interactive mode and to accommodate changes in the environment and the decision making approach of the user, DSS need emphasizes flexibility and adaptability.

2.2.2 DSS Flow

Figure 2.1 show the flow of how DSS. In DSS, there have four components involve which is inputs, user knowledge, outputs and lastly decisions. User insert inputs such as factors and characteristics to analyse. Then, after inputs, need to get user knowledge which requiring the inputs by manual analysis from user. All the inputs transfromed to data from which DSS decisions are generated. Then, the results generated by the DSS based on user criteria. The results generated is the last step in DSS.
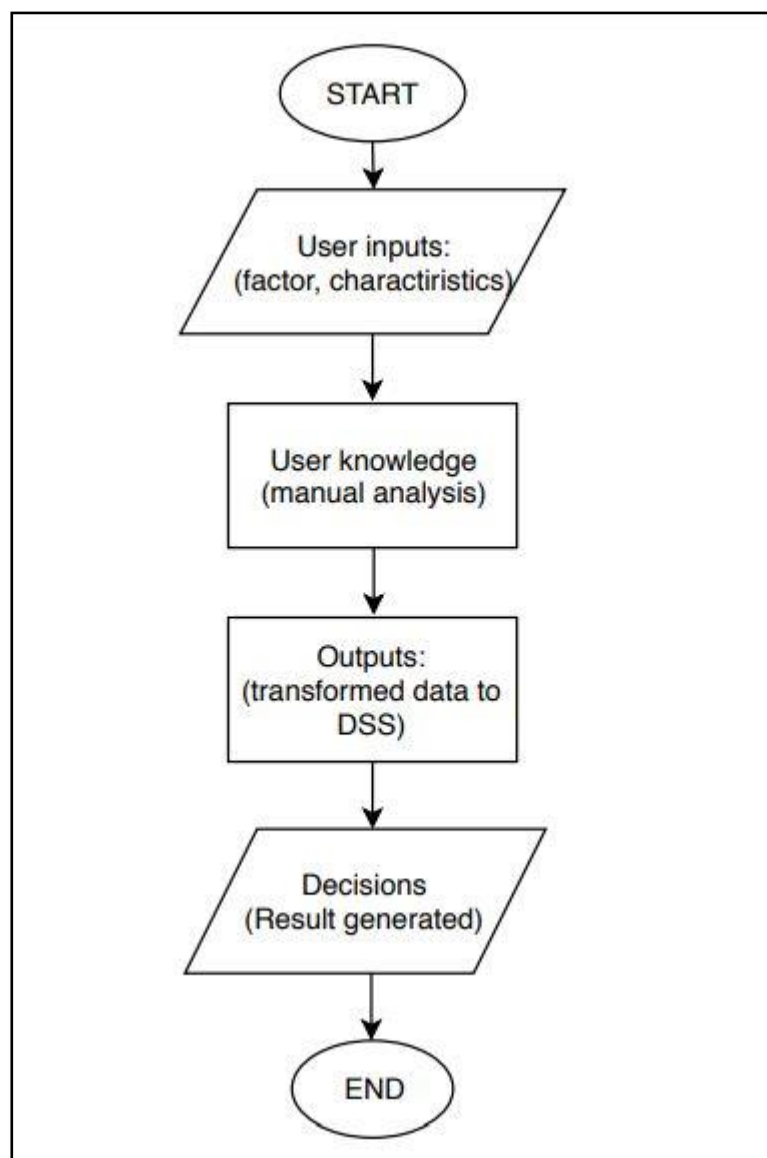
Figure 2.1   DSS Flow

2.3 Fuzzy Logic Concepts

Fuzzy logic is a kind of logic based on multiple values and it reasons approximately instead of exactly. The concept of partial truth, that has been used and deal where the truth value may take any value between true or false. Moreover, with a set of linguistic rules obtained from individuals' experiences that can control a combined steam engine. Fuzzy rules are a set of linguistic phrases that describe how to make decisions by fuzzy inference system based on the classification of an input or controlling an output Taha Samad-Soltani (2015).

In this study, the fuzzy systems were used that are a popular computational framework. Fuzzy inference systems, also known as fuzzy decision support systems. Basic structure of fuzzy inference systems consists of three conceptual parts, namely fuzzy rules, database and the inference process Taha Samad-Soltani (2015). The design of a Fuzzy Inferential System (FIS) requires, first of all, the definition of the domain knowledge in cooperation with clinical experts by means of interviews, questionnaires and observation of their day-by-day clinical practice S. Santini, Abate, & P. Ricchi (2014).

Besides, application of fuzzy logic very useful in manipulating imprecise of uncertain information and can increase the reliability of expected rating. So, by using fuzzy logic may solve the problem such as maximum value range was not really accurate in current skincare decision support system.

2.4 Comparison existing research using DSS

This section discussed on the comparison existing research using DSS. The comparison are based on the aim of the research, problem need to be solved, method use and the limitation that have in the research. Table 2.1 show the comparison of existing research using DSS. The researchers are (Eta S.Berner & Tonya J.La Lande, 2016), (Ustundag, 2014), (Dian Tri Wiyanti & Eny Widhia Agustin, 2016) and (Irmawati, 2015).

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Table 2.1   Comparison existing research using DSS

Sources	Aim	Problem	Method	Limitation
(Eta S.Berner & Tonya J.La Lande, 2016)	To impact clinician decision making about individual patients at the point in time that these decisions are made.	There are no standards that are universally agreed upon for clinical vocabulary and since most of the DSS have a controlled vocabulary, errors can have a major impact.	DSS	These systems can be useful, but their full benefits cannot be gained without collaboration between the information technology professionals & the clinicians.
(Ustundag, 2014)	To solve DND problem under uncertainty and a framework is created to optimize a distribution network.	Formulated in a stochastic mixed integer linear programming decision making form as a multi-stage stochastic program.	DSS DND	-
(Dian Tri Wiyanti & Eny Widhia Agustin, 2016)	To know the type of skin first. To make diagnosis treatment more advisable.	-	Certainty Factor Fuzzy Logic	-
(Irmawati, 2015)	To simplify the calculation for ensure what powder is in accordance with patient's skin type.	Problem what is handled by an expert is not only an issue that relies on algorithms, but sometimes also difficult problems to understand.	Certainty Factor	-

2.5   Comparison between existing Support Systems

From Table 2.2 below shows the comparison between existing systems. There are many existing web pages that have skin care support system which can determine user skin symptoms. Mostly, of these existing system has same features and functionality.

Table 2.2   Comparison between existing Support systems

Website	BioClarity	Renee Rouleau	Prokerala.com	SCRDSS using Fuzzy Logic
Sources	www.bioclarity.com	www.reneerouleau.com	www.prokerala.com	Localhost/ PSM/main page.php
Interface	The interface nice and easy to use.	The interface nice and easy to use.	The interface nice and easy to use.	The interface simple and easy to use.
Programming Languages	JavaScript	JavaScript	JavaScript	PHP
Advantages	Recommended products based on option user choose.	Ask about current environment in the question.	Use simple word for user understanding and result show skin care tips for your skin type.	Provide skin care routine, use and avoid ingredient information and how to pamper the skin in one page.
Disadvantages	The question not enough to user to insert (only for 3 questions).	The categories that listed are only for the top concerns.	The question and the answer button not arrange nicely.	The user data not save in the database.

CHAPTER 3

METHODOLOGY

3.1   Introduction

This chapter discussed on methodology that has been used to implement the development of this support system. In this chapter, covers the problem, limitation and existing support system used from the previous chapter and the factor determination to develop this support system. The progress on how support system works is explained in flowchart diagram Figure 3.3 which is from user insert input until the result generated by system.

Besides, hardware and software requirements that used in this research development also included in explanation in the methodology chapter.

3.2   Methodology

As shown in Figure 3.1, to accomplish this final year project this research used the following methodology to achieve all the objectives below. From the methodology, there have activity and outcome, activity based on the information get from journals, articles, books and then analyse, identified, evaluation. Next, outcome, the result that concludes after done with each activity in methodology phase. Lastly, after complete until evaluation phase, then can start with writing report to complete all the phases.

START	ACTIVITY	OUTCOME
LITERATURE REVIEW	Analyze and do some investigation to get the information from the journal, articles and web.	From the literature review, problem statment, objectives, scope and technique of the research is stated.
IDENTIFY FACTORS OF SKIN CARE ROUTINE DECISION SUPPORT SYSTEM	Analyze the journal and article from internet to identify the factors of skin care routine DSS.	The list of factors and parameters is finalized to determine the features of skin care routine.
IMPLEMENT SKIN CARE ROUTINE DECISION SUPPORT SYSTEM USING FUZZY LOGIC	Make comparison between the previous method and investigate the component that involve in the previous method. Develop the skin care routine decision support system using fuzzy logic approach. New rules is generated refer to factors that finalized.	Context and flowchart for skin care routine decision support system is produced.
EVALUATE THE SKIN CARE ROUTINE DECISION SUPPORT SYSTEM USING FUZZY LOGIC	The evaluation is done with the previous support system that using decision support system method. The data sets use the same with the previous but with new sets of rules are created.	The accuracy of the data used in the method.
END	Writing a report for skin care routine decision support system using fuzzy logic method.	The report complete with all six chapters is produced and ready to submit.

Figure 3.1   Research Methodology

3.3   Literature Review

From the existing system was implemented by using method DSS. By using DSS, there have the limitation of the scope that cannot go further to the user satisfaction. Concept of knowledge-based systems in decision support system actually can make the data value not accurate, while using the new combination of fuzzy rules, there might be different from previous. In 1965, fuzzy logic starts by Lofti Zadeh with the presentation of fuzzy set theory. By using fuzzy rules method can gives to settle on

positive choices in view of uncertain and questionable information. Since reality esteem is a range, it can deal with incomplete truth.

Besides, to overcome the problem and limitation, concept of fuzzy logic approaches. In the fuzzy logic approach, user can have knowledge about the understanding of skin symptoms, then finding the better solutions for skin keep healthy and good, not expecting 100% for healthy skin by using only skin care product where the ingredients don't know good or not.

3.4 Research Requirements Specification

Requirements phase is the phase to identify all the information and prepare budgets and costing which is established and define all software or hardware requirements used in this research and research framework are presented for research implementation. This stage involves researching and analysing about the requirements that will be used for the research and to ensure the researches can success, there are certain computer hardware and software requirements that need to be fulfilled to implement research on SCRDSS using Fuzzy Logic.

3.4.1 Hardware and Software Requirements

Table 3.1 and Table 3.2 shows list of hardware and software requirements with specification and the purpose of software used during development process and also documentation.

Table 3.1   Hardware Requirement

Hardware	Specification
Laptop	- HP Pavilion g4 series brand - Processor: Intel® CORE™ i5-2430M - CPU: 2.40GHz - RAM: 4.00 GB - OS Architecture: 64-bit - Operating System: Microsoft Windows 7 Ultimate

Table 3.2   Software Requirement

Software	Purpose
Microsoft Word 2010	Used to prepare all the documentation
Microsoft Excel 2010	Used to prepare all the documentation
Xampp	To connect the apache to run the interface
Sublime Text 3	As editor to create PHP source code
Microsoft Visio	Used to draw the diagram involve
Microsoft Project	To generate the Gantt chart

3.5   Gantt Chart

From the Gantt chart, shows the timeline or duration to complete this research. This research were arranged and scheduled by using the methodology that have used in Figure 3.1. This purpose of Gantt chart, to make sure the development of the research will finish by the right time. Refer to the Appendix A for the research timeline.

3.6   Factors Determination

In order to determine the skin symptoms, people need to have a deep knowledge based on the skin. This can cause difficulty for the people to analyst skin symptoms. There are four types of skin such as normal, oily, combination and dry that will be considered in the decision support system. Usually, the selection based on commonly discussed by the cosmetic expert. Four skin types mostly use the user reaction and conditions of skin, because the most of the researcher use the term to identify the skin symptoms.

Other factors can also influenced to determine the skin symptoms such as age, gender, sleeping hours, skin conditions categories and environment. The factors shown in the Table 3.3 are based on previous support system implementation. From previous, the skin care routine support system has been developed using concept of knowledge-based. As for this research, the new set of rules has represented to make sure that all user different kind of skin symptoms can determine the skin without any problem.

Table 3.3   History factors from previous support system

Factors Develop	Description
Age	-This factor seems as the big factor that affects the skin symptoms, when we young, the skin can easily maintain healthy and the layer inside the skin not became thin. But when older, the skin starts changes and can see the different from inside and outside of skin. As you age, the skin produces less sebum and because of that, the skin cannot produce moist, can lead to dryness and itchiness to skin. So, need to care the skin even already older.
Sleep Hours	-Second, lack of sleep can causes many problems. Sleep is an important function to keep the immune system in body good. At least, to get the healthy, for average adult, need to sleep around 7-8 hours each night.
Gender	-Lastly, different type of gender also can make the differences between skins. Besides, women and men have different lifestyles and of course the skin care routine also different. As we can see, there are few of men sometimes, really take care of their skin, so that with the follows for each routine, can make the skin healthier and not aging too fast.

Table 3.4   Skin conditions categories

	Skin Conditions	Value	Percentage Value =(Value/20) *100	Rules Selected (45% above)
	Radiant skin	5	25	No
	Smooth texture	11	55	Yes
Normal Skin	Balance complexion	9	45	Yes
	Even skin tone	7	35	No
	Fines pores	14	70	Yes
	Few or no wrinkle	3	15	No
	No breakout	3	15	No
	No marked blemish	10	50	Yes
	Good skin elasticity	2	10	No
	Dullness	1	5	No
	Shiny	16	80	Yes
	Enlarged pores	7	35	No
	Blackhead	7	35	No
Oily Skin	Acne/pimples	10	50	Yes
	Blemish	4	20	No
	Greasy	9	45	Yes
	Breakout	3	15	No
	Oily 'T zone'	20	100	Yes
	Large pores	10	50	Yes
	Blackhead	3	15	No

Combination Skin	Breakout	5	25	No
	Dry in some spots	17	85	Yes
	Uneven skin tone	1	5	No
	Fine line & wrinkles	2	10	No
	Shiny	4	20	No
	Acne/pimples	2	10	No
Dry Skin				
	Skin tight	10	50	Yes
	Almost invisible pores	3	15	No
	Redness	5	25	No
	Flaking/ Scaling	12	60	Yes
	Dullness	5	25	No
	Itching	11	55	Yes
	Less elastic	2	10	No
	Fine line	4	20	No
	Chapping/crack	9	45	Yes
	Rough skin	12	60	Yes
	Uneven skin tone	3	15	No

3.7   Prototype Design

During this phase, all the information and data gather to analysis, so Figure 3.2 and Figure 3.3 is the diagram that comes out for user more understanding of the system flow process.

3.7.1   Context Diagram

Figure 3.2 shows context diagram for SCRDSS. In the diagram shows, the interaction between user, DSS and fuzzy rules. Users insert inputs in system for user details and skin condition categories based on user option to analyse. Then, after complete all the inputs, in the DSS process check the rules based on user option. The rules check based on user option, Example situation: IF user chooses 2 options from normal and 3 options from oily, THEN the result displayed oily skin. The result generated and then display to the user based on what have user option.
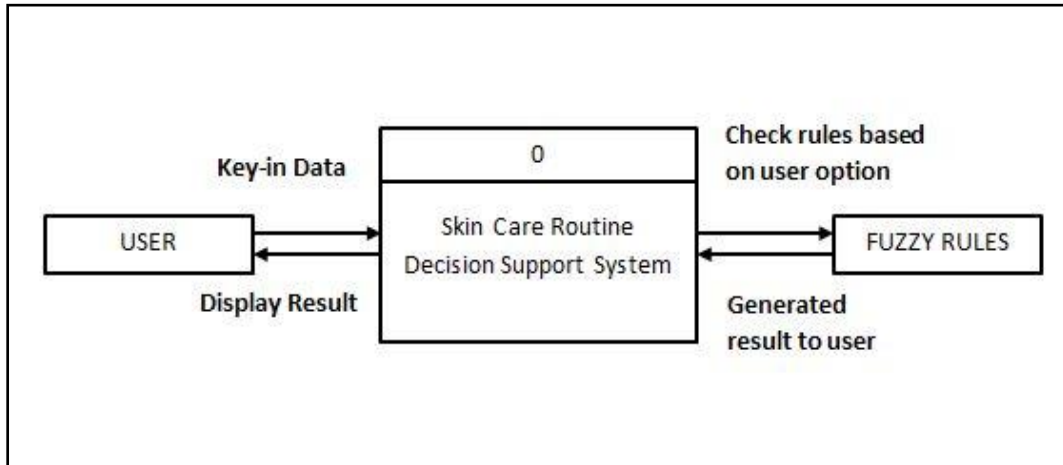
Figure 3.2   Context diagram SCRDSS

3.7.2 Flowchart Diagram

Figure 3.3 shows flowchart diagram for SCRDSS. In the diagram shows from users insert inputs in system for user details and skin condition categories based on user option to analyse. Then, after analysis, the result displayed based on what have user option choose. Besides, user can get more information about skin care routines, what good and avoid ingredient should user used in each product and how to pamper the skin in the system.
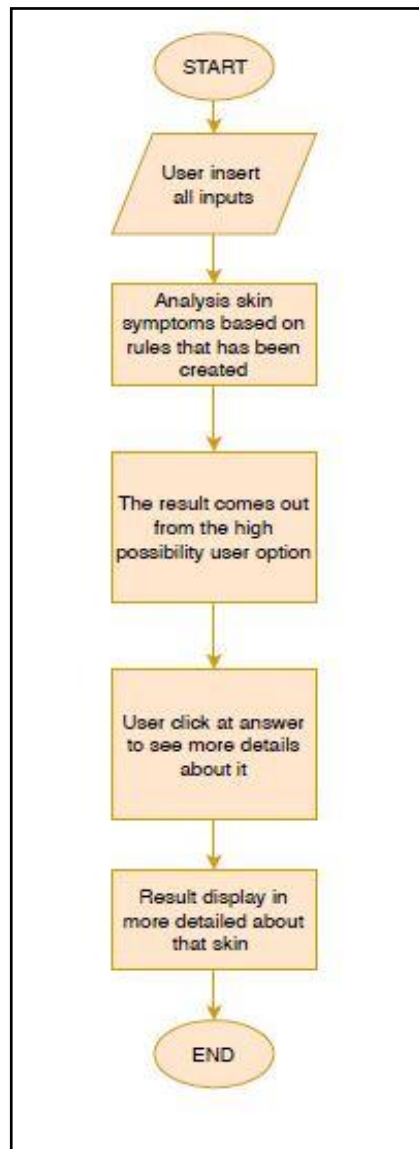
Figure 3.3   Flowchart diagram SCRDSS

3.7.3   Prototype Development using Fuzzy Rules

Fuzzy rules implemented by considering high percentage values of skin conditions that shows in the Table 3.5. It should be noted that fuzzy rules should be developed under experts' supervision and according to their knowledge. Otherwise, the results wouldn't be satisfactory. In the proposed system, 20 fuzzy rules were used. The Table 3.6 below, shown all the fuzzy rules used.

Define:-

    i.   Skin conditions Ex: Smooth, Balance

    ii.   Normal, Oily, Combination, Dry

IF smooth AND balance

THEN normal skin

Table 3.5   Linguistic variable

No	Skin Symptoms	Skin Conditions	Percentage Value (%)
1	Normal Skin	Smooth	55
		Balance	45
		Fine Pores	70
		No marked blemish	50
2	Oily Skin	Shiny	80
		Acne/Pimples	50
		Greasy	45
3	Combination Skin	Oily 'T-zone'	100
		Large pores	50
		Dry in some parts	85
4	Dry Skin	Skin tightness	50
		Flaking/Scaling	60
		Itching	55
		Chapping/crack	45
		Rough skin	60

Table 3.6   Fuzzy Rule Base

No	Rules	Conclusion	Result
1	If smooth texture AND balance complexion AND fine pores AND no marked blemish	THEN normal	Normal Skin
2	If smooth texture AND balance complexion AND no marked blemish	THEN normal	Normal Skin
3	If no marked blemish AND smooth texture	THEN normal	Normal Skin
4	If smooth texture AND fine pores	THEN normal	Normal Skin
5	If fine pores	THEN normal	Normal Skin
6	If shiny AND acne/pimples AND greasy	THEN oily	Oily Skin
7	If shiny AND acne/pimples	THEN oily	Oily Skin
8	If acne/pimples AND greasy	THEN oily	Oily Skin
9	If shiny	THEN oily	Oily Skin
10	If oily 'T-zone' AND large pores AND dry in some parts	THEN combination	Combination Skin
11	If oily 'T-zone' AND dry in some parts	THEN combination	Combination Skin
12	If large pores AND dry in some parts	THEN combination	Combination Skin
13	If oily 'T-zone'	THEN combination	Combination Skin
14	If skin tightness AND flaking/scaling AND itching AND chapping/crack AND rough skin	THEN dry	Dry Skin
15	If skin tightness AND flaking/scaling AND itching AND rough skin	THEN dry	Dry Skin
16	If skin tightness AND itching AND rough skin AND chapping/crack	THEN dry	Dry Skin
17	If itching AND rough skin	THEN dry	Dry Skin
18	If chapping/crack AND skin tightness	THEN dry	Dry Skin
19	If rough skin AND flaking/scaling	THEN dry	Dry Skin
20	If flaking/scaling	THEN dry	Dry Skin

3.8   Evaluation

The results evaluated based on user knowledge before and after using SCRDSS using Fuzzy Logic method which can determine skin symptoms of four skin symptoms such as normal skin, oily skin, combination skin, dry skin and also provide the information of skin care routines.

CHAPTER 4

IMPLEMENTATION AND TESTING

4.1 Introduction

In this chapter, all the implementations clearly describe in more details for the process to develop the system, which are from data preparation, rules preparation, and develop the prototype what tools and software that used in this phase to implement the system.

4.2 Development Setup

In the development setup, there have two section, data preparation and rules preparation. From data preparation, the data has been collected and transformed into rules. After construct rules shown in Table 3.6, then the rules converted into source code which is fuzzy rules, to run the system.

4.2.1 Data Preparation

At this phase, the data have been collected from web and previous data where the data calculated the percentage value of each skin conditions. Then, the new set of rules are created by using the percentage value, the selected value from 45% above until the maximum value of skin conditions categories data. The data represented into the fuzzy rules and the rules included into the system. Table 3.4 shows, the data calculated by using this formula:

$$(Value/20) * 100 = Percentage\ Value$$

4.2.2 Rules Preparation

Figure 4.1 show the example of PHP code used for fuzzy rules. All the source codes create by using software Sublime Text 3. Software sublime text 3 has syntax highlighting packages, which makes developer feel more interesting to use it. Besides, the editor is easy and not complicated to run it.

Figure 4.1   Fuzzy Rules in PHP code using Sublime Text 3 editor

Figure 4.2, Figure 4.3, Figure 4.4 and Figure 4.5 shows the fuzzy rules in the PHP code. The source code separate based on the skin symptoms. All the fuzzy rules constructed based on the analysis data collected in Table 3.6.

```php
<?php
if(isset($_POST['smooth']) && isset($_POST['balance']) && isset($_POST['fine']) &&
isset($_POST['nohave8']))
{
  echo "<strong><a href=http://localhost/PSM/normal.php target=_blank>Normal
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['smooth']) && isset($_POST['balance']) && isset($_POST['nohave8']))
{
  echo "<strong><a href=http://localhost/PSM/normal.php target=_blank>Normal
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['nohave8']) && isset($_POST['smooth']))
{
  echo "<strong><a href=http://localhost/PSM/normal.php target=_blank>Normal
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['smooth']) && isset($_POST['fine']))
{
  echo "<strong><a href=http://localhost/PSM/normal.php target=_blank>Normal
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['fine']))
{
  echo "<strong><a href=http://localhost/PSM/normal.php target=_blank>Normal
Skin</a></strong>", "<strong><--Click Here</strong>";
}
```

Figure 4.2   Fuzzy Rules for normal skin

Fuzzy rules for normal skin has determined by user click the option of having smooth skin texture, balance skin complexion, fines pores and no marked blemish. The result shows normal skin if user clicks the options that exist in the normal skin characteristics which are smooth texture, balance complexion, fines pores and no marked blemish.

```
elseif(isset($_POST['shiny']) && isset($_POST['acne11']) && isset($_POST['greasy']))
{
 echo "<strong><a href=http://localhost/PSM/oily.php target=_blank>Oily
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['shiny']) && isset($_POST['acne11']))
{
 echo "<strong><a href=http://localhost/PSM/oily.php target=_blank>Oily
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['acne11']) && isset($_POST['greasy']))
{
 echo "<strong><a href=http://localhost/PSM/oily.php target=_blank>Oily
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['shiny']))
{
 echo "<strong><a href=http://localhost/PSM/oily.php target=_blank>Oily
Skin</a></strong>", "<strong><--Click Here</strong>";
}
```

Figure 4.3   Fuzzy Rules for oily skin

Fuzzy rules for oily skin has determined by user click the option of having shiny skin, acne or pimples and the skin feel greasy. The result shows oily skin if user clicks the options that exist in the oily skin characteristics which are shiny skin, acne or pimples and the skin feel greasy.

```php
elseif(isset($_POST['oily']) && isset($_POST['large']) && isset($_POST['dry']))
{
  echo "<strong><a href=http://localhost/PSM/combination.php target=_blank>Combination
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['oily']) && isset($_POST['dry']))
{
  echo "<strong><a href=http://localhost/PSM/combination.php target=_blank>Combination
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['large']) && isset($_POST['dry']))
{
  echo "<strong><a href=http://localhost/PSM/combination.php target=_blank>Combination
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['oily']) )
{
  echo "<strong><a href=http://localhost/PSM/combination.php target=_blank>Combination
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif(isset($_POST['yes3']) && isset($_POST['flaking']) && isset($_POST['itching']) &&
isset($_POST['chapping'] ))
{
```

Figure 4.4   Fuzzy Rules for combination skin

Fuzzy rules for combination skin has determined by user click the option of having oily 'T zone' area, large pores and dry in some spots. The result shows combination skin if user clicks the options that exist in the combination skin characteristics which are oily 'T zone' area, large pores and dry in some spots.

```php
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['yes3']) && isset($_POST['flaking']) && isset($_POST['itching']) &&
isset($_POST['rough']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['yes3']) && isset($_POST['itching']) && isset($_POST['rough']) &&
isset($_POST['chapping']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['itching']) && isset($_POST['rough']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['chapping']) && isset($_POST['yes3']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['rough']) && isset($_POST['flaking']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
elseif (isset($_POST['flaking']))
{
  echo "<strong><a href=http://localhost/PSM/dry.php target=_blank>Dry
Skin</a></strong>", "<strong><--Click Here</strong>";
}
?>
```

Figure 4.5   Fuzzy Rules for dry skin

Fuzzy rules for dry skin have determined by user click the option of having skin tightness, flaking or scaling skin, itching, chapping or crack and rough skin texture. The result shows dry skin if user clicks the options that exist in the dry skin characteristics which are skin tightness, flaking or scaling skin, itching, chapping or crack and rough skin texture.

4.3   Development Tools

As for system development system works, PHP programming language was chosen for build the interface for this system. Basically, many developers used PHP programming language as their platform to build system where the platform is open source so easy for developer to use it.

4.4   Software Installation

This system using XAMPP and Sublime Text 3 which XAMPP is a free and open source cross-platform web server solution stack package, consisting main of the Apache HTTP Server, MySQL database and interpreters for scripts written in PHP and PERL Programming Languages. Many developers used this platform to create a local web server for testing purposes because this software is easy to learn and can explore more about it if want to be a successful developers. To develop web server need server application (Apache), database (MySQL) and scripting language (PHP) that already included in a simple extractable file. Therefore, website designer and programmers can test the work by own computers without need to access to the internet but not for running system. As for running system, web server must be installed in computer and the root of its web folder can be accessed by typing http://localhostt in the web server. Usually, developer use notepad++ software for source code editor, but during implement this system, found Sublime Text 3 so interesting and its functionality better than notepad++. But, actually both software can use as source code editor.
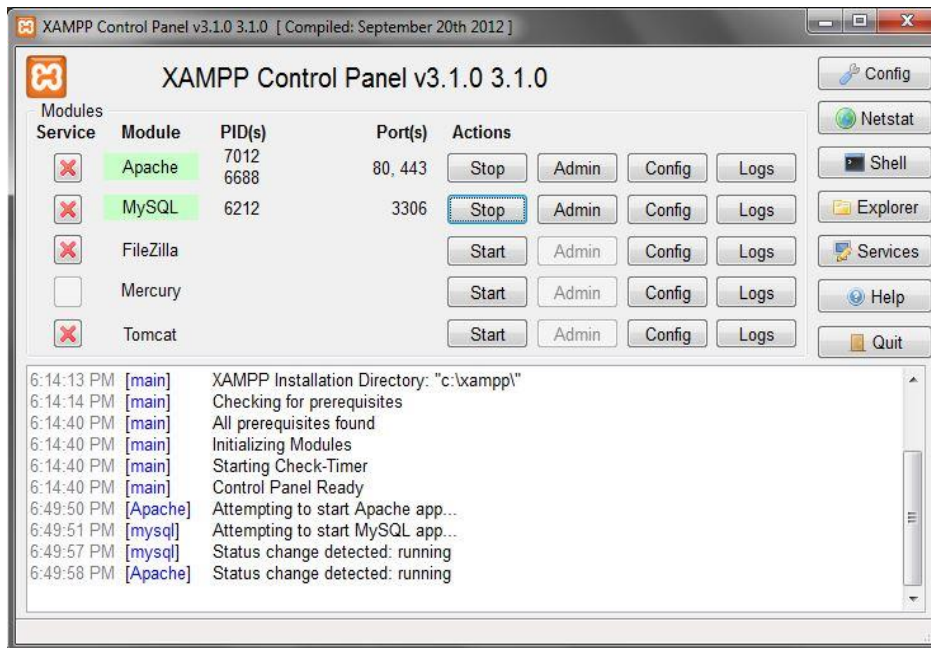
Figure 4.6   XAMPP control panel version 3.1.0

4.5   Implementation

This phase emphasizes on how the interface system is going to be implemented. Figure 4.7 until Figure 4.11 shows the interface on system that has been implementing by using PHP.

4.5.1   Main page

Figure 4.7 show the interface design for the main page of the system. In this interface, user needs to fill up all the details to find skin symptoms. User need to fill name, gender, age, sleep hours and choose the option given before click at submit button.

Figure 4.7   Main page interface

4.5.2   Skin symptoms page

Figure 4.8 shows the interface of skin symptoms result. The result generated when user click the option given in the main page. At the result given, user can click to get all the information about those skin symptoms for user.

Figure 4.8   Skin symptoms interface

4.5.3   Details information page

In this Figure 4.9 shows, all the information, which is user can get the information of characteristics, skin care routine, what should user use and avoid ingredients in the product and how to pamper the skin based on user result.

.

Figure 4.9   Combination skin details interface

4.5.4   Skin details page

For Figure 4.10 show, user can click the hyperlink text to see the details about each of skin symptoms.

Figure 4.10   Skin details interface

31

4.5.5   Thank you page

For Figure 4.11 show, the last page of this system where user can click the button to return to the main page. This page for thank you to user for used this system.

Figure 4.11   Thank you interface

4.6   The User Requirement Specification

SCRDSS using Fuzzy Logic is a web-based system application developed to determine the skin symptoms of four skin types such as normal skin, oily skin, combination skin and dry skin which based on the skin conditions and the rules that has represent into percentage.

4.6.1   User

Users need to insert inputs in system for user details and skin condition categories based on user option to analyse.

CHAPTER 5

RESULT AND DISCUSSION

5.1   Introduction

In this chapter, result testing phase been initiated properly to test the system functionality. This phase to ensure that all the objectives meet the requirements and user satisfied with the system. The proposed solution has been successful develop by using web system. The test has been conducted by user survey form to gain user knowledge before and after using the system. The user testing is among UMP student which is randomly selected by age and gender to ask to use the system as user testing. The expert evaluation is not conducted because of time constraint. Thus rule verification is not provided.

5.2   Result of SCRDSS

Figure 5.1, Figure 5.2, Figure 5.3 and Figure 5.4 shows the user testing result. All the testing result based on skin symptoms of four skin types, normal skin, oily skin, combination skin and dry skin.

Figure 5.1   User for normal skin

Figure 5.2   User for oily skin

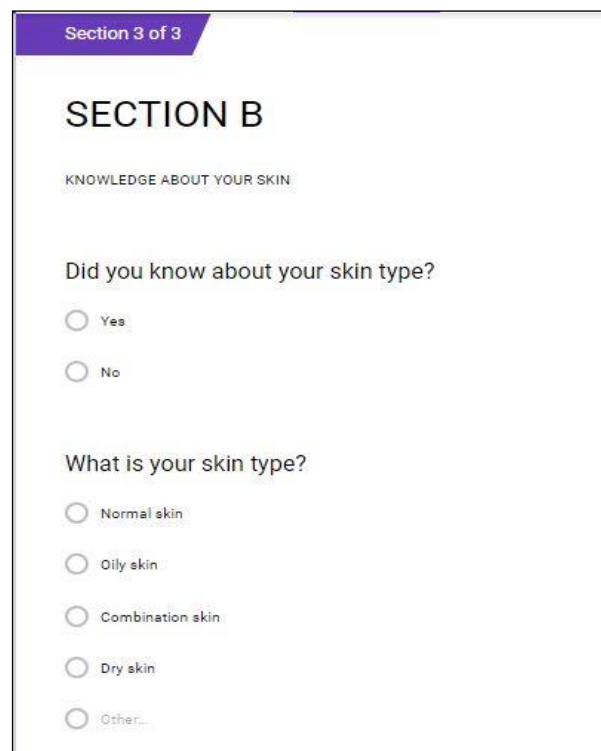Figure 5.3   User for combination skin

Figure 5.4   User for dry skin

5.3   User knowledge testing

User knowledge testing has been conducted to measure the user knowledge before and after used this system.

5.3.1   Respondent of user knowledge

Figure 5.5, Figure 5.6 and Figure 5.7 show question from survey form. This survey form is to measure the user knowledge-based about skin before using the SCRDSS using Fuzzy Logic approach. Randomly respondents have been selected from different gender, age, and sleeping hours and others to get the answer for the public respondent knowledge. The questionnaires consists of two sections, there have section A and section B. Section A for respondent's details, where the section B is the knowledge about respondent's skin question. The data collection finalized and the results show from the graph. The results focus on section B, because section is the important part to measure.

Figure 5.5   User knowledge 1

Figure 5.6   User knowledge 2

Figure 5.7   User knowledge 3

5.3.2 User knowledge result

Most of the question graph shows the positive result about respondents knowledge, because they already aware about this kind of knowledge especially women that really concern about skin. For the first question from 15 respondents show in the Figure 5.8, that 12 of them answer yes means, mostly of them know about own skin type, but seems more think that has combination skin. Combination skin is not sensitive skin, but focuses of combination skin are oily T zone and dry on cheeks.
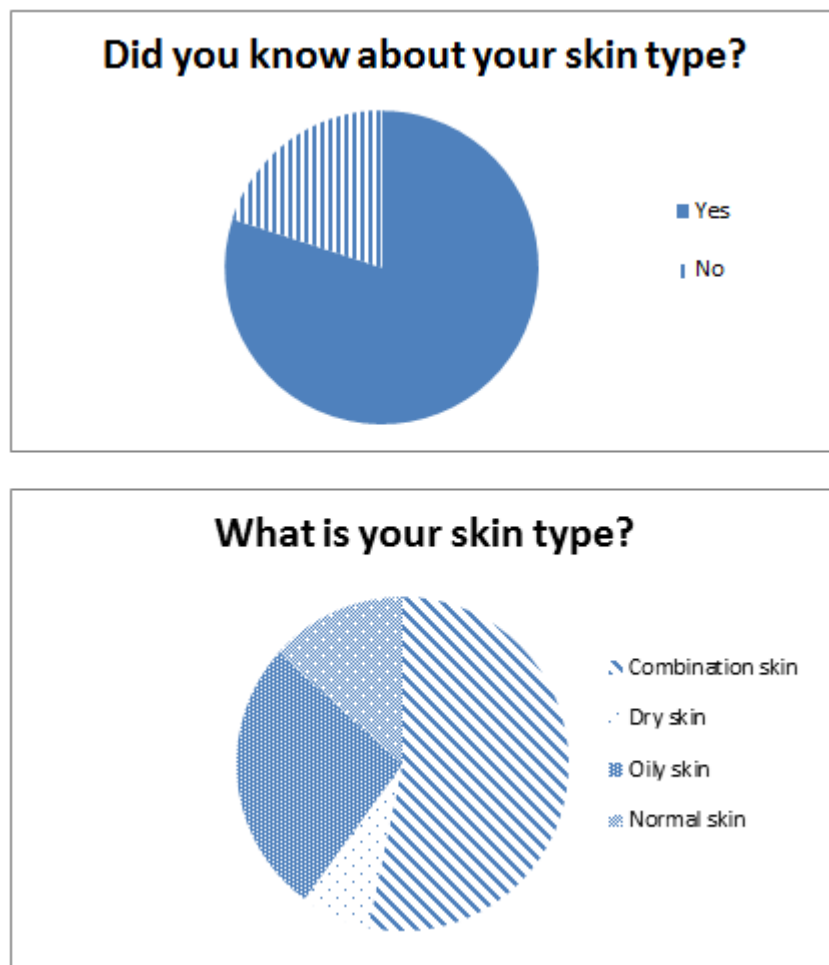
Figure 5.8   Result 1

Figure 5.9 show that most of the respondents answer is preferred to be natural. Natural means, the skin looks healthy and glowing without using heavy makeup. For the second question, respondents choose answer wash face for two times per day. For the better result, to get healthy skin, need to wash face more than 2 times because the dirt on face skin we cannot see, but it has on the skin.
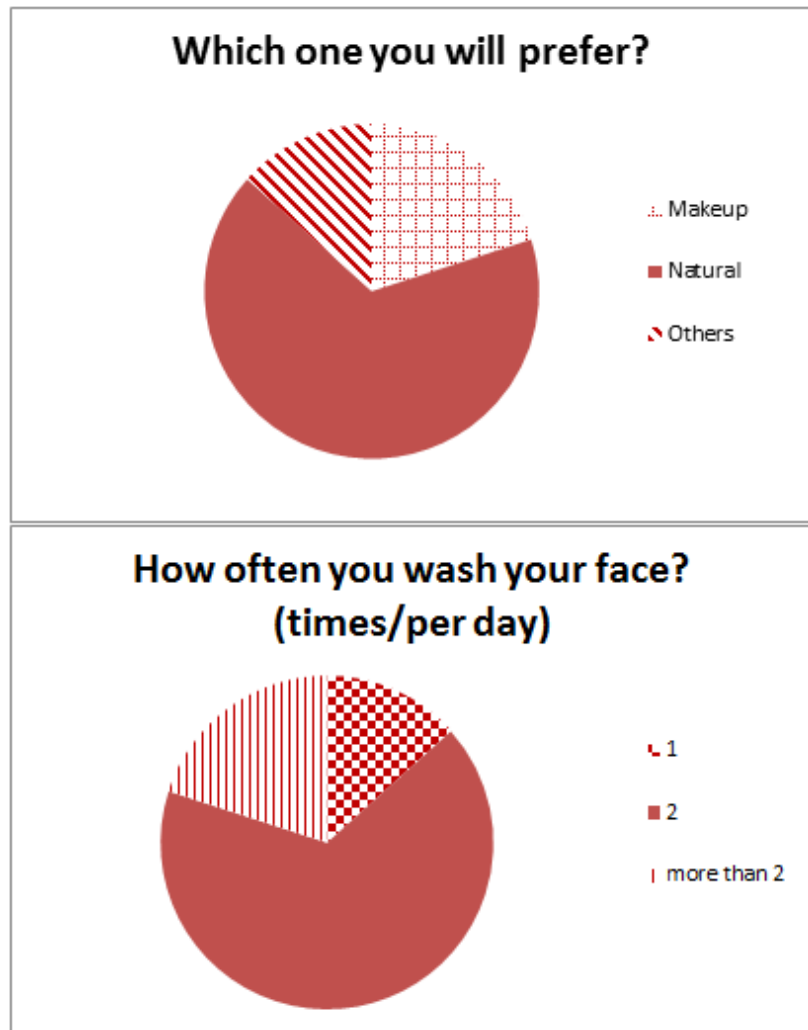
Figure 5.9   Result 2

Figure 5.10, first question show that most of the respondents answer is used the suitable product for own face. Using the product on face and the face not having any trouble, that means the product really suitable for you but not for everyone, every people have different type of skin. For the second question, respondents choose answer about pores can clog up. This question based on what kind of product used, whether it's suitable for skin or not.

Figure 5.10   Result 3

From Figure 5.11 show that respondents really concern with own skin, because important to take care skin. If user always follow step in skin routine every day, probably the skin will look in good condition, even though without using any makeup, the confident level to face others become higher.
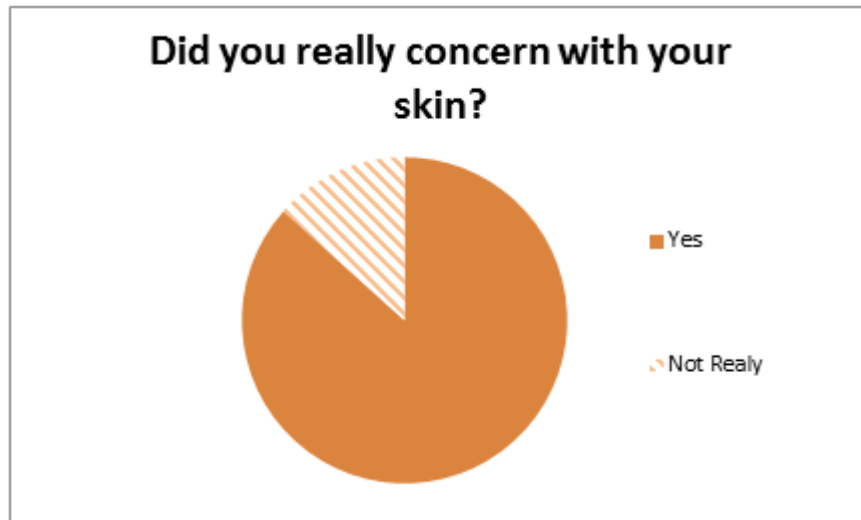
Figure 5.11   Result 4

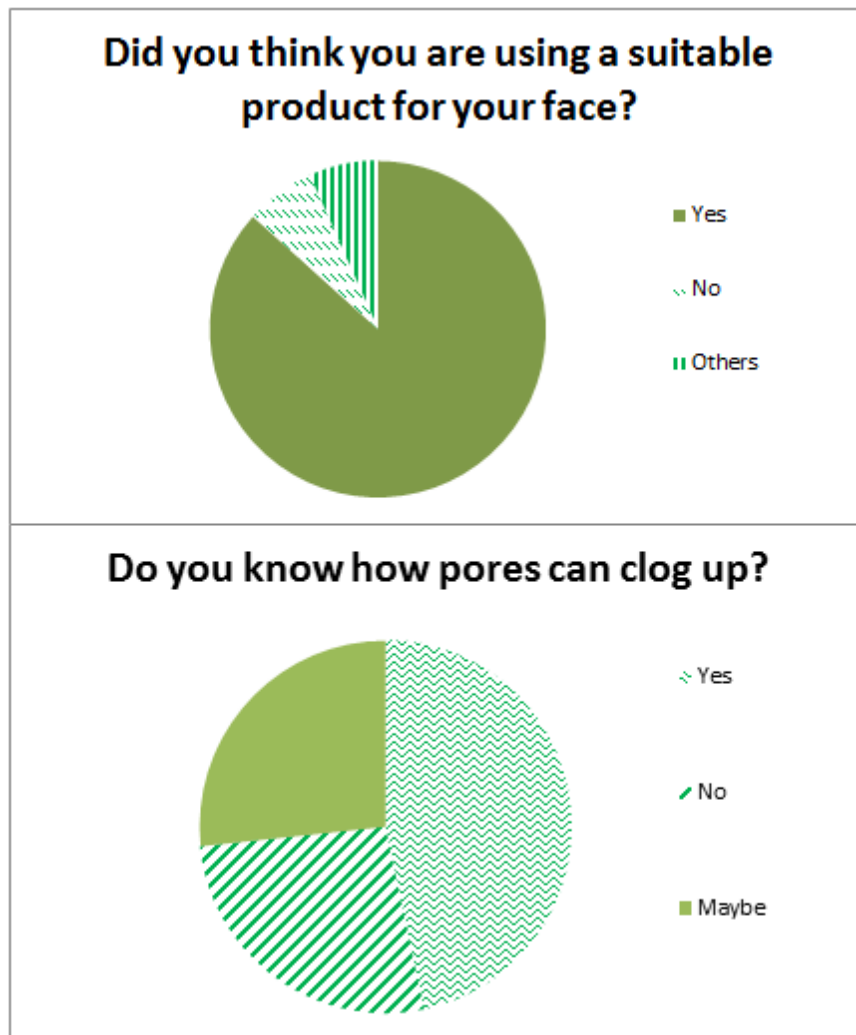## 5.4   Comparison before and after using SCRDSS using Fuzzy Logic

Figure 5.12, the comparison of user knowledge about skin type and the concern for own skin type. Before using the SCRDSS, user already have a little bit of knowledge and the concern for skin type. After using SCRDSS, user can really know about skin type based on user skin conditions.

Figure 5.13, the comparison of user knows about each skin type and suitable product used for skin care routine. As mention before, mostly user know about own skin type, but seems more think that has combination skin, by using this SCRDSS user might have different skin type from what user think. Same goes with using suitable product, as long as the user doesn't have the problem while using any product, so user thinks it's suitable for skin. So, by using SCRDSS user will know what suitable and avoid product user should know in skin care routine.

Figure 5.12   Comparison between knowledge and concern
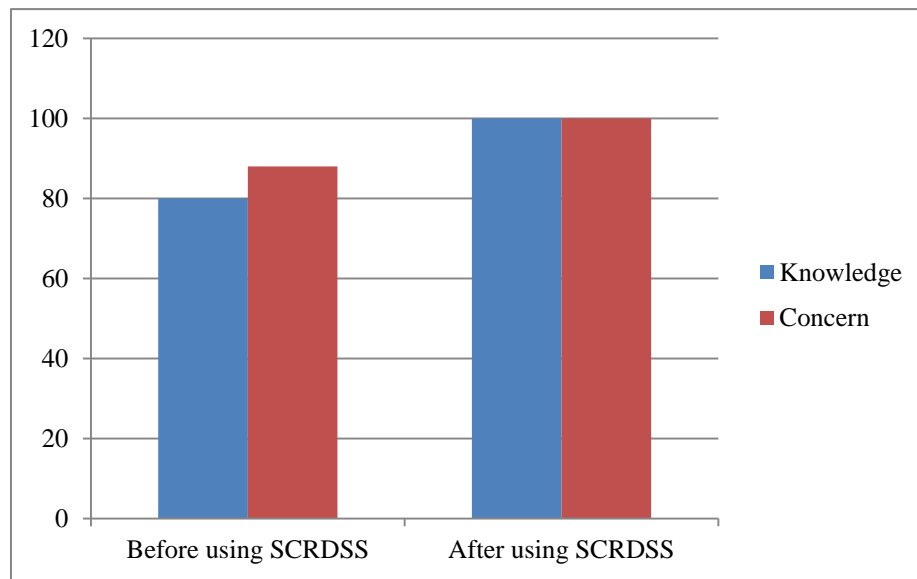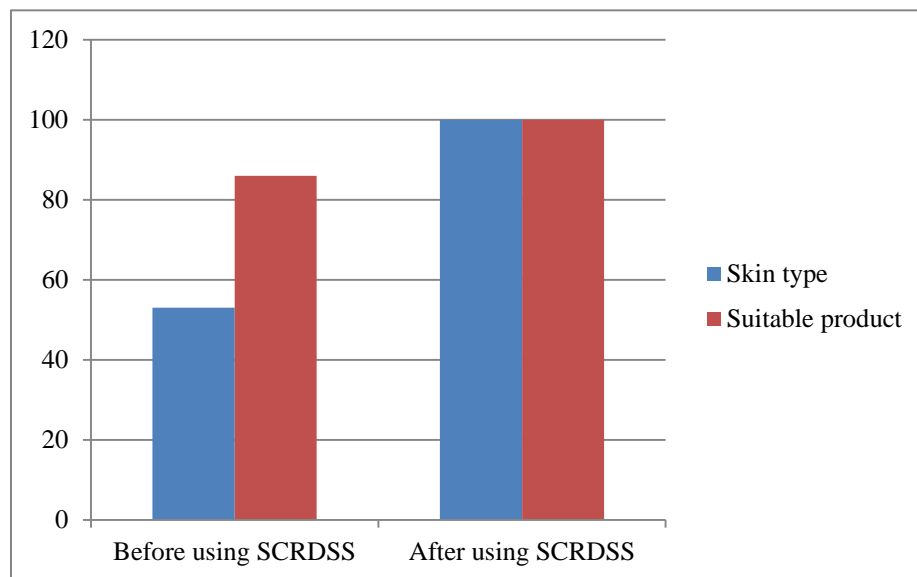

Figure 5.13   Comparison between skin type and suitable product

CHAPTER 6

CONCLUSION

6.1   Introduction

This chapter concluded the system that has been completed. The conclusion consists of system conclusion; data retrieved and observed methodology and project implementation. This chapter also provided with research constraint and future works.

SCRDSS using Fuzzy Logic approach can be important to all users, to know their skin symptoms and skin concerns when it comes to care and treatment thing. This skin care routine decision support system using fuzzy logic can help many people to be more concerns on the skin care routine, not only can know the skin symptoms but also after know the skin symptoms, can know what skin care product suitable for skin based on skin symptoms. By using any skin care product, without knowing whether the ingredients inside the product are good or bad, also important to skin. When choosing skin care products, need to choose the skin care product that match with skin type, so the skin keep healthy and glowing without acne, white head and black head. Skin symptoms also changes over time, or can be affected by age, sleep hours, gender, environment, or hormone changes.

As conclusion, for this research study, at the end of this research will achieving the objectives; To identify the skin symptoms based on percentage value in skin conditions, the information of skin care routine, what should use and avoid ingredients in product and also how to pamper the skin, to implement decision support system using fuzzy rules approach and lastly to test the decision support system to determine skin symptoms. The test has been conducted to gain the user knowledge before and after using the system. However, the rules verification is not been conducted because of time constraint to meet with the skin expert.

6.2 Research Constraint

Constraint of the system:

i. The user testing need to test by the expert one which have deep knowledge about skin care routines.

ii. The system cannot display the range of each skin type.

6.3 Future Works

This research still has some limitations and need to be upgrade. Thus, the future system need to enhance, which is the system must to do testing with the expert dermatologist to verify the rules. Other than that, this system should include the range for each skin type and routines. Then, the factors of system implementation can be added more based on user surroundings.

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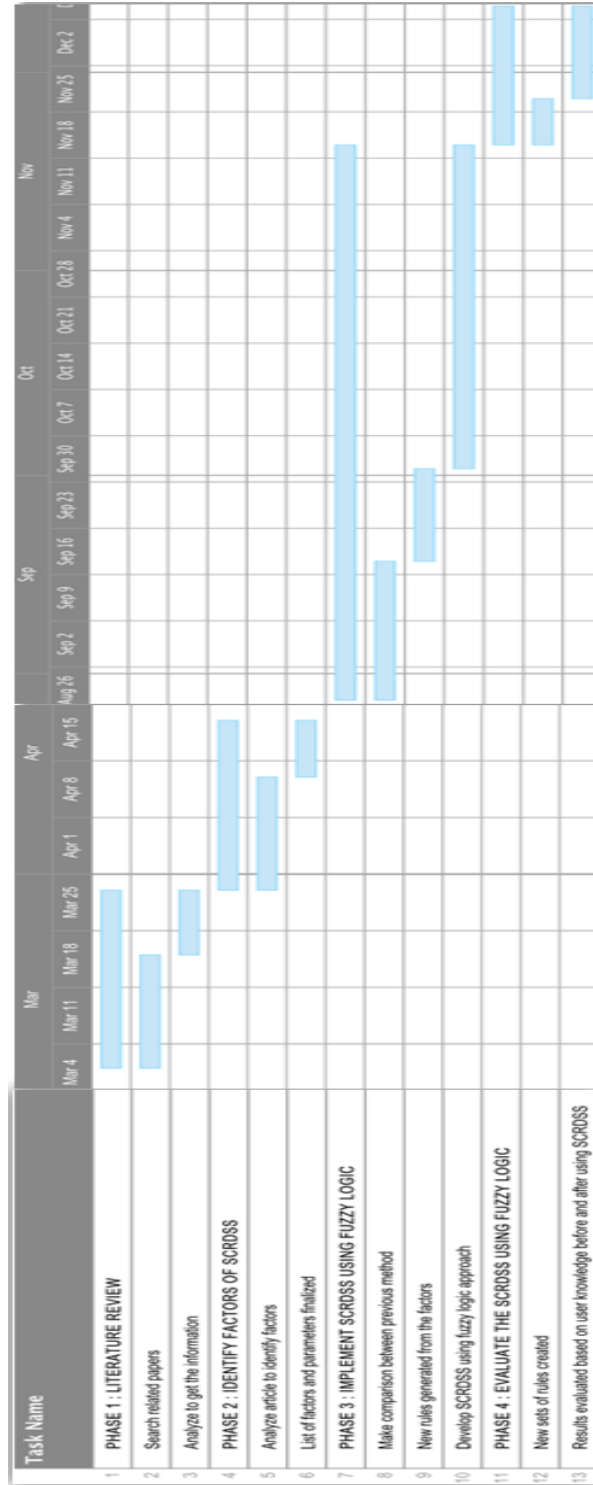
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#	Task Name
1	PHASE 1 : LITERATURE REVIEW
2	Search related papers
3	Analyze to get the information
4	PHASE 2 : IDENTIFY FACTORS OF SCRDSS
5	Analyze article to identify factors
6	List of factors and parameters finalized
7	PHASE 3 : IMPLEMENT SCRDSS USING FUZZY LOGIC
8	Make comparison between previous method
9	New rules generated from the factors
10	Develop SCRDSS using fuzzy logic approach
11	PHASE 4 : EVALUATE THE SCRDSS USING FUZZY LOGIC
12	New sets of rules created
13	Results evaluated based on user knowledge before and after using SCRDSS

APPENDIX B
USER INPUTS IN SYSTEM

User information

Name : _____

Background factor

Gender: ☐ Male   Age: ☐ 19-25 years ☐ 31-40 years

☐ Female   ☐ 26-30 years ☐ 41-50 years

Sleeping hours:

☐ >= 7 hours   ☐ < 7 hours

Skin Conditions

1. How does your skin complexion?

☐ Radiant   ☐ Dullness

☐ Shiny   ☐ Oily T zone

☐ Balance (not too oily or dry) ☐ Dry in some part

2. How does your feel the skin texture?

☐ Smooth   ☐ Rough

3. Has you feel your skin tightness?

☐ Yes   ☐ No

4. How about your skin tone?

☐ Even   ☐ Uneven

5. How your skin pores?

☐ Large (especially around nose)

☐ Fine

6. How does your skin feature?

☐ Few or no wrinkle   ☐ Fine line

7. Have your skin breakout?

☐ Have   ☐ No have

8. Have your skin has marked or flaw which spoils skin?

☐ Acne/Pigmentation   ☐ No have

9. How does your skin feel (elasticity) when touched?

☐ Yes   ☐ No

10. Does your skin have blackhead?

☐ Yes   ☐ No

11. How does your skin condition?

☐ Redness   ☐ Acne/pimples

☐ Itching   ☐ Flaking/scaling

☐ Chapping/crack   ☐ Greasy (Oily that can be feeling)

APPENDIX C
RESPONDENT KNOWLEDGE

Respondent details

Gender: ☐ Male   Age: ☐ 19-25 years   ☐ 31-40 years

        ☐ Female   ☐ 26-30 years   ☐ 41-50 years

Sleep (hours):

☐ More than 7   ☐ Less than 7

Steps taken in skin routine: ☐ 3 (basic)

                             ☐ 5 (minimum)

                             ☐ 8 (maximum)

Knowledge about skin

1. Did you know about your skin type?

   ☐ Yes   ☐ No

2. What is your skin type?

   ☐ Normal skin

   ☐ Oily skin

   ☐ Combination skin

   ☐ Dry skin

3. Which one you will prefer?

   ☐ Makeup   ☐ Natural

4. How often you wash your face? (times/per day)

   ☐ 1   ☐ 2

   ☐ More than 2

5. Did you think you are using a suitable product for your face?

☐ Yes

☐ No

6. Do you know how pores can clog up?

☐ Yes

☐ Maybe

☐ No

7. Did you really concern with your skin?

☐ Yes

☐ Not really