College of Graduate Studies

Information Technology and Management System Department

Developing a Novel Expert System to Assist High School Students in Selecting their Appropriate University program: A Case Study of Hebron University

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Dedication

This thesis is dedicated to:

The Sake of Allah who supported me in facing all circumstances to complete this work.

To the Palestinian martyrs and prisoners who spent their lives for their country.

My dear parents who have always encouraged me to give the best, my family, and friends,

Dr. Nabil Hasasneh, Prof. Mario Macido, Hebron University and the staff of the Information Technology and Management System Department.

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List of Abbreviations

	Abbreviation	Concept
1.	HU	Hebron University
2.	ICT	Information and Communications Technology
3.	AI	Artificial Intelligence
4.	PCBS	Palestinian Central Bureau of Statistics
5.	GPA	Grade Point Average
6.	KB	knowledge base
7.	RDMS	Relational Database Management Systems
8.	ERD	Entities Relationships Diagram
9.	PHP	Hypertext Pre-processor
10.	IQ	Intelligence quotient
11.	SDLC	Systems development life cycle
12.	DTC	Decision Tree Classification
13.	SVM	Support Vector Machine
14.	DAM	Descriptive-Analytical methodology
15.	SPSS	Statistical Package for Social Sciences
16.	CSV	Comma-separated values

تطوير نظام خبير حديث لتوجيه طلاب الثانوية العامة في اختيار تخصصهم الجامعي المناسب: دراسة حالة / جامعة الخليل

الملخص

في ظل التطور التكنولوجي المتسارع فقد أصبحت تكنولوجيا المعلومات والاتصالات مقياسًا لمستوى تقدم المؤسسة وتظهر قدرتها على المنافسة. لا شك أن تطبيقات الذكاء الاصطناعي قد ساهمت إلى حد بعيد في التقدم التكنولوجي في مجالات مختلفة من بينها الأنظمة الخبيرة، والتي تُعرَّف ببساطة على أنها النظام الذي يحل محل خبير بشري أو يساعده في مهمة معقدة تتطلب معرفة متخصصة. لقد انتشر في الآونة الأخيرة توظيف واستخدام الأنظمة الخبيرة في العديد من المجالات منها: الصحي، العسكري، الإداري، بالإضافة إلى العملية التعليمية. حيث يواجه طلبة الثانوية العامة في فلسطين مشكلة عند اختيارهم لتخصصهم الجامعي نظرًا لأن هذه العملية تتأثر بالعديد من العوامل المحيطة. ومن هنا فإن الغرض الأساسي من هذه الدراسة هو اقتراح وتطوير نظام برمجي خبير لتوجيه طلاب الثانوية العامة (التوجيهي) في اختيار التخصص الجامعي المناسب لميولهم، وعليه فإن الدراسة الحالية تتطرق إلى الإجابة على الأسئلة التالية: ما هي العوامل التي تؤثر على اختيار الطلاب للبرنامج الجامعي المناسب من وجهة نظر الطلاب؟ وما رأي الطلاب في تطوير نظام خبير يساعد طلاب الثانوية العامة في اختيار برنامجهم الجامعي المناسب؟ وكيف يتم تطوير نظام خبير جديد لمساعدة طلاب المدارس الثانوية في اختيار برنامجهم الجامعي؟ حيث يقوم النظام الخبير بتحليل ميول الطالب وقدراته، ومتطلبات القبول والتسجيل ليقترح البرامج التي تقدمها جامعة الخليل والتي تتوافق مع شخصية الطالب. إضافة إلى أن النظام يقدم للطالب تحليل حول احتياجات السوق الفلسطيني من هذه البرامج. وقد تم تطوير هذا النظام الخبير استنادًا إلى إحدى نظريات علم النفس الشهيرة في جانب تحليل الشخصيات وهي نظرية هولند، حيث يحتوي النظام على قاعدة المعرفة التي يخزن فيها أنواع الشخصيات التي اقترحتها هذه النظرية. إضافة إلى أن النظام يستخدم كل من: القواعد وخوارزميات التعلم الآلي لتحليل ميول وقدرات الطالب وعرض أفضل البرامج الجامعية التي تناسب شخصيته. أظهرت النتائج أن ٨٥٪ من الطلاب يرغبون باستخدام النظام الخبير وأوصوا باستخدامه، بينما وجد ١٥٪ من العينة المشاركة أن ذلك غير مفيد ويفضلون الرجوع إلى الأساليب التقليدية. وعليه، توصي الباحثة بضرورة اعتماد النظام بشكل أساسي لجميع الطلاب الراغبين في الالتحاق بجامعة الخليل لأنه يقوم على أسس علمية إلى جانب التخلي عن الأساليب العشوائية في اختيار التخصص الجامعي. بالإضافة إلى ذلك، يفضل اعتماد النظام من قبل الجهات المختصة في فلسطين، وتحديث النظام بشكل متكرر بما يتناسب واحتياجات السوق الفلسطيني. كما توصي الباحثة

بضرورة توفير البيانات عن كافة القطاعات المتعلقة بالسوق الفلسطيني من خلال تعاون المؤسسات المختلفة التي تمتلك هذه البيانات.

الكلمات المفتاحية: طلبة الثانوية العامة، التخصص الجامعي، النظام الخبير، جامعة الخليل، معدل الثانوية العامة، احتياجات السوق، نظرية هولند، التعلم الآلي.

Abstract

In the light of the rapid Information and Communication Technology **(ICT)** development, it became a measure of the level of progress of an organization and shows its ability to compete. There is no doubt that the applications of Artificial Intelligence **(AI)** have contributed to a technological shift in various fields among which is the expert system, which is defined simply as the system that replaces or assists a human expert in a complex task that requires a specialized knowledge. The employment and use of expert systems has recently spread in many areas, including: health, military, administrative, in addition to the educational process. Whereas, high school students in Palestine face a problem when choosing their university program because this process is affected by many surrounding factors. Hence the fundamental purpose of the present study is to propose and develop an expert software system to guide high school students in choosing the appropriate university program at Hebron University as a case study. Therefore, the current study addresses the answer to the following questions: what are the factors affecting the students' choice of the appropriate university program from the students' point of view? In addition, what is the students' opinion towards developing an expert system that helps high school students in choosing their appropriate university program? Moreover, how to develop a novel expert system to help high school students in choosing their university program? Where the expert system analyzes the student's tendencies and abilities, and the requirements for admission and registration to suggest university programs offered by Hebron University that are compatible with the student's personality. In addition, the system provides the student with an analysis of the needs of the Palestinian market from these university programs. This expert system was developed based on one of the famous theories of psychology in the aspect of personality analysis, Holland's theory, where the system contains the knowledge base

in which the types of personality suggested by this theory are stored. In addition, the system uses both rules and machine learning algorithms to analyze the student's tendencies and abilities and display the best university programs that suit his/her personality. The results showed that 85% of the students would like to use the expert system and recommend it, while 15% thought that it is not beneficial and would rather referring to traditional methods. Accordingly, the researcher recommends that the system be adopted mainly for all students wishing to enrol in Hebron University since it is based on scientific grounds besides abandoning random methods in the selection of university major. In addition, the researcher recommends the adoption of the system by the competent authorities in Palestine, and updating the system frequently. Furthermore, the researcher also recommends the necessity of providing data on all sectors related to the Palestinian market through the cooperation of the various institutions that own these data.

Key Words: High School Students, University program, Expert System, Hebron University, GPA, Market Demand, Holland Theory, Machine Learning.

1 Chapter One: Introduction

Rapid progress in the field of Information and Communications Technology **(ICT)** has made information technology a Lifestyle and an indispensable tool. Technology became a measure of the level of progress of an organization and shows its ability to compete. There is no doubt that the applications of Artificial Intelligence **(AI)** have contributed to a technological shift in various fields among which is expert systems, which has grown from a mere idea into a practical reality contributing to the development of many systems. The expert system can be defined simply as the system that replaces or assists a human expert in a complex task that requires specialized knowledge. Recently, the use of expert systems has spread around the world and in various sectors including the educational sector. Simsek et al (Simsek et al., 2019) discussed the use of expert systems in individual online exams. Moreover, the research conducted by Supriyanto et al (Supriyanto et al., 2019) investigated developing an expert system that aims at providing career guidance for the students.

Usually, students choose their major without any scientific bases or international standards which can help them determine the university program that suits their personality and takes into account current market demand. Yet, it can be notified that our country is in dire need of development to catch up with the technological revolution. This can be illustrated in the fact that, until now, there is no electronic system approved by the Palestinian Ministry of Education and Higher Education to help high school students choose their university majors. Therefore, the present study aims at shedding light on an expert software system that helps students in the process of choosing the appropriate university major. It also takes into account market demand which depends on international standards and statistical indicators.

The development of such a system will be of major benefits to the students, as they will not have to follow traditional methods such as consulting family or friends when choosing their university major. Thus, through this system, they can get to know their personality and the university program that suits them best, and this will definitely reduce their tension and the possibility choosing a specialty that might not be suitable for them. Moreover, through this system, students can view details about the job opportunities available in the market, and the university programs that are required for the market demand.

1.1 Background and Context

Students select the major they wish to study according to their high school branch in which they studied for their high school and according to the Grade Point Average (**GPA**). However, students were facing some difficulties in choosing the major that will determine their career in the future. Further, the selection process may be affected by many factors including tendencies, personality traits, the demand of the local market, and other influential factors, such as friends and family or the social status of the specialty. As a result, the process of choosing a major becomes even harder.

On the other hand, choosing the major is a fateful decision because it will reflect upon the students' future life and career (Mundra et al., 2014). If a student chooses an unsuitable major or a major that has a surplus of graduates in the market, this will lead to negative results on the student. These negative results would force students to work in a field other than their specialty or to travel abroad in an attempt to find different job opportunities. Hence, the idea of introducing a software system to guide high school students in choosing the appropriate university program based on their preferences and personality is needed. The current system (The Path) will also provide statistics reflecting upon the market demand of these disciplines, and the unemployment rates of

the graduate students. This will help the student in selecting the accurate major that prevents them from falling into the wrong choice after graduation. Accordingly, future negative circumstances will be avoided.

1.2 Statement of the Problem

Studies showed that high school students in Palestine face a problem in choosing their university major. A study conducted by Ziad Shawer (Shawer, 2015) determined how students choose their university program at Palestine Polytechnic University **(PPU)**. His study showed that 36% of students chose their majors alone without referring to anyone, and 82% of them faced problems in choosing a university program, as a result, the student was influenced by the advice offered by the family, friends, and teachers. Hence, these tips, sometimes, turned out to be inaccurate and based on personal views without being referred to the attributes and tendencies of the student. They may also be isolated from the market's demand or even provided based on personal experience. In the present research, the researcher published a questionnaire (Appendix 3.1) to Hebron University **(HU)** students from various disciplines aiming at identifying the factors that affected them when choosing their university major.

In the present study, several questionnaires were used including a questionnaire directed to the current students of Hebron University in various academic years to identify the factors that played a role in the process of choosing their university major. The questionnaires included several dimensions: the social dimension, the university's requirements, the market needs, and the expert systems dimension. After analyzing this questionnaire, the researcher found that 48.8% of the students were influenced by the opinions of their parents when choosing their university major, 36.4% were influenced by the opinions of their friends, and 36% were influenced by the opinions of their relatives. The results also showed that 53% relied upon the advice provided by college

professors, and 76.6% chosen their specialty alone without consulting anyone. The aspect related to the analysis of the questionnaire will be explained in detail in the third chapter of this thesis.

Sometimes, the advice and guidance providers do not encompass all facts in the process of choosing the university major. Shawer's study (Shawer, 2015) found that 73% of those who provided advice were not based on a complete knowledge of the factors affecting the choice of a university program. Moreover, inappropriate choices may lead to negative consequences for the student, and these consequences may face students during their studies or after graduation. In general, these consequences may include the following aspects:

- Students' inability to continue studying in the chosen major due to students' low educational attainment or the inadequacy of university program. This would lead students to fail academically or even be dismissed from the university or college.
- Students may change their university program later due to the late realization that the university program does not suit them.
- After graduation, students may work in a field different from their university program.

1.3 Research Questions

This thesis investigates developing an expert software system that guides high school students in choosing the appropriate university major at HU as a case study. Therefore, the present study attempts at answering the following questions:

1. What are the factors affecting the students' choice of the appropriate university program from the students' point of view?

2. What is the students' opinion towards developing an expert system that helps high school students choose their appropriate university program?
3. How to develop a novel expert system to help high school students in choosing their university program?

1.4 Research Objectives

As mentioned previously, the fundamental purpose of the present study is to propose and develop an expert software system to guide high school students. The detailed objectives of the current research include the following aspects:

1. Determine the factors that affect the students' choice of their university program from the students' viewpoint.
2. Investigating students' opinions towards developing an expert system that helps high school students in choosing their university program.
3. Developing and testing the novel expert system that helps high school students choose their university program.

1.5 Relevance and Importance of the Research

The system is supposed to solve the aforementioned problems and will serve as a guide and assistant to students in choosing their major. The current software system has the following features:

1. Assist and guide students in choosing the most appropriate major according to their tendencies and abilities through the analysis and examination of their abilities, personality, and tendencies electronically.
2. The system provides accurate and clear indicators and statistics regarding the market needs by providing statistics available on the Palestinian market. The system also introduces the student to the needs of the labour market from each

major, including the knowledge of employment rates for each discipline. In addition to realizing the needed disciplines by the market and university programs that have a surplus of graduates through the provision of statistical studies.

3. The system provides students with the opportunity to easily access the software via Internet.
4. The system will increase students' educational attainment due to its consistency with the chosen major. As a result, this should reduce the number of students who change their majors and increase the quality of education. Additionally, students' creativity will appear in their fields of study.
5. The system will familiarize the student closely with the university programs of HU including the knowledge of the major study plans and the description of courses. Accordingly, this will expand the student's perception and knowledge about the university program before choosing it. It is worth mentioning that the current system is targeting HU students as a case study and it will be easily expanded for other Palestinian universities.

1.6 Method of Data Collection

In order to achieve the research objectives, the researcher adopted two data sources.

1.1.1 Primary Sources

In the current research, questionnaires are represented as the main study tool for collecting primary data with the aim of addressing the analytical aspects of the topic of the role of expert systems in guiding high school students in choosing the appropriate university program. Among the main data sources are the raw data obtained from the Palestinian Central Bureau of Statistics **(PCBS)** (PCBS, 2020) on the labour market and unemployment rates, with the aim of analysing the Palestinian market statistically.

In addition, the data obtained from each of the Registration Unit and the Graduates Unit at HU.

In addition, interviews can be considered one of the primary methods of data collection in the present research. Many interviews were held with each of the current high school students and high school counsellors in Palestinian schools to gather their opinions regarding choosing the university major and the possibility of assisting them through this expert system. Moreover, interviews were also held with a group of human experts such as psychology experts and artificial intelligence experts.

1.1.2 Secondary Sources

The second sources of data in the present research are previous related researches, books, articles, periodicals, reports, and scientific thesis the field of study. Using secondary sources will be acquainted with the latest developments in the field of using expert systems to guide students.

1.7 Study Limitations

The present research faces different types of limitations. The first of which is the human limit as this thesis included a selected sample of HU students as a case study in different academic years. In addition, it has geographical limits as HU will be the starting point for developing this system. In addition, it has objective limits that examined the role of expert systems in guiding high school students in the process of selecting the appropriate university program for them. Moreover, the thesis has time limits where this study was conducted in three academic semesters.

1.8 Research Contribution

As it was discussed earlier, so far, there is no system approved by the Palestinian Ministry of Education that helps and guides high school students in choosing their university major. Therefore, high school students in Palestine face a problem when choosing their university program. Thus, the present study aims at using modern techniques in Artificial intelligence **(AI)** science to develop a specialized expert system that analyzes the abilities and tendencies of the students. It suggests the university program that suits their personality. However, one of the advantages of this system that it was developed after studying the major factors that affect students when choosing their university major which include social factors, university requirements, and labour market demand. The system provides data and information about university program demand in the Palestinian market which is influential in the process of choosing their major. The results of the analysis showed that 70% of HU students believe that market demand for university program guides students when choosing their major. In addition, 52% of HU students believe that the admission conditions of the university affect their choice of the university major. The expert system proposed in the present research also takes into account the university requirements such as the GPA and the high school branch.

The current expert system is a combine system, meaning that it consists of two developing methods. The first one is a static expert system that is rule-based, and the second is a dynamic expert system that is based on machine learning.

Moreover, the researcher has created a dataset that includes 2520 records with its attributes: student personality, high school branch, and GPA. This dataset was used in the machine-learning model, which predicts the best university program (s) for the

student through the Decision Tree Classification (**DTC**) algorithm, which is one of the most important supervisory machine learning algorithms.

1.9 Research Challenges

Commonly, all systems face challenges during their development cycle. In this section, the researcher will present the challenges faced during the process of building the system and how these challenges had been resolved, which include the following:

- The lack of sufficient data about the market demand for different specialties. The proposed solution for this is to make use of the statistics available at PCBS and the data available at the Graduate Unit at HU.
- The difficulty of making visits to graduates at their worksites due to the Coronavirus pandemic. One of the proposed solutions for this challenge is to work on collecting and analyzing data electronically in order to create new statistics on unemployment rates and the workforce among graduates.
- The lack of similar works related to the research topic in Palestinian society. The proposed solution to this challenge was to take advantage of expert systems and scientific research in Arab and Western societies that worked to develop systems similar to the current expert system.

1.10 Thesis Organization

The six major chapters of the present thesis are the introduction, literature review, methodology and procedures, the results of research questions, developing the expert system, and conclusion and future work. These chapters can be summarized as follow:

- Chapter I: **Introduction**: This chapter introduces the research background and context, research problem, research questions, research objectives, research importance, method of data collection, research limits, research contribution, research challenges, research structure, and summary.

- Chapter II: **Literature Review**: In this chapter, the researcher will discuss the introduction, introduction to expert system, define concepts, related work, and summary.
- Chapter III: **Methodology and Procedures**: This chapter introduces the introduction, methodology, study population, study sample, study variables, study tool, study procedures, and summary.
- Chapter IV: **The Results of Analysing Questions**: In this chapter, the researcher will discuss the introduction, statistical results related to the research questions, and summary.
- Chapter V: **Developing the Expert System**: This chapter investigates the current expert system, discusses the introduction, system specifications, model development methodology, testing and evaluation, and summary.
- Chapter VI: **Conclusions and Future Work**: This chapter introduces the conclusions, research results, recommendations, and future work.

1.11 Summary

In this chapter, the researcher discussed the fundamentals and main aspects of the present research. The chapter also highlighted the research problems which include the challenges and difficulties that high school students face during choosing the appropriate university program. Therefore, the present study aimed at finding a solution to these problems by developing a novel expert system that directs students towards choosing the appropriate university program based on several support variables such as student personality, student's GPA, and market demands for university program. This chapter also introduces the research questions, research objectives, research importance, method of data collection, research limits, research contribution, research

challenges, and research structure. The next chapter will discuss related studies in the same field and the theoretical framework.

2 Chapter Two: Theoretical Framework and Literature Review

2.1 Introduction

As previously mentioned, choosing a university program is one of the major problems faced by students after completing secondary school due to the existence of many fields of study and universities. As a result, students feel confused or forced to follow traditional methods in choosing their major especially when choosing the university major upon the friends' opinions or those who have previous experiences. However, taken a random decision would lead to unpleasant results. Students may work in a disappointing profession that lacks good planning and of no scientific basis. Several factors play a significant role in the selection of students' majors. These factors may be personal, professional, academic, social, or family factors. It can be noted that personal factors that affect students' process of choosing their major are connected to the personal desire regarding the selected major. However, they are considered to be the one with the best influence on the student's future. Professional factors refer to job future opportunities offered to the chosen major that is associated with the market needs. Furthermore, academic factors refer to the ability of the chosen major to influence students' manner of thinking. As for the social factors, they reflect upon the importance of the selected major in terms of society and its ability to achieve a suitable social position for its owner in the future. Finally, family factors refer to the desire to improve the family’s socio-economic status (Shalaui, 2008).Therefore, students must be aware of a set of basic elements when they plan to choose the university program including tendencies, desire, abilities, goals, values, labour market as well as GPA(Jassem & Helou, 2014; Mundra et al., 2014). Nevertheless, the present research aims at developing an expert system that contributes to reducing the aforementioned

problem that high school students suffer from in Palestine, Besides, the researcher will shed light upon various factors, which are: social, academic, and professional factors.

The emergence and development of expert systems began in the early 1970s after artificial intelligence researches and continued to this day (Tan et al., 2016). These systems played a significant role in automating some intellectual functions such as identification and event prediction. Expert systems are built by extracting knowledge from human experts and storing it in a university program that imitates the human capabilities of thinking in his work at the same level by processing the stored knowledge so that the expert system can deal with quantitative and qualitative data (Abuhamda, 2012; Tan et al., 2016). Expert systems have received the attention of researchers, so, recently, expert systems became widely used in most fields such as medicine (Abuzayed, 2017; Tan et al., 2016), education and training (Banswal & Madaan, 2016; Engin et al., 2014; Hasebrook & Nathusius, 1997), management(Abuzayed, 2017; Shariat et al., 2013), 2017), military (Abuhamda, 2012; Tan et al., 2016), and others.

In this chapter, we will discuss three main parts: introduction to expert systems, the concept definition and theories of the present research, and the related work.

2.2 Introduction to Expert Systems:

Expert systems are branches of artificial intelligence **(AI)** in the form of software that uses science, facts, and thinking techniques to solve problems in special areas that usually require human expertise. Computer applications represent comprehensive knowledge in a field of human expertise and offer complete solutions in this area. They simulate the human experts by collecting and using information from one or more experts in a particular field. It is the merging of the experience and knowledge of several experts specializing in several different fields who contribute to producing one system specialized in a specific field that engages in solving some problems without the need

to resort to an expert person when making decisions (Abuhamda, 2012; Fakeeh, 2015; Shawer, 2015; Supriyanto et al., 2019).

As a result of the wide successes achieved by the expert systems in various fields, they were adopted in the present research to solve the problem that high school students face when choosing their university major. One of the advantages of the current system is that the student can reach it at any time because he can access it via the Internet. Besides, the system has been developed according to scientific foundations and based on the knowledge of many experts in various fields such as psychology, statistics, and AI.

2.2.1 Expert Systems Features

The most important feature of expert systems is their ability to preserve and analyze human experience and knowledge, thus providing solutions to complex problems in record time and more than one place. The characteristics of expert systems as mentioned by (Abuhamda, 2012; Abuzayed, 2017) include the following aspects:

- Imitate specialists in the decision-making process.
- Interacts with the user by asking a group of questions to facilitate the understanding of the problem, finding the appropriate solution, and presenting it to the user.
- Easily used by non-professionals because they are treated with user-friendly and easy-to-use interfaces.
- Use logical analysis in dealing with problems.
- Gives us the ability to develop the performance of individuals specializing in a specific field of knowledge with low experience.

- Work at the speed required by the situation, and this means that the processing speed is the same as the event speed for the systems that interact with humans, and the real-time speed for the systems that interact with other systems because these systems use the parallel processing method. That is, the implementation of several commands at the same time, and this is closer to the way people think and solve problems.

2.2.2 Components of Expert Systems

It is very well known that the expert system consists of four major architectural components (Alasgarova & Muradkhanli, 2008): a knowledge acquisition module, a knowledge base, an inference engine , and an I / O user interface. These components are shown in Figure 1.

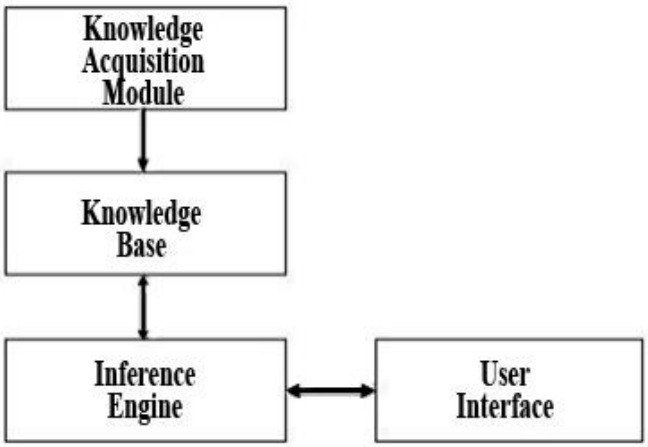


Figure 1. The Architecture of an Expert System (Alasgarova & Muradkhanli, 2008).

2.2.2.1 Knowledge Base

The knowledge base **(KB)** contains domain-specific knowledge that is used to solve problems in a specific field. It includes two main elements (Abuzayed, 2017; Alasgarova & Muradkhanli, 2008; Sekari et al., 2005):

- Facts: such as theories that prove their validity.

- Rules: It guides the use of knowledge to solve specific problems in a specific domain. Knowledge can be represented and stored in the knowledge base in a format suitable for computer manipulation. and rules are one of the most popular ways to represent knowledge (in If-then form).

In the present research, the domain-specific knowledge will be about the personality of the student and his abilities. The knowledge base is a warehouse of knowledge taken from Holland's theory (Holland, 1987) in which the six different types (It will be explained in Chapter II) of personality will be stored. To represent the rules for producing knowledge, the rules are used in IF-THEN form.

2.2.2.2 Inference Engine

The inference engine represents the brain for a knowledge-based system. It is a university program that contains logic and a conclusion mechanism that simulates the experts' mechanism of action, and their logic when providing advice on the problem to be solved. Moreover, it works as an interpreter analyzing and manipulating the rules. The inference is the process of generating information from known or assumed facts. In the expert system, the inference process is implemented in the inference engine which uses the data obtained from the knowledge base and the end-user to implement the inference process and present the proposed findings and recommendations. The inference process is done through forward or backward chaining approaches. The inference engine that uses forward chaining works to extract data until it reaches the goal. "It searches the inference rules until it finds the solution." Whereas, the inference engine that uses the backward chaining starts with the desired result and goes back to find the supporting facts (Abuzayed, 2017; Kapoor & Bahl, 2016; Supriyanto et al., 2019).

In the present research, the inference engine performs a major process after the student finishes answering the questions posed by the system. The inference engine also searches in the knowledge base for the type of personality that corresponds to the result obtained by the student and works on analyzing it by following the forward-chaining approach to display the appropriate university program for the student's personality, that is Rule Interpreter.

2.2.2.3 Knowledge Acquisition Module

This module enables experts to store their knowledge in the knowledge base to derive new knowledge from existing knowledge through the machine learning process. The techniques used for knowledge acquisition are protocol analysis, interviewing, and observation (Ahmed et al., 2019; Alasgarova & Muradkhanli, 2008). To carry out the acquisition of knowledge in the expert system, it requires the efforts of two main parties:

- The first is the expert person and his expertise and knowledge in the field of university program.
- The second is the knowledge engineer who works to convert human experience into a language that can be university programmed to be understood by both the end-user of the system and the expert system.

In the present research, knowledge has been obtained from various sources, the most important of which is Hollande's theory (Holland, 1987) of personality types. In addition to the knowledge obtained from human experts, such as psychologists. As for the knowledge engineer, it represents the researcher, as the obtained knowledge has been transferred to the PHP language so that both the expert system and the end-user can understand it through simple user interfaces, which will be explained in more detail in Chapter VI.

2.2.2.4 User interface

The component forms a link between the expert system and its users. Yet, the expert system users could be humans or other computers. However, this dialogue - between the expert system and its users is simple and lively.

The main requirement for designing interfaces is through asking questions, obtaining information from the beneficiaries, and providing guidance, warning, or correction signals to the system user. These interfaces may contain several elements including Graphics, Menus, and Made Screens (Abuhamda, 2012).

As mentioned in (Sekari et al., 2005) study, the information described the required in two ways:

- Choose from lists presented by the user interface to the user. The user may choose what he wants from the information through pre-formatted questions stored in the system, and this method makes it easier to access the information.
- Providing the system with information on a specific topic or a specific situation so that the system diagnoses that situation and then responds to the inquiry or finds an appropriate solution.

In the current expert system, the user interfaces present to the student a set of questions, and after analyzing the student's result, the interfaces present to him the university program (s) that suit his personality. In addition, the system provides a set of statistics and facts about this university program (s) in the Palestinian labour market.

As described by Suleiman (Suleiman, 2010), there are three types of expert systems:

- **Rules-based expert systems:** In this type, the system runs a series of rules to arrive at a specific conclusion to solve the problem according to the data given to the system. These systems can simulate the ability of human experts to make

decisions. they are designed to solve problems in a way that mimics what humans do by exploiting encoded human knowledge or experience (Engin et al., 2014).

- **Example-based expert systems:** These systems derive their conclusions from comparing a given situation with an example stored in the system's knowledge base.
- **Model-based expert systems:** These systems are useful for diagnosing problems with specific equipment, machines, or devices. The system contains an ideal model of the equipment to be diagnosed, and this model is used to identify fault areas in it.

In the present research, the first part of the current expert system is rule-based while the second part is based on comparing the current state with data and knowledge which are stored in the dataset and knowledge base through a machine learning model by the DTC algorithm. The combined system will be accessed through the web. Thus, it can be categorized as a web-based expert system.

2.2.3 Principles of Developing Expert Systems

Some basic steps can be described by developing an expert system as follows (Abuhamda, 2012):

A. Define the Domain

The process of building expert systems requires holding multiple sessions with human experts or experts in the specific field. Human experts provide their knowledge and the methods they use to solve problems in this area. The developer of the expert system must place this knowledge and information in a form that is easy to study and to refer to. In the present research, several sessions were held with experts in

psychology and it was concluded that Holland's theory is suitable for the purpose of the current expert system.

B. Users

Several people deal directly and indirectly with the system as end-users. Nevertheless, they are not required to have great computer skills because they deal with the expert system through the screen and the keyboard by asking the user questions and receiving solutions and recommendations. Moreover, the domain experts who have experience and knowledge in a specific field can solve problems in that domain. The expertise he possesses is the basis from which the knowledge base of the expert system will be built. So, the domain expert is the most important person among the system development team because his experience is the cornerstone of the success of the system. As previously indicated, knowledge has been obtained from Holland's theory and psychologists. Besides, university programmers can describe the knowledge of the field expert in a university programming language that the computer can understand. Furthermore, knowledge engineers can design, develop, and test an expert system where he/she holds numerous personal interviews with the field expert to find a way to solve a specific problem. Through communicating with the expert, the knowledge engineer determines the thinking methods that the expert uses in dealing with facts and rules, determines how they will be represented in the system, and then selects some development software systems to develop the expert system. Besides, he also chooses a university programming language to write the knowledge code; and finally, the knowledge engineer is responsible for On-site testing, review, and integration of the system. The university programmer can be dispensed if the knowledge engineer is fluent in dealing with the appropriate university programming languages to develop the expert system (Abuhamda, 2012; Abuzayed, 2017; Alasgarova & Muradkhanli, 2008).

This is found in the present research where the researcher represents both the university programmer and the knowledge engineer. So, the researcher held several sessions with psychological experts to obtain the knowledge necessary to be represented in the system. Then, this knowledge was organized to be employed in the expert system and to have access to it through the inference engine which works to process the requests of the end-user who represents the student in the present research, to analyze the student's request, and to obtain the final result.

2.2.4 Expert System Implementation

In software engineering science, a methodology with clear steps for developing systems is usually followed and this is called Systems development life cycle (SDLC). Figure 2 shows the general stages indicated by Sagheb-Tehrani (Sagheb-Tehrani, 1993) that can be followed to develop expert systems.

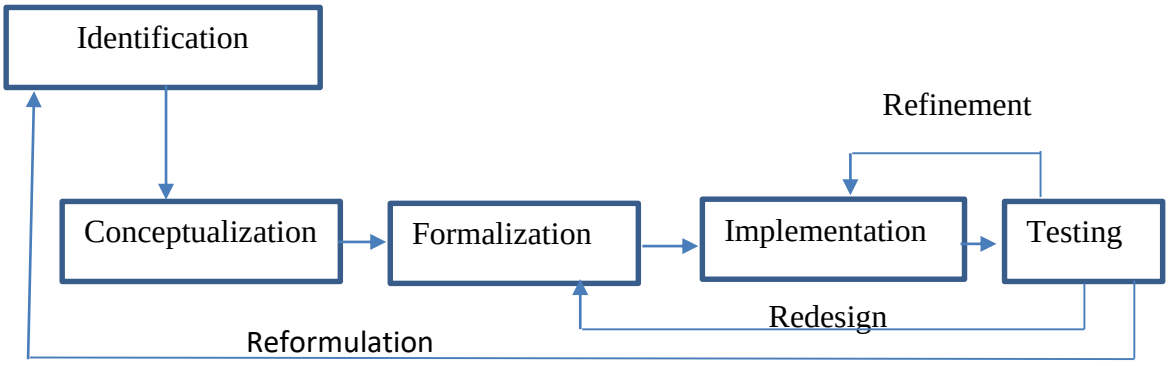


Figure 2. General Stages of Expert System Development.

These stages have proven successful in many previously developed expert systems such as the expert developed by Albakri et al.(Albakri et al., 2017). These stages can be explained as follow:

A. Identification:

In the identification stage, the problem is precisely identified. The problem that the current expert system addresses in the present research is that there is no current expert

system at HU that helps the student in the process of choosing the appropriate university program according to his personality and the needs of both the university and the labour market demand. Furthermore, at this stage, the sources of knowledge are identified. In the current system, the knowledge is obtained from psychology professionals, Holland model, market demand, HU Admission requirements, the Alumni Unit at HU, the PCBS, interviews, questionnaires, and literature review.

B. Conceptualization:

The Conceptualization stage means that the problem is analyzed to understand all its details. The knowledge is also elicited from the sources identified in the previous step. Then, the acquired knowledge is expressed in clear concepts like using different symbols to express the types of characters.

C. Formalization:

In this stage, the knowledge acquired is represented in organized structures. This is known as Knowledge Representation which is to represent this knowledge in the form of decision tables, in preparation for the next stage, which is to design models that represent the knowledge acquired in a way that links all the important criteria in determining the appropriate university program. In the present research, the expert system was divided into subsystems which are admission requirements, student personality analysis, and market demand analysis. This will be clarified in Chapter V.

D. Implementation:

Here, the rules are formulated to embody the knowledge. Since the data and domain knowledge has been represented in decision tables and models, it is easy to obtain the required knowledge. In the current expert system, a set of rules (if-then) develop to represent the knowledge obtained. This means that the knowledge base is created at this stage. This will be clarified in Chapter V.

E. Testing:

The testing stage represents validation, verification, and maintenance so that the feedback is taken to correct errors if any. And often presented in the initial version of the system. Ultimately, an expert software system can be judged to be successful only if it operates at the level of a human expert.

2.3 Define Concepts, Theories, and Studies

In this section, the most prominent terms used in the present research will be discussed. For more details, more terms used in the present research are clarified and discussed in Appendix 2.1.

2.3.1 Satisfaction with the Academic University program:

Khalid Jassem and Ali Al-Helou (Jassem & Helou, 2014) defined satisfaction with the university program as the students' internal feeling that is reflected in his/her behaviour and which expresses satisfaction with the university program and the college in which he/she is studying. If the students feel satisfied with their university programs, they will succeed in it. However, many students may study majors in which they do not feel satisfied, and this is why they face many problems either during their studies or after their graduation.

The researcher seeks to help the students and brings them satisfaction. In order for the students to reflect upon the usage of the expert system, a place has been allocated in the expert system to allow the students to express their satisfaction with the results obtained from the current system. Accordingly, the student's satisfaction can be judged through their feedback.

2.3.2 Machine Learning

Machine Learning **(ML)** is a branch of artificial intelligence that is growing rapidly in the present time because we live in the era of data and machine learning, algorithms had to evolve and provide us with the keys to classifying and analyzing this data. There are several types of these algorithms. Common types of these algorithms include (Mahesh, 2019; Mohd Shafiee et al., 2020; Oladipupo, 2010):

1. Supervised learning: The algorithm learning is a function that maps the input to the desired output based on the example of input-output pairs. Supervised algorithms split the input dataset into the train and test dataset. In addition, it needs to specify the partition ratio. The training dataset contains an output variable that needs to be predicted or classified so that all supervised algorithms learn some kind of pattern from the training dataset and apply it to the test dataset for prediction or classification. The most popular types of supervised machine learning algorithms are:

    - Decision Tree: It is a graph representing choices and their outcomes in the form of a tree. It has applications in our daily life for example, detecting spam emails. In addition, they are used in more complex fields such as medicine, astronomy, radar signal classification, expert systems, and speech recognition (Chourasia, 2013; Saqib et al., 2015).

    - Support Vector Machine (**SVM**): One of the most famous machine learning algorithms used to analyze data in order to classify it statistically or regression the analysis to it. The algorithm works to find the optimal division of data and separates them into two categories. In addition, this algorithm is closely related to neural networks.

2. Unsupervised learning: It is called by this name because unlike supervised learning where there are no correct answers and no need for a teacher, these algorithms are used in clustering. It discovers and presents the interesting structure in the data. One of the most famous is the K-Means clustering algorithm that solves the well-known clustering problem.

3. Semi-supervised learning: This type of algorithm combines supervised and unsupervised machine learning to generate a suitable job or classifier. These algorithms are proven efficient in data mining. One of the most famous of these algorithms is Transductive SVM.
4. Learning to learn: This area of machine learning is concerned with teaching an algorithm policy of how to behave and take actions in a given environment.

In current expert system, supervised machine learning was adopted. Initially the appropriate algorithm was chosen after testing both SVM and DTC algorithms. Therefore, a measure of accuracy is adopted, which is defined as the ratio of the number of correctly classified cases to the total number of cases under evaluation (Lakshmanamoorthy, 2021). In the expert system, it turns out that the accuracy of the SVM algorithm was 78%. The DTC algorithm has an accuracy of 98%. So, the DTC algorithm was implemented in the current expert system where a dataset was created to represent the data source so that the DTC algorithm divides this data into the two datasets of training and testing. In the end, it performs the process of classification and prediction of the appropriate university program for the student based on a set of inputs, which are the high school branch, GPA, and personality type of the student. This section will be explained in detail in Chapter Five.

2.3.3 Holland's Theory

The American scientist John Holland (Holland, 1987) established his theory which is considered one of the best means to know the professional tendencies that correspond to the desires of individuals. Holland focuses on the importance of compatibility between personal and professional patterns and its necessity to provide harmony and success in an individual's professional life and achieve job satisfaction in the future.

A student who chooses the type of education that fits with a personal style will be more productive, as opposed to a student who cannot choose the type of education in a way that suits his personality style. Hence, a solution has been found to the study problem related to high school students 'choice of their university major. According to Holland, individuals can be characterized by their resemblance to each of the six personality types (Mumme, 1997; Salah, 2009): Realistic (R), Investigative (I), Artistic (A), Social (S), Enterprising (E), and Conventional (C). Through studying the characteristics of these types of personalities, the researcher can find the university program that fits the student's personality. Types of characters and their description according to the Holland model (Landrum & Davis, 2013; Shatkin, 2007) can be described as follows:

- **Realists (R):** This environment includes individuals who are characterized by sporting and mechanical capabilities and prefer to work with machines, equipment, plants, and animals more than dealing with people. They find it difficult to express themselves. They enjoy creating new ideas, assuming responsibilities, and creativity. They prefer to work outside the office area. They have trading and commerce skills.
- **Investigators (I):** It is represented by people who prefer scientific and intellectual professions and enjoy solving problems, collecting information, finding theories or facts, and analyzing and interpreting information. They bear responsibilities that provide opportunities for research, study, and science.
- **Artistes (A):** It includes individuals who do not prefer to adhere to a specific system and who express aesthetic qualities through their artistic and literary works. They have no interest in problems and issues that require physical exertion. They love working alone and need a greater expression of

individuality and less persistence in their opinions and abilities, independent and unconventional, who take advantage of opportunities that demonstrate their artistic creativity, and are flexible in their tasks.

- **Social (S):** It includes people who have high communication skills and enjoy playing their roles by helping others and prefer to work in groups. Pure, social, and humanistic who are good at dealing with others and getting good relationships, love, and attention. Prefer to solve problems by discussing them with others. They do not like businesses that deal with machines or that require physical exertion. Describe themselves as optimistic, popular, and good leaders. They have social focus responsibilities that provide an opportunity to help others and include types of educational and social care.
- **An entrepreneur (E):** These types include individuals with managerial personalities who are distinguished by the superior ability to communicate their thoughts and opinions to others and have the ability to persuade, especially in selling, domination, and leadership. They prefer social tasks because they can persuade their views. Impatient for delicate work or work that takes a lot of time or work that needs intellectual effort, love strength, status, and material wealth. Enjoy the challenge and adventurous tasks that lead to the growth of personality.
- **Conventional (C):** It includes people who are precise at work and are distinguished by adherence to the rules, laws, and regulations specified in the course of work. They prefer to deal with numbers. They do not prefer physical work or that requires effort, rather office work. They do not like ambiguity, do not seek leadership, prefer activities that are numerical and verbal, and can be

relied upon. Enjoy things and routine procedures and responsibilities that do not need to change and include people with a high degree of self-control.

Table 1 shows the Personality type proposed by Holland, The characteristics of each personality, as well as some of the Suggested jobs for each character (*Know Yourself*, n.d.; Landrum & Davis, 2013; Mumme, 1997; Salah, 2009; Shawer, 2015).

Table 1. Personality types, their Properties, and Suggested Jobs for each Type According to Holland's Theory.

Personality type	Properties	Suggested jobs
Realists	Frankness, stubbornness, humility, physical effort, selfishness, and clarity.	Pharmacist, optometrist, agricultural engineer, environment engineer, carpenter, mechanical engineer, electrical, tailor.
Investigators	Rationality, accuracy, isolated, analytical, cautious, complex, curious, disciplined, intellectual, logical, contemplative, and pessimistic.	Pharmacy assistant, physiotherapist, food scientist, anaesthesiologist, school health specialist, community health specialist, paediatrician, dentist, laboratory specialist, biologist, physicist, chemical, computer university programmer.
Artistes	Aesthetic, Complex, Creator, Emotional, Ideal, Fanciful, Intuitive, Distinctive, Unconventional, Independent.	Beauty technician, singer, TV director, songwriter, music player, English teacher, Arabic language teacher, art education teacher, story writer, fashion designer.
Social	Caring, tolerant, considerate, open-minded, trustworthy, diplomatic, friendly, generous, Mercy, helpful, ideal, gentle, responsible, social, enthusiastic.	Doctor, nurse, social service, psychologist, social worker, physiotherapist, optometrist, handicapped technician, director of medical records, pharmacist, headmaster, hospital director, radiologist, ambulance officer.

Entrepreneur	Adaptable, ambitious, risky, material, optimistic, spontaneous, energetic, loves attention, confident, controlling, open-minded, persuasive, reckless, popular.	Medical records employee, factory health safety officer, production engineer, pilot, bank employee, accountant, statistician, entrepreneurial activities, challenges and risks, business development, decision making, sales, and marketing activities, negotiation contracts, and offers.
Conventional	Stability, traditionalism and routine, self-control, cooperation, accuracy, caution, conscience, effectiveness, non-creativity, obedience, order, and continuity.	Dental Clinic Technician, Radiotherapy Technician, Animal Sanctuary Officer, Fire Protection Engineer, Archive Officer, Computer Security Specialist, Auditor, Report Writer

(*Know Yourself*, n.d.; Landrum & Davis, 2013; Mumme, 1997; Salah, 2009; Shawer, 2015).

Hence, the idea of the study emerged by employing Holland's theory in the current expert system to assist high school students in choosing the appropriate major for their personalities and abilities.

2.4 Related Work

Several previous studies have investigated expert systems implementation to solve the which high school students face. Thus, one of these problems is the process of choosing a university program. This will be discussed in this section.

The study done by Mumme (Mumme, 1997) who applied Holland's theory of professional personalities and work environments over undergraduate students enrolled in family and consumer sciences at one of the major southwestern universities. The research was based on responses from 159 freshmen enrolled in an introductory seminar course and 163 juniors and seniors in the capstone seminar course. The students answered the Basic Information Questionnaire developed by the researcher which was a professional assessment inventory based on Holland's theory in the Personality and Environment Interaction Model.

Mumme's study provided a detailed description of Holland's theory, so, it is an important study for building the current expert system, as the present system will apply Holland's theory in analyzing students' personalities. Besides, Mumme's presented a set of questions that he relied on upon analyzing the personality of the study sample. This was also beneficial when formulating questions that the expert system might pose. However, the current system has the advantage of being electronic and the student can easily access it. Moreover, it provides an analysis of the Palestinian market.

Naser et al. (Naser et al., 2005) developed a rule-based expert system to measure the capabilities of students who intend to enroll at Al-Azhar University in Gaza. Their

expert system is developed by relying on visual basic and using C Language Integrated Production System **(CLIPS)** to build the rules and facts that will be stored in the knowledge base. Yet, CLIPS does not support graphical interfaces, so their system was designed as a desktop application, accordingly, it is not easily accessed. Moreover, their system focused on analyzing students' abilities such as intelligence and finding a college or major that suits their abilities only. In contrast, the current expert system is characterized by being easy of access and user-friendly because it supports graphical user interfaces that are designed with consideration for multimedia elements. In addition, the current system is easily accessed because it can be accessed via the Internet, as the expert system was developed based on the Hypertext Pre-processor **(PHP)** language. Moreover, the system is concerned with analyzing professional factors such as unemployment rates, and being concerned with analyzing the abilities and tendencies of the student.

Albakri et al.(Albakri et al., 2017) discussed the problem of choosing the appropriate university major for high school students wishing to enroll in Palestine Polytechnic University **(PPU)**. The researchers indicated that 7% of students are influenced by their family's opinion when they choose their university major, and 21% of them think that the financial aspect has an impact on their choice of major. Therefore, the researchers suggested that they develop a rules-based expert system to help students choose their major. The dimensions analyzed by their expert system were similar to the dimensions in this study, which are an analysis of the student's personality, market requirements, and admission and registration requirements. Therefore, this research is considered one of the strong references to this thesis. In any case, their research did not address an actual analysis of the requirements of the Palestinian market. In addition, the

researchers did not employ machine-learning algorithms in their proposed expert system. In contrast, the current expert system consists of two parts as follow:

- The rule-based expert system: In this part, the if-then statements were used to make the system able to decide on the university program (s) that suit the student by analyzing the GPA, branch of high school, and the personality type of the student stored in the knowledge base.
- Machine learning model: The system predicts the appropriate university program(s) for the student by analyzing the generated dataset that contains the GPA, high school branch, student's personality as inputs, and university programs as outputs. The system analyzes this dataset through the DTC algorithm.

These components are explained in detail in Chapter Five.

Hayadi et al.(Hayadi et al., 2018) proposed a solution to the problem of choosing university program among students of higher education in Indonesia. This research pointed out that many students do not know their abilities and personalities and prefer to listen to the opinions of their families or friends when choosing their university major. Many students do not prefer to go to a psychologist to discuss their intelligence capabilities. Therefore, researcher believe that modern technologies can be applied to develop an expert system to determine the appropriate university program for higher education students. In addition, the researchers presented their design for the expert system, relying on the Unified Modeling Language **(UML)** process and Microsoft Access as a database. To design the system interfaces, he used the Microsoft Visual Studio university program. It is worth mentioning that the researcher worked on a detailed explanation of all database tables for his expert system, and one of the influential presented tables was the knowledge base table. The forward-chaining

technique was adopted so that the inference engine matches the results of the analysis of the student's answers with the facts stored in the knowledge base to display the result of the student. Although their research is characterized by simplicity, yet, its final result provides the student with an explanation of his capabilities such as his level of intelligence. Moreover, it represents an alternative or assistant system for a psychological guide. However, the researchers do not give the student details about his personality or the specialty that suits him. Meanwhile, the expert system proposed in this thesis provides details about the student's personality type, the university program that suits his abilities, informs students of the jobs that they can be as their work in the future, and provides details about the labour market. Furthermore, the current expert system is characterized by being easily used and accessed since the student can access it via the Internet.

The system proposed by Ween (*Ween*, 2018) provides high school graduates or undergraduate students with easily accessed information on the university programs offered by Palestinian universities and in one place. Ween's system offers some study plans and conditions for admission to certain university programs in Palestinian universities. However, this system is still in the process of development. The system provides information regarding the appropriate university program of the students based on their GPA on the first part without taking into account their wishes, tendencies, and abilities. On the other hand, the current expert system allows the student to choose the appropriate major based on several criteria such as the student's GPA, personality, and clarification of the labour market needs to university programs.

A research conducted by Bakkar (Bakkar, 2018) provides a roadmap for economic and developmental work in the upcoming years in Saudi Arabia. Bakkar's work provides a full explanation of the most important university disciplines and diplomas in

line with the Kingdom's ambitious directions for the year 2030. The Kingdom of Saudi Arabia has adopted this vision to set out the general policies, objectives, goals, and commitments to be a leading model at all levels. In that system, the researcher has linked all the career paths presented in his study with the Discover platform which is the largest Saudi platform to help students choose their path after high school. The platform provides two scales to help students discover their inclinations through the Arab Scale for Professional Attitudes **(ACIA).** They also can discover the students' ability through The Arab Scale for Multiple Intelligences **(AMIAS).**

However, Bakkar's study provided two tests that can be used in the current expert system. In contrast, the current system is based on many factors like desires and tendencies. In addition, the expert system is also based on factors other than motivation and personal abilities. For instance, they may include the Palestinian market demand, the employment ratios of a particular discipline, and the GPA at which a student can be measured through the AMIAS. It is worth mentioning that students' GPA plays a key role in the process of the students' choice of their university major.

A work published by Forsa (*Forsa*, 2020) offers a system to test and analyze student's personality to determine the appropriate university majors. The system asks the user to specify the top six colleges he/she prefers to enroll in, then the system presents a set of questions to the user in which the user must choose the degree that reflects upon the user's satisfaction from 1-7. In addition, the system displays Closed-ended questions in which the user must choose one of the presented answers. The system provides the first personality analysis and shows the type of user's personality, then the system presents another set of questions to analyze the user's skills such as leadership and communication skills. Finally, the system presents the last set of questions to analyze the user's capabilities. In the end, the system provides a detailed

report regarding the results of the analysis about all of the previous tests and displays the percentage of compatibility between the faculties that the user chose at the beginning with his personality analysis.

However, the system does not consider the student's GPA or the labour market needs of a particular major. Also, the system offers advice to the student to join a specific college not a specific major. On the other hand, the current expert system will be able to advise the student about a specific major not only a college because the system is currently dedicated to the majors offered by HU. Moreover, the current system provides an analysis of the market needs of this university program and certainly will take into account the student's GPA.

Budiyono's Study (Budiyono, 2020) proposed a web-based system aimed at helping students at Yogyakarta University of Technology **(UTY)** learn about occupation characteristics and work interests or positions that match their qualifications which helps them achieve optimum career achievement. The study relied on John Holland's theory as a basis for developing the system. Besides, a review study (Supriyanto et al., 2019) presented studies focusing on the impact of using expert systems on student orientation and their careers. Further, the results of the analysis showed that the application of expert systems in educational guidance helped students greatly in achieving: success in learning, training university program, student performance, achievement, and self-evaluation. In addition, the implementation of expert systems greatly assists students in identifying and aligning the choice of academic majors with their career options. Nevertheless, the current expert system applied the same theory (Holland theory), but at an early stage of the student's life which is upon the completion of his secondary education to choose the appropriate university major. In addition to Holland's theory and according to the decision resulting from the analysis of the

student's personality, he will be directed towards the future jobs that he can join and the market demand for them.

Table 2 shows a systematic review of the literature. Where the table shows the author, the publication year, the title of the research or the system, in addition, the strengths and weaknesses of each work.

Table 2. Systematic Review of the Literature.

	Author /Publication Year	**Paper Title**	**Strength**	**weakness**
1.	Mumme, 1997	Holland's theory of vocational personalities and work environments applied to students majoring in family and consumer sciences	• Provided a detailed description of Holland's theory. • Mumme's presented a set of questions that he relied on to analyze the personality of the study sample.	• It follows the paper-based system where the student needs to answer the questions and analyze the results on his own
2.	Naser et al., 2005	A proposed expert system for guiding freshman students in choosing a major in Al-Azhar University	Their system analyzing students' abilities such as intelligence and finding a college or major that suits their abilities.	• Their system was designed as a desktop application; accordingly, it is not easily accessed.

				• Their system does not consider the analysis of the labour market requirements of university programs.
3.	Albakri et al., 2017	Rule-based expert system to lead freshmen students in choosing a suitable college major in Palestine Polytechnic University	• The researchers suggested that the expert system analyze three main axes that affect the choice of the university major, namely the student's personality, the requirements of the labor market, and the requirements of the Admission and	• The research did not provide an actual analysis of the requirements of the Palestinian market. • The research did not suggest employing machine learning algorithms for the expert system.

			Registration Department at PPU • The researchers suggested that the student's personality be analyzed based on Holland's theory.	
4.	Hayadi et al., 2018	Design of expert system to determine a major in higher Education using forward chaining method	• They designed an expert system relying on the Unified Modelling Language (UML) process and Microsoft Access as a database • Using forward-chaining technique.	• Their system does not give the student details about his personality or the specialty that fits him. • Their system does not inform student of the jobs that best fits him and does

			• Their research is characterized by simplicity. In addition, it represents an alternative or assistant system for a psychological guide.	not provide a labour market analysis.
5.	Ween, 2018	Ween- Palestinian universities	• Ween system provides high school graduates or undergraduate students with easily accessed information on the university programs offered by Palestinian universities.	• The system provides information about the appropriate university program of the students based on their GPA on the first part without any consideration of their wishes, tendencies,

			• It offers some study plans and conditions for admission to certain university programs in Palestinian universities	abilities, and labour market needs to university programs.
6.	Bakkar, 2018	What university disciplines are in line with the Kingdom’s Vision 2030?	• Bakkar's work provides a full explanation of the most important university disciplines and diplomas in line with the Kingdom's ambitious directions for the year 2030. • In that system, the researcher has linked all the career paths	Bakkar's system does not consider students GPA or labour market analysis.

			presented in his study with the Discover platform. • The platform provides two metrics to help students discover their inclinations and ability through ACIA and AMIAS.	
7.	Forsa, 2020	FORSA	The system tests and analyzes student's personality to determine the appropriate university majors for him.	• The system does not consider the student's GPA or the labour market needs of a particular major. • The system offers advice to the student to join a

				specific college rather than a specific major.
8.	Budiyono, 2020	Development of Web Based John Holland Theory Career Interest Detection Instruments	• Proposed a web-based system aimed at helping students at Yogyakarta University of Technology (UTY) learn about occupation characteristics and work interests or positions that match their qualifications which helps them achieve optimum career achievement.	The system is intended for students after completing their university studies to introduce them to jobs that fit their personalities. Further, it is not directed to the students before joining the university in order to introduce them to the university programs appropriate for them.

			• The study relied on John Holland's theory.	

2.5 Summary

In this chapter, the literature review is presented on the same topic as the present research. In addition, some important terms and aspects related to expert systems was clarified. Finally, the key concepts used in the current research are discussed.

Moreover, we discussed the components of the current combined expert system. The first part is the rule-based expert system, which is based on a set of if-then rules to analyze the factors affecting the choice of the university program, GPA, the branch of high school, and the student's personality. It was expressed based on Holland's theory, which are symbols stored in the knowledge base of the expert system. The second part is the machine-learning model, which depends on the analysis of a dataset through the DTC algorithm, the results of which are the appropriate university program (s) for the student.

In the next chapter, the methodology and procedures used in research analysis will be explained in more detail.

3 Chapter Three: Research Methodology and Procedures

3.1 Introduction

In the previous chapter, the theoretical framework and previous studies were discussed. This chapter, however, reflects upon the research methodology in addition to the followed procedures in terms of population, sample, variables, tool, validity and reliability of the study tool, the statistical methods used, and the steps followed in conducting the study.

3.2 Research Methodology

This research adopted the Descriptive-Analytical Methodology **(DAM)** (Saunders et al., 2009). The **DAM** tends to study the phenomenon as existed in practice. It is concerned with an accurate description and is expressed qualitatively to reflect upon its characteristics. In addition, it is quantified by giving a digital description by displaying numbers and tables which demonstrate the extent of this phenomenon, its size, or degree of association with other phenomena. Moreover, the **DAM** is used in collecting and analyzing data. In addition, in the development stage of the system, a special methodology for developing expert systems was adopted, which will be explained in detail in Chapter Five.

Figure 3 shows the methodology used in the research. The first stage in this methodology aimed at identifying the most important factors affecting the choice of high school students for their university major by reviewing literature review and distributing a questionnaire (Appendix 3.1) to be published to students of HU to find out the factors that affected their choice of university program. Another questionnaire was published (Appendix 5.4) for graduates in order to analyze the needs of the Palestinian market for university majors. After that, the researcher analyzed the results of the questionnaires and presented them in the form of tables and charts, which reflects

upon the importance of the DAM methodology. The following stages represent the steps of developing expert systems, which is represented in knowledge elicitation, and extracting the rules to move to the implementation stage, where the extracted knowledge was stored in the knowledge base, and it was accessed through the inference engine that uses the rules that were previously extracted. Furthermore, in this stage, the machine-learning model was implemented by creating a data set and using machine-learning algorithms. Finally, it was moved to the testing phase. All of these stages will be discussed in detail in the coming chapters.

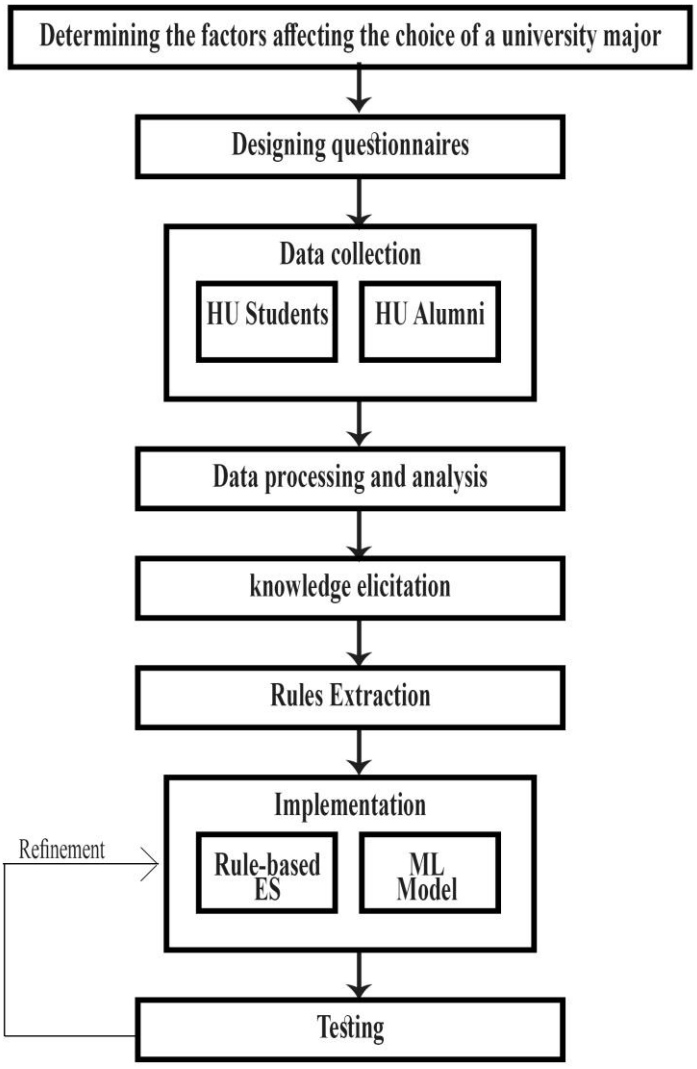


Figure 3. The Research Methodology.

3.3 The Population of the Study

HU was established in 1971, and is the oldest Palestinian higher academic institution. This institution took concrete steps and achieved remarkable qualitative and quantitative developments regarding its academic university programs and disciplines, in addition to the number of its students and faculty members. Nowadays, the university includes twelve colleges that provide more than 80 bachelors and diplomas university programs. As for the number of HU students now is around 7879, with 77.82% female students. However, so far, more than 25,000 students have graduated from HU.

The population refers to the complete set of cases from which a sample is taken. In this research, the study population encompasses students from all disciplines and all academic levels 2020-2021 from within HU, and the sampling frame has been defined as shown in Table 3. The sampling frame for any probability sample is "a complete list of all the cases in the population from which your sample will be drawn" (Saunders et al., 2009).

HU includes many scientific and humanities colleges; the Scientific colleges include: Medicine, Pharmacy and Medical Laboratories, Nursing, Science and Technology, Agriculture, and Information Technology. On the other hand, Humanities colleges include: Islamic law (Sharia), Arts, Education, Law and Political Science, Finance and Management, and Professions and Applied Sciences. Table 3 shows the population distribution according to gender and college in HU in the year 2020.

Table 3. Distribution of the Study Population According to the Gender and College at HU, 2020.

College / Gender	Scientific	Humanities	Total	percent
Male	584	1164	1748	22.18%
Female	2673	3458	6131	77.82%
Total	3257	4622	**7879**	100%
Percent	44.33 %	55.67%	100%	

3.4 Study Sample

3.4.1 Probability Sampling

Probability sampling or representative sampling refers to inferences from a sample about a population to answer the research questions or to achieve specific goals (Saunders et al, 2009). In the present study, it is divided into three main phases:

1. Determine an appropriate sampling frame based on the research questions or objectives. As shown in Table 3 above.
2. Determine the most appropriate method for sampling, and then define the sample.
3. Determine the appropriate sample size.

3.4.2 Sample Selection Method

Since the members of the present study population are heterogeneous, the process of choosing their university program may differ according to gender, college, university program, or academic year. Therefore, the random stratified sample method was chosen to obtain more homogeneous groups as shown in Table 3 and Table 4 respectively. The

total number of distributed questionnaires reached 788 participants, all of which were retrieved according to the size of the study sample shown in Table 3.

3.4.3 Sampling Techniques

The generalization of the study upon the whole population results requires the sample to appropriate to the population size. However, if the population is large, it is possible to take 5% or more than 5% of the total population size (Van Dalen, 1973). In the present study, the population size is large (7879), accordingly, we took 10% from the size of each strata stratum to grant a more homogeneous sample and a representative sample. According to the following equation:

$$n_i = \frac{\mathrm{s}_i}{\mathrm{N}} \times n,$$

Wherein

n_i: $strara\ size$,

s_i: $strata\ num$, N: population $size$,

n: $sample\ size$. $In\ the\ present\ research, n\ is\ 10\%\ of N$.

The following example shows the application of this equation to obtain the study sample shown in Table 4.

$$n_1 = \frac{584}{7879} \times 788$$

$$n_1 = 58$$

Therefore, after taking 10% of all strata stratum in Table 3, the data in Table 4 are obtained which represents the size of the study sample. As shown in Table 4, some strata have a different size than they should be, and this is due to the actual study sample who answered the questionnaire, moreover, there were no missing values.

Table 4. Sample Size**.**

College / Gender	Scientific	Humanities	Total	The percentage of participants
Male	81	94	175	22%
Female	323	290	613	78%
Total	404	384	**788**	100%
The percentage of participants	51%	49%	100%	

Figure 4 shows that the percentage of the participated female students in this study is 78% which is greater than the percentage of the participated male students which is 22%. In addition, Figure 5 shows the percentage of students participating in this research from humanities colleges, which is 49% of HU participants. While the percentage of participants students from scientific colleges is 51% of HU participants.

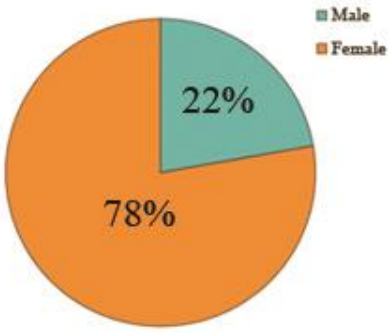


Figure 4. Percentage of Students Participating by Gender.

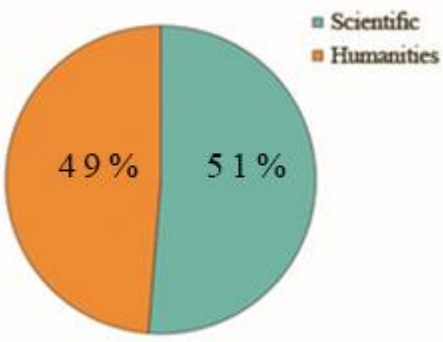


Figure 5. Percentage of Students Participating by College Type.

3.4.4 Characteristics of the Study Sample

In this section, the characteristics of the study sample of HU students will be examined.

According to the academic year variable, the number of participants in the first year was 345 students, which represents 43.70% of the sample size and it is the highest percentage. While the participants from the second year, were 184 students, which represents 23.40% of the sample size, and so on as shown in Table 5 below. Figure 6 also shows a pie chart of the representation of Table 5.

Table 5. Distribution of the Study Sample According to the Academic Year Variable.

Academic year	Frequency	Percent
First	345	43.70%
Second	184	23.40%
Third	125	15.90%
Fourth	112	14.20%
Fifth	22	2.80%
Total	**788**	**100.0%**

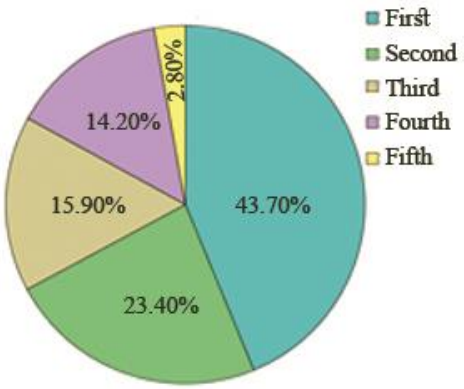


Figure 6 . Percentage of Students Participating by Academic Year.

Regarding the faculty variable, an explanation of the study sample from each college at HU appears in Table 6 and Figure 7 respectively. The students of the College of Pharmacy & Medical Science were the most involved in filling out the questionnaire in this research and their number reached 156 students, which represents 19.8% of the sample size.

Table 6. Distribution of the Study Sample According to the College Variable.

	College	Frequency	Percent
Scientific	Medicine	17	2.2%
	Information Technology	94	11.9%
	Nursing	45	5.7%
	Science & Technology	63	8.0%
	Pharmacy & Medical Science	156	19.8%
	Agriculture	29	3.7%
Humanities	Islamic Law (Sharia)	19	2.4%
	Arts	140	17.7%
	Education	84	10.7%
	Law & Political Science	48	6.1%
	Professions & Applied Sciences	19	2.4%
	Finance & Management	74	9.4%
	Total	**788**	**100%**

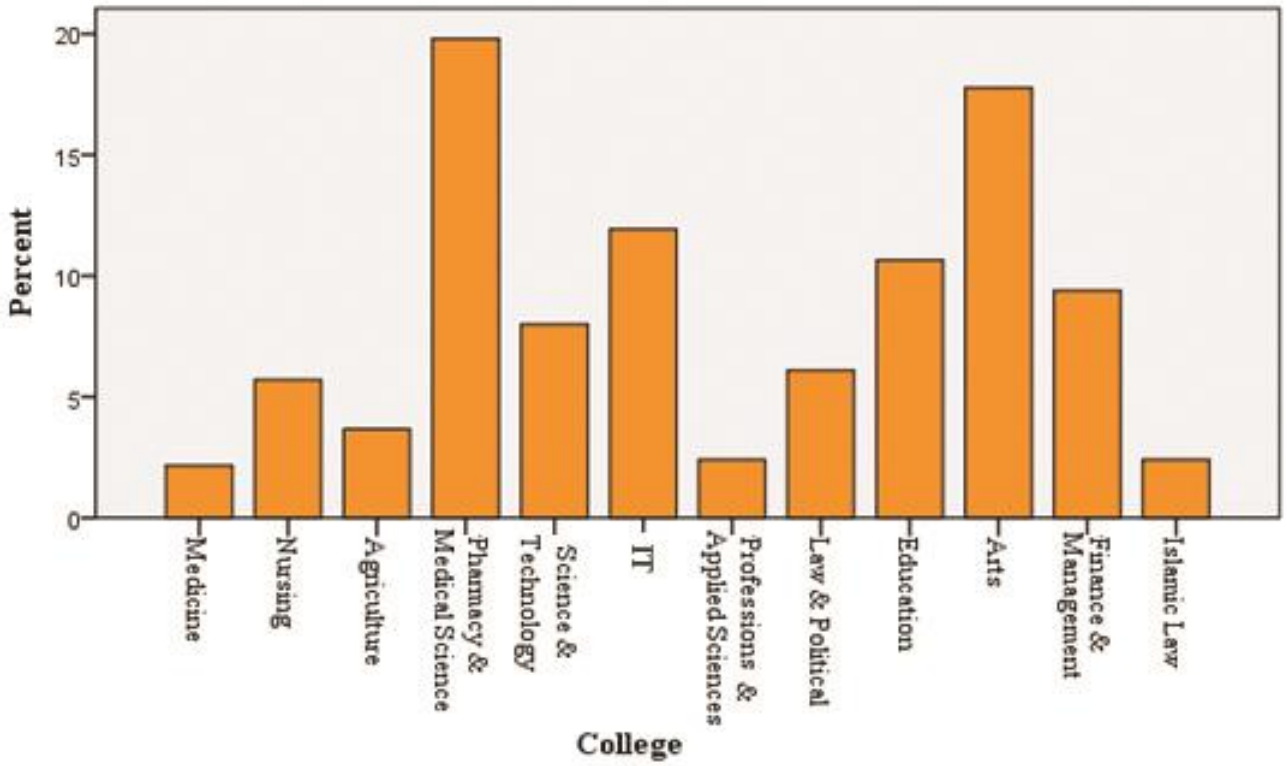


Figure 7. Percentage of Students Participating by College.

3.5 Study Variables

The present study included three types of variables as shown in Figure 8. These variables include the following:

- **Independent variables:** these are the variables that affect the dependent variable. Independent variables of the present study include the social dimension, the needs of the labour market dimension, the university dimension (registration requirements), and the expert systems dimension.
- **Dependent variable:** they are the variables upon which the effect of the independent variables is measured. The dependent variable in this study was the student's decision-making process for the appropriate university major.
- **The personal variables** of these variables were represented by gender, college, and academic year.

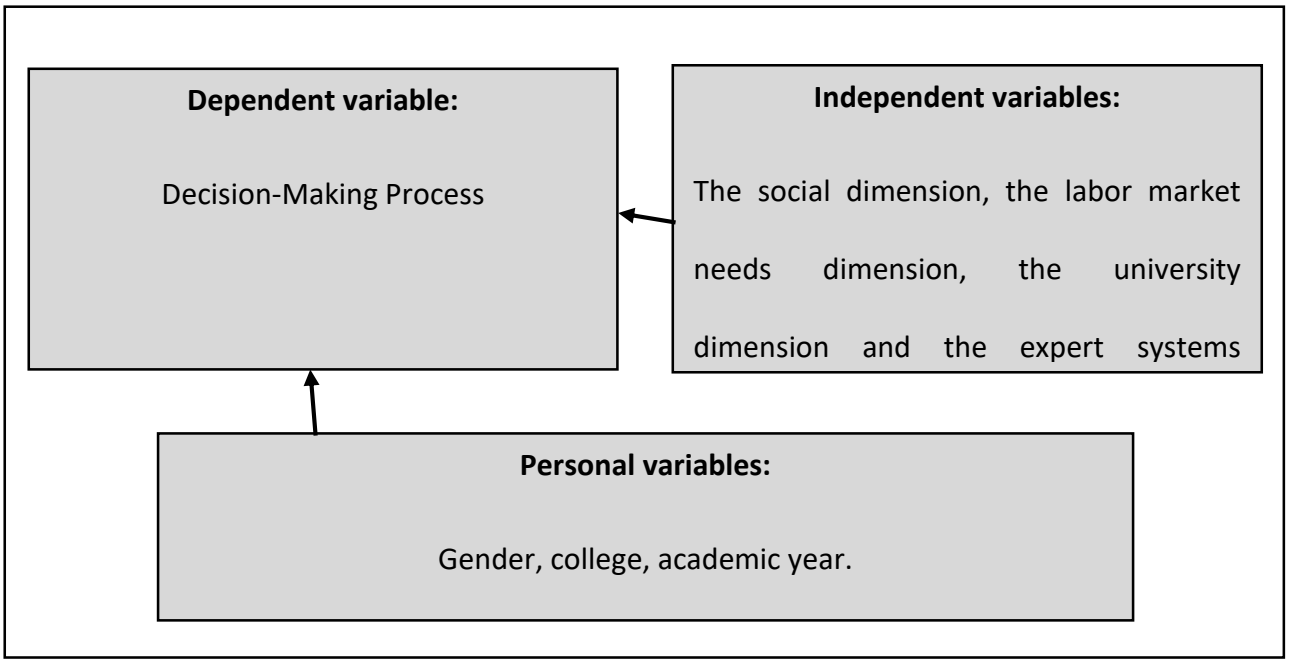


Figure 8. Study variables**.**

3.6 Study Tools

The questionnaire is a fundamental method of data collection. It is an effective way of collecting responses from a large sample of respondents who answer the same set of questions. In addition, interviews help in gathering valid, reliable, and relevant data to the research questions and objectives (Saunders et al., 2009).

The present study will depend on the questionnaire shown in Appendix (3.1) and the interviews with specialists and some high school students. The questionnaire preparation was based on the scientific method concerning previous studies and specialists. This questionnaire is distributed to HU students via e-mail as a Google Form and then collects data from the sample members. It is worth mentioning that the questionnaire went through several steps during its preparation so that it would be usable. These steps are summarized as follow:

1. The initial construction of the phrases of the questionnaire.
2. The division of the questionnaire into three parts, namely:
    a. General information.
    b. Determining the student's university program. This includes three dimensions:
        i. Social Dimension: the phrases (1-10) are assigned to it.
        ii. The labour market dimension: the phrases (11-20) are assigned to it.
        iii. The university dimension: the phrases (21-30) are assigned to it.
3. Expert system: which reflects upon the effect of using expert systems in helping the students when choosing their university major: the phrases are (31-49) assigned to it.

3.6.1 The Sincerity of Study Tools

This means measuring the clarity of the questionnaire terms and their belonging to the fields for which it has been allocated. To confirm this, the questionnaire was presented through an arbitration letter which is shown in Appendix (3.2) to a group of 4 arbitrators, numbering in Appendix (3.3), to know their views on the clarity of the phrases, and the appropriateness of the phrases for the field assigned to them. Moreover, to add any paragraph not mentioned in the questionnaire, or to delete an expression not related to the field. The opinions of the arbitrators were considered as a criterion for judging the validity of the statements. After collecting the opinions of the arbitrators, the paragraphs were deleted and amended based on their opinions to start the distribution process among the members of the study sample.

3.6.2 Stability of the Study Tool

To achieve stability, the questionnaire should give the same results when it is applied to the same group of individuals again and in similar circumstances, meaning that the results do not change. In the present study, the stability of the questionnaire has been confirmed through the Cronbach alpha equation as an indicator of internal consistency, as shown in the following table.

Table 7. Correlation Coefficients Using the Alpha-Cronbach Equation for the Dimensions of the Questionnaire.

Numb	Dimension	Cronbach's Alpha
1.	The social dimension	0.55
2.	The market demand dimension	0.75
3.	The university dimension	0.84
4.	The Expert Systems Dimension	0.96
Total dimensions		0.91

It is evident from Table 7 shown above that the correlation coefficients using the Alpha Cronbach equation for the questionnaire dimension are statistically significant stability coefficients and achieves the objectives of the study as the alpha Cronbach correlation coefficient is high (0.91).

3.7 Study Procedures:

1. The descriptive approach was used in data analysis as previous studies and literature were reviewed in investigating the same study problem, thus, the study problem was formulated as a question form.

2. Design the study tool (the questionnaire) and verify its validity and reliability.
3. Determining the study population of the students of HU, then selecting the study sample and distributing the online questionnaire to them.
    - Analyzing the data using the Statistical Package for Social Sciences (**SPSS**) in which many tests were applied such as Cronbach's alpha equation to measure the stability of the questionnaire.
4. Interpreting and discussing the results and formulating recommendations.

3.8 Summary

In this chapter, the researcher presented the study population, the method followed in determining the study sample, the description of its characteristics, the study variables, the tool used in the study (the questionnaire), besides, the validity and reliability of the study tool were checked. Finally, the procedures for applying the study were reviewed. In the next chapter, the results, and answers to the study questions will be discussed.

4 Chapter Four: Results of analysing questions

4.1 Introduction

In the previous chapter, the Research Methodology, Procedures, and the used Analysis Methods were discussed. In this chapter, the obtained results will be discussed. The present study aimed at developing an expert system to help high school students in choosing a suitable university major. It worth mentioning that the expert system is applied for HU students as a case study.

4.2 Results of Research Questions

- The first question is what are the factors affecting the students' choice of their university program according to the students' viewpoint?

The second part of the questionnaire reflects upon this question regarding the students' choice of university program which includes the first three dimensions: the social dimension, the labour market dimension, and the university dimension. To answer this question, Table 8 shows the mean, standard deviations, assessment score, percentage, and rank for these dimensions.

As mentioned previously, the methodology used in the current study is descriptive analysis, which includes describing the results through the mean and standard deviation (Creswell, 2013). In addition, the percentage indicates the strength of the dimension, according to the answers of the participants in the study sample. This percentage was calculated according to the following equation:

$$\text{percentage } = \frac{mean}{5} \times 100\%$$

Wherein: 5 refers to the Likert scale used in the questionnaire.

Each dimension was evaluated in assessment score column according to the percentage as the following:

- From (0-49.9%) is a low score.
- From (50.0-69.9%) is a medium score.
- More than 70.0% is a high score.

Finally, the rank column indicates the ranking of the dimension based on its percentage.

Table 8. The mean, Standard Deviations, Percentage, Assessment Score, and Rank for the First Research Dimension**.**

Numb	**Dimension**	**Mean**	**Standard deviations**	**Percentage**	**Assessment score**	**Rank**
1.	Social dimension	2.52	1.23	50%	Medium	3
2.	Market demands	3.50	1.17	70%	High	1
3.	University requirements	2.61	1.41	52%	Medium	2
Total		2.88	1.34	57%	Medium	

Table 8 indicates that the assessment score levels from medium to high, and this indicates that the three dimensions affect the students' decision-making process regarding the appropriate university major. In addition, the table shows that the market demand dimension obtained 70% which is the highest percentage compared to other dimensions. The university requirement dimension comes next with the percentage of 52% of the sample. And the final one is the social dimension with the percentage of 50% of the sample.

For further clarification, Tables 9, 10, and 11 show the mean, standard deviation, and assessment score for each paragraph within its dimension.

Table 9. The Mean, Standard Deviation, and Percentage of the Social Dimension Paragraphs.

Paragraph #	Paragraph Text	Mean	Standard deviation	Percentage	Assessment score	Rank
P5	I feel that I chose my university major according to my desire and abilities, and without consulting anyone.	3.83	1.29	76.6%	High	1
P9	I chose my university major because I aspire to have a specific job.	3.51	1.36	70.2%	High	2
P6	I think that my college major was in my mind before the high school results came out.	2.94	1.60	58.8%	Medium	3
P4	In my pursue of choosing my university program, I relied on the consultations of specialists and faculty professors.	2.65	1.25	53%	Medium	4
P7	I think that my family's economic condition took part and helped me in choosing my university major.	2.53	1.36	50.6%	Medium	5
P1	I was influenced by my father's opinion in choosing my college major	2.44	1.22	48.8%	Low	6

P10	I chose my college major to manage the profession of my family (as a business).	1.93	1.08	38.6%	low	7
P2	I chose my college major influenced by friends' opinions.	1.82	0.93	36.4%	low	8
P3	I chose my college major according to the opinion of relatives.	1.80	0.95	36%	low	9
P8	I chose my college major based on the father/mother career.	1.71	1.01	34.2%	low	10
Total		2.52	1.41	50%	Medium	

As shown in Table 9, the mean of the social dimension paragraphs was (2.52) according to the responses of the sample members. This dimension can be assessed as a medium score in effecting the process of choosing a university program. Wherein, according to the responses of the sample members, the percentage for this dimension is 50%.

Moreover, the fifth paragraph of the social dimension got the first place with the mean of (3.83). This indicates that the student himself has a major role in choosing his university program. However, the results in the present research indicated that 76.6% of students choose their university program on their own without consulting anyone. Thus, this might cause some students to face problems during their studies or after their graduation because they did not choose the appropriate university program for themselves. This result is similar to Shawer's study result (Shawer, 2015) wherein 82% of students faced problems when choosing their university major, which prompted them to receive advice from the people around them whether family, friends, or others. However, the results of the current research showed that 48.8% of students were influenced by the opinions of their parents when choosing their major, while 36.4% of students were influenced by the opinion of their friends. Moreover, the results stated in the previous table show many other factors affecting the students' choice of university program including the economic condition, the career of the mother or father, the profession of the family, and others.

Table 10. The Mean, Standard Deviation, and Percentage of the Market Demand Dimension Paragraphs.

Paragraph #	Paragraph Text	Mean	Standard deviation	Percentage	Assessment score	Rank
P12	I feel that employment opportunities after graduation determine the type of university major.	3.780	1.026	75.6%	High	1
P17	I feel that I have chosen a major that qualifies me to work in more than one job.	3.740	1.139	74.8%	High	2
P19	I see that I chose my specialty because I believe that it contributes to the development of my community.	3.710	1.191	74.2%	High	3
P11	I see that the market needs to guide the students to choose their university major.	3.690	1.097	73.8%	High	4
P13	Job's financial income contributes to choosing a university major.	3.570	1.078	71.4%	High	5

P16	I think that providing data from the labor market about different jobs affects the choice of university program.	3.530	1.056	70.6%	High	6
P20	I think that I chose a major that qualifies me to work in a specific sector (such as the government sector, the private sector ...)	3.380	1.205	67.6%	Medium	7
P18	I believe that I chose the major that allows me to combine two jobs with two shifts (morning and evening).	3.320	1.278	66.4%	Medium	8
P14	I see that the social position of the major that I chose influenced my university major.	3.140	1.209	62.8%	Medium	9
P15	I feel that the specialist job I've chosen is comfortable and not difficult.	3.000	1.109	60%	Medium	10
Total		3.500	1.17	70%	High	

It can be observed from Table 10 that the market needs for university program have a high impact on the students' choice of university major as the overall percentage of this dimension is 70%. In addition, paragraph 12 took the first place from the paragraphs of this dimension with the percentage of 75.6% from the students who saw that providing information about university program such as unemployment rates and salaries affects their choice of their university major. This is what Salwa et. al in (Salwa & Zarrouki, 2016) showed that 29% of the respondents believed that choosing a university program is affected by the ability of graduates to integrate into the labour market. As a result, Table 10 shows that students' opinions are influenced by the available data from the labour market regarding different jobs. In addition to the many other factors affecting the students' choice of university program, such as financial income, job's social position, a major that qualifies working in many jobs. Moreover, this is what Paragraph 11 stated with the percentage of 74.8% from HU students who saw that this factor has affected their choice of their university major.

Therefore, market demand for university program is a key factor affecting the students' choice of their university major. This can be noted in Bakkar's study (Bakkar, 2018) who stated that:

> *"Choosing the appropriate university program means that this university program is compatible with your preferences and capabilities on the one hand, and is characterized by future job market opportunities on the other hand"* (Bakkar, 2018, p. 13)

Table 11. The Mean, Standard Deviation, and Percentage of the University Requirements Dimension Paragraphs.

Paragraph #	Paragraph Text	Mean	Standard deviation	Percentage	Assessment score	Rank
P21	The admission requirements (such as the GPA and the branch of high school) in universities affected my choice of university major.	3.080	1.35	61.6%	Medium	1
P30	I think that the novelty/the modernity of the major influenced my choice of my university major.	2.800	1.269	56%	Medium	2
P24	The availability of qualified professors at the university contributed to choosing my university major.	2.750	1.233	55%	Medium	3

P29	I think that the length of study (academic years) affected the choice of university major.	2.700	1.257	54%	Medium	4
P26	The difficulty level of the majors influenced my college major.	2.600	1.194	52%	Medium	5
P28	The variation in registration fees for university majors affected the choice.	2.590	1.235	51.8%	Medium	6
P27	Providing networking opportunities (student exchange, practical training ...) between the university and other institutions influenced the choice of my university major.	2.500	1.164	50%	Medium	7
P22	The promotion of university programs has affected my college major.	2.450	1.15	49%	Low	8

P23	The advisory services provided by the university have affected my university major.	2.370	1.138	47.4%	Low	9
P25	The modern technological tools provided by the university have influenced my university major.	2.290	1.056	55%	Low	10
Total		2.610	1.23	52%	Medium	

Logically, enrollment in a specific major is associated with a set of conditions that differ from one university to another and from one major to another. However, from the students' viewpoint, the university's requirements are considered a moderate factor in the selection process for the university major. As shown in Table 11, the mean of the paragraphs of this dimension is 2.61 and the percentage is 52% of HU students who believe that this dimension affects their choice of university major.

Table 11 also shows many factors affecting the selection of the university program regarding the university requirements dimension including the GPA and the high school branch, where 61.6% of HU students believe that these factors are the most influential over their choice of their university major. Therefore, paragraph 21 got the first place from other paragraphs of this dimension. In addition, important factors include the novelty/ modernity of the major, the number of academic years of study, etc.

- The second question is what are the students' viewpoint towards developing an expert system that helps high school students choose their university program?

To answer this question, Table 12 shows the mean, the standard deviation, the percentage, and assessment score of the second dimension of the questionnaire that is about the expert systems.

As shown in the Table 12, the percentage for the Expert System dimension was 78% of the sample. This indicates a high rank according to the answers received from the study sample. This indicates that most students from the study sample support developing an expert system that helps high school students in choosing the appropriate university major.

Table 12. The Mean, Standard Deviations, Percentage, Assessment Score And Rank for the Second Research Dimension.

Numb	Dimension	Mean	Standard deviations	Percentage	Assessment score
4.	Expert system	3.898	0.97	78%	High

For further clarification, Table 13 shows the mean, standard deviation, percentage, and assessment score for each paragraph of the Expert System dimension and then arranged them according to high percentage.

Table 13 shows many paragraphs related to the expert systems dimension, which shows the properties that students prefer to have in the expert system such as ease of access, usability, safety, the ability to analyze each of university requirements, the student's abilities and personality, and the requirements of the labour market.

It should be noted here, that the expert system has been developed taking into account what is mentioned in Table 13 of the properties that students prefer to have in the expert system, and that will be clarified in the next chapter.

Table 13. The Mean, Standard Deviation, Percentage, of the Expert System Dimension Paragraphs.

Paragraph #	Paragraph Text	Mean	Standard deviation	Percentage	Assessment score	Rank
P32	I feel that if an expert system is available that provides statistics and predicts the jobs that will be in demand in the market in the future will assist the student in choosing his university major.	4.120	0.876	82.4%	High	1
P33	I believe that if an expert system is available that analyses the student's personality (his desires and abilities) will help him choosing his university major.	4.100	0.96	82%	High	2
P49	I believe that the presence of the expert system by assigning a page for it on the university's	4.060	0.931	81.2%	High	3

	website will facilitate the student's access to the system when choosing his university major.					
P41	I believe that providing security and maintaining the privacy of information in the expert system will increase the student's confidence in using the system when choosing to pursue his university major.	4.050	0.913	81%	High	4
P48	I believe that the expert system that explains to the student details about future jobs (such as salaries, qualifications ...) will help the student choose his university major.	4.020	0.955	80.4%	High	5
P34	I think that personality analysis tests (desires and abilities) have a role in choosing the appropriate university major.	4.010	0.999	80.2%	High	6

P42	I believe that the speed of the expert data analysis system will encourage the student to use it when choosing his undergraduate major.	3.970	0.883	79.4%	High	7
P47	I believe that the availability of an expert system that informs the student of details about the university programs that suit him (such as study plans, credit hours ...) will affect the choice of his university major.	3.920	0.994	78.4%	High	8
P38	Electronic systems supported by various multimedia elements (such as videos, pictures, graphics, texts ...) contribute to drawing the student's attention when choosing his university major.	3.909	0.966	78.2%	High	9

P45	I believe that the expert systems contribute to saving effort when choosing a university major.	3.906	0.916	78.2%	High	10
P31	I think that if an expert system is available that analyses the admission requirements at the university will assist the student in choosing his university major.	3.903	0.989	78%	High	11
P40	I believe that the easy access to the online expert system will encourage the student to use it when choosing his university major.	3.890	0.964	77.8%	High	12
P39	I think that the ease of using expert systems will encourage the student to use it when choosing his university major.	3.870	0.967	77.4%	High	13

P44	I believe that if expert systems are available that help the student choose his major reduces stress that negatively affects the student.	3.860	0.932	77.2%	High	14
P37	If expert systems are available, it reduces my need to visit the university to inquire about the available majors.	3.784	1.005	75.6%	High	15
P43	I believe that the availability of graphs in the expert system will encourage the student to use it when choosing his undergraduate major.	3.777	0.931	75.6%	High	16
P46	I feel that if the student uses expert systems when choosing his university major will limit the influence of those around him.	3.777	1.002	75.6%	High	17
P35	Providing expert systems will be more useful to me than traditional methods (such as family	3.750	1.073	75%	High	18

	and friends opinions, professional advice ...) in a student's choice of his university major.					
P36	I can trust the results provided by expert systems when choosing a university major.	3.400	0.997	68%	Medium	19
Total		3.898	0.97	78%	High	

As has been explained previously, high school students face a problem when choosing their university major. So, they welcomed the notion of developing an expert system that would help them solve this problem. It can be noted from the previous table that most of the paragraphs of this dimension received a high estimate. Wherein 82.4% of HU students prefer that the system contains an analysis of the labour market and suggests some jobs for students and that this has an impact on their choice of university major. Moreover, 82% of HU students expressed their desire for the expert system to analyze their personalities and abilities since they are unable of doing so.

4.3 Summary

In this chapter, we discussed the results related to the first two questions of the present study, the first of which is investigating the factors affecting the choice of university program from the students' viewpoint. These factors included the social dimension and the requirements of the university which had a moderate impact on the students' choice of their university major. Furthermore, the requirements of the labour market factor had a high impact in choosing the university program from the students' viewpoint. Moreover, the students' viewpoint regarding developing an expert system to help them choose their university major was discussed. The results showed that 78% of HU students agreed upon and support this notion. Therefore, in the next chapter, the developed expert system will be clarified by answering the third question of the present study regarding the methods used in developing this expert system to help high school students in choosing their university program?

5 Chapter Five: Developing the Expert System

5.1 Introduction

In the previous chapter, the results were discussed by answering the first and second research questions which were about the factors affecting students in choosing the appropriate university program, and students' opinion towards developing an expert system that helps them in this process. In this chapter, we will investigate the development of an expert system that helps high school students in choosing the appropriate university program. This will be fulfilled by answering the third research question about how to develop a novel expert system that guides high school students aiming at joining the HU in choosing the appropriate major.

The implementation of the current expert system considers the factors that affect the student's choice of the university program. The results showed that 70% of HU students prefer that the system show information about the Palestinian labour market. In addition, 52% of students believe that the system must analyze the university requirements and the student's personality as well. Accordingly, the current expert system has been developed based on these factors, and this will be explained in this chapter.

Moreover, this chapter will explain the phases of the Software Development Lifecycle **(SDLC)** that have been followed in developing the current system.

5.2 System Specifications

As previously mentioned, one of the main objectives of the present study is to develop a system that helps students choosing the appropriate university program based on analyzing their personality by relying on a web-based expert system, rather than traditional methods. This system analyzes the most important criteria that have a

significant role in guiding student's choice to the right university program. These criteria can be summarized as follow:

1. **The personality test:** The test is based on Holland's theory of personality analysis. At the end of this test, the expert system suggests the university program (s) that fit the student's personality within the disciplines of HU as a case study (see Appendix 5.1).
2. **Student's GPA and the branch of high school:** This factor determines the university's requirements (Admission and enrollment criteria).
3. **Palestinian market:** This factor determines the needs of the Palestinian market of university programs at HU. This lies in the work of collecting real data regarding the graduating students who work in Palestinian institutions, companies, centers, and the university programs that have high market demand.

5.3 Model Development Methodology

The current expert system is addressing the scope of university programs at HU as a case study, which contains 12 colleges that give bachelor's and diploma degrees. These colleges and their university programs are shown in (Appendix 5.1, 5.2).

The methodology used in developing the current expert system is based on the stages mentioned in Figure 2 in Chapter II. These stages can be summarized as follow:

A. Identification

At this stage, the problem was identified which is the difficulties that high school students face when choosing their university major. Then, the solution to this problem was identified by developing an expert system that helps high school students in choosing their university major by studying their capabilities, tendencies, in addition to

knowing the disciplines needed by the market. Moreover, at this stage, the sources for acquiring knowledge were identified through represented by psychologists, Holland theory, PCBS, the graduate unit, and the registration unit at HU. In addition, at this stage, the expert system requirements were identified which are divided into two parts: the functional requirements, and the non-functional requirements.

5.3.1 The Functional Requirements:

The functional requirements include the main objectives of the system and practical answers to questions about the current system. These requirements can be summarized as follow:

- Sign up.
- Sign in.
- Amendment to public data.
- Personality Test (Holland).
- Market demand analyses.
- Analysis of the admission and registration requirements
- Description of the university programs.
- User feedback.

5.3.2 Non-Functional Requirements:

Regarding the non-functional requirements, they include objectives and implied conditions that must be met in the system which are not less, in terms of importance, than functional requirements. The goal of these requirements is to raise the level of useability, and the friendly level of the system. These requirements can be summarized as follow:

- **Interface Requirements:** For example, user interfaces and their features (e.g., user-friendliness). As the system user will not find it difficult to enter or retrieve information through the screens designated for adding, modifying, deleting, and retrieving information that was previously entered. During the testing phase of the system, a set of questions were asked to the users, and the results showed that 83% of users find the interfaces are user-friendliness.
- **Performance Requirements:** it is a description of the performance restrictions involved the following:
    - Time limits, response time, and availability.
    - Reliability involves the integrity of the information that is maintained and the availability of components.
    - Security, such as the permitted flow of information. Taking into account that the system will contain personal information for each account, then, this data must be kept confidential.
    - Survivability, such as carrying the system under natural disasters.
- **Lifecycle Requirements:** it about the possibility of maintenance and reinforcing ability. As it is important to do the regular maintenance of the system and to remedy errors when needed. In addition, this includes making the system expandable, which is able to include all disciplines offered by Palestinian universities.

B. Conceptualization

This stage reflects upon the knowledge which was elicited from the sources specified in the previous step, such as the types of characters that were defined based on Holland's theory, and were represented in the form of symbols. Holland's theory proposed that everyone has a unique blend of all types. In addition, the theory suggests

that many people resemble more than one. Every person has a unique blend of all types. That is, all people fulfill two of the six characteristics and are either primary or secondary as shown in the matrix in Figure 9. It should be noted that some studies relied on three characteristics of individuals, not two (Albakri et al., 2017).

Primary		Secondary					
		R	I	A	S	E	C
	R	RR	RI	RA	RS	RE	RC
	I	IR	II	IA	IS	IE	IC
	A	AR	AI	AA	AS	AE	AC
	S	SR	SI	SA	SS	SE	SC
	E	ER	EI	EA	ES	EE	EC
	C	CR	CI	CA	CS	CE	CC

Figure 9. Matrix Character Codes According to Holland's Theory.

In addition, in this stage, the previous functional requirements have been analyzed. The following is an explanation of this analysis.

5.3.3 Use Case Diagram

This kind of diagrams shows the status of all operations performed by everyone who uses the system. As the system users are the guest, student, and admin.

5.3.3.1 System Administrator

The system administrator is the one who can see a list of registered users in the system. He can also manage the questions presented by the system to test the student's personality by assigning each question according to the personality type, adding a question, adding a picture to the question, deleting a question, and modifying the question. Moreover, Figure 10 shows the system admin use case diagram. As shown, the system administrator can manage the majors offered by the university, by adding a new university program, adding a picture of the university program, determining the conditions for joining the university program, adding unemployment rates and salary

rates among the ranks of graduates of a particular university program, adding a description about the university program, deleting a major, modifying a major.

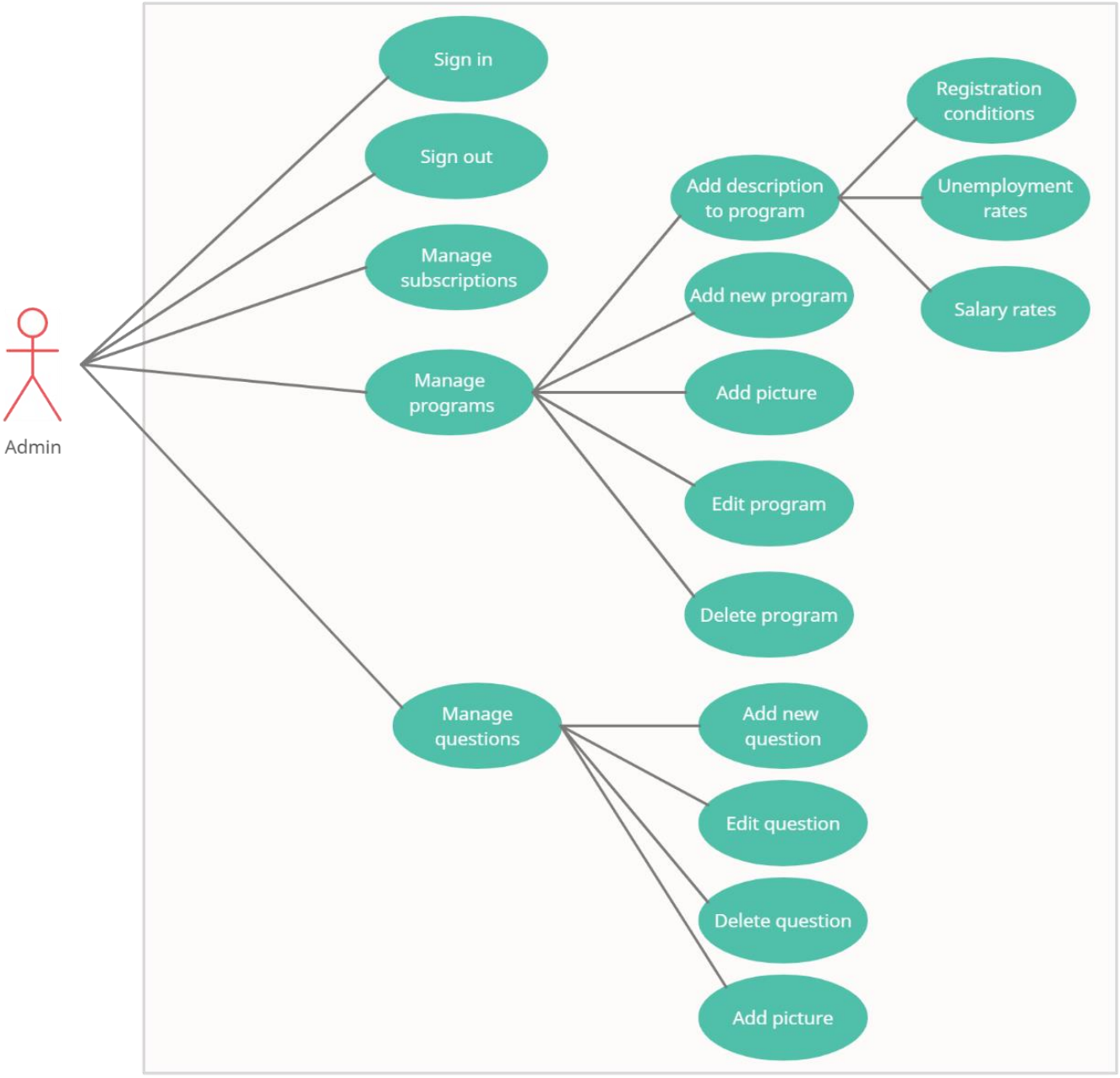


Figure 10. System Admin Use Case Diagram.

5.3.3.2 Student

Figure 11 illustrates the operations that the registered student can perform, where he can login to the system and move between the system pages, such as the student

personality analysis page, the labour market analysis page, and others. Also, the student can log out from the system.

Figure 11. Student Use Case Diagram.

5.3.3.3 Guest

As shown in Figure 12, a guest is a person who does not have an account in the system and who can browse some of the system pages, and register for a subscription.

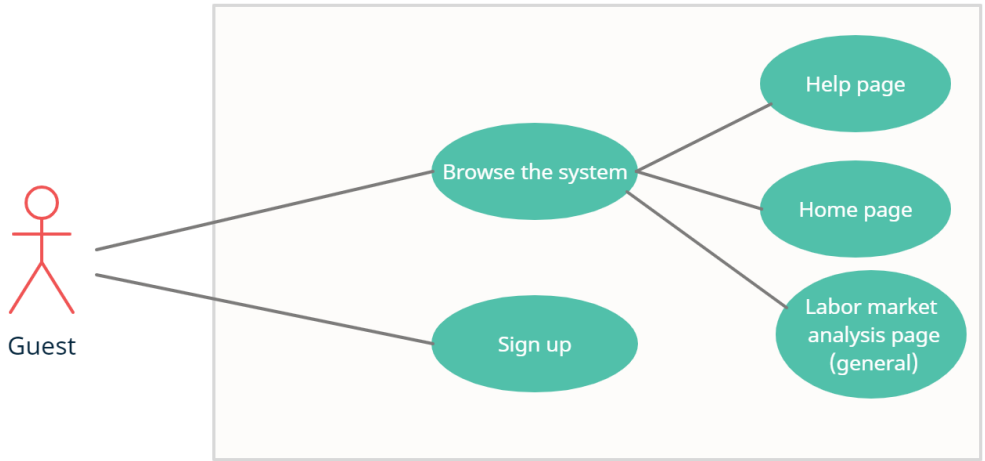


Figure 12. Guest Use Case Diagram.

5.3.4 Activity Diagram

Activity diagram shows the sequence to that should be followed to achieve a particular process. Figure 13.A illustrates the sequence of steps that go through the process of registering a new student. In addition, Figure 13.B shows the sequence of steps to go through in order to login to the system successful. In addition, Figure 13.C shows the steps that the admin takes when adding a new major. Figure 13.D shows the sequence of steps the admin goes through when adding a new question. Finally, Figure 13.E illustrates the logout process.

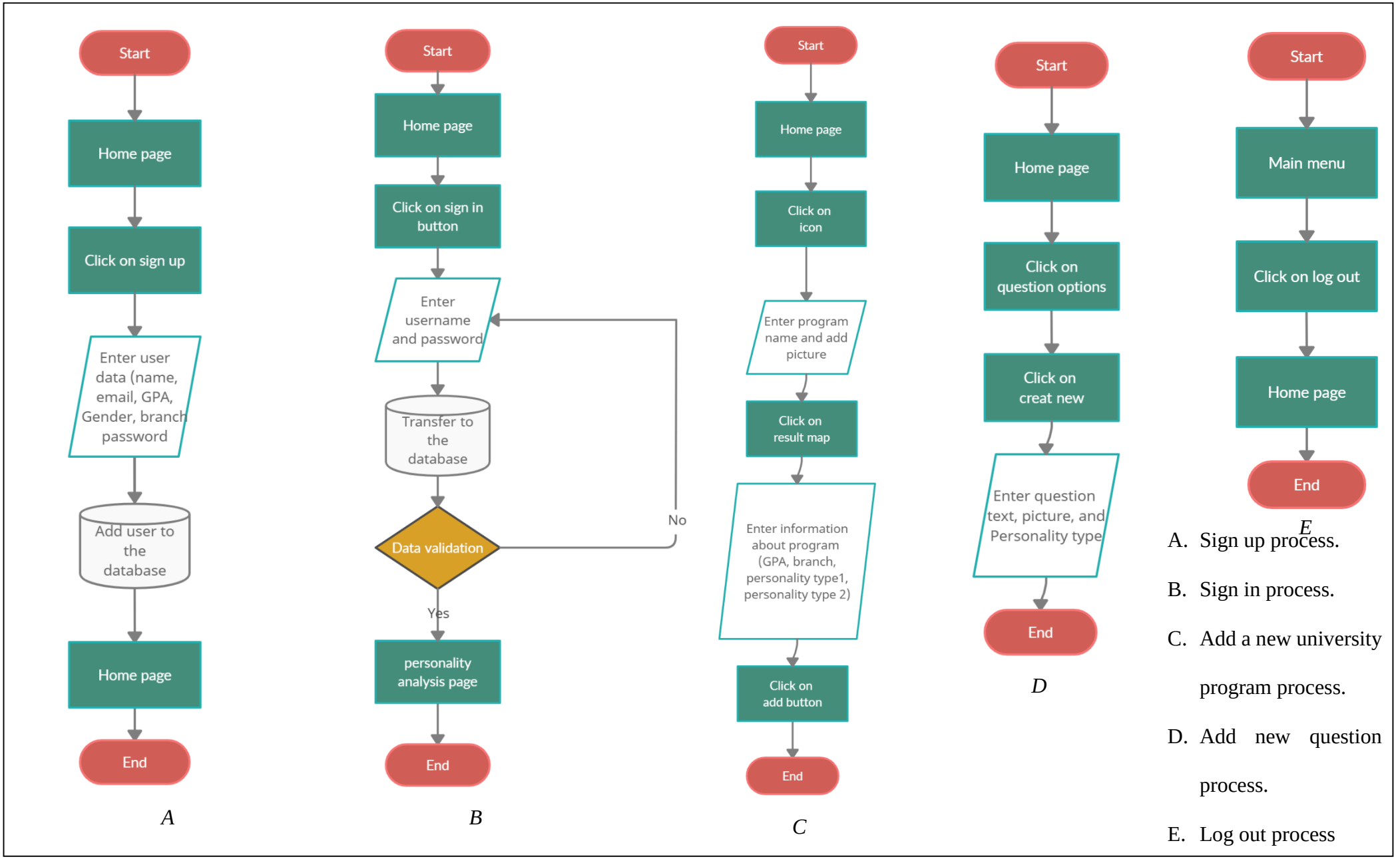


Figure 13. Activity Diagrams of Some Processes in the Expert System.

C. Formalization

This stage represents the acquired knowledge in decision tables for the sake of preparing for the next stage and working on the representation of these separate tables in a well-organized manner within the expert system. These separate tables include the admission and registration requirements, types of personalities according to Holland's theory, and the analysis of the Palestinian market labour as shown in the following pages.

5.3.5 Admission Requirements

The choice of the students for their university program in Palestine is related to the branch that the student studied in high school, as well as the GPA obtained. As for the studied branch, students are divided into several branches, "scientific, humanities, commercial, industrial, professional, agricultural ... etc". Each branch has specific goals and specific outputs. The branch in the high school authorizes the student to enter in several university programs, for example, students of the scientific branch are allowed to study all the majors that they want, yet, according to the competitive rate and according to the admission rates in universities. As for the branch of the humanities, it enables the student to study specific majors related to the humanities. And likewise for the rest of branches in which students can study certain majors according to the outputs of their branch if they are suitable for some majors in universities and also according to the admission rate and the competitive rate in universities. HU includes several colleges. For more details, see (Appendix 5.1).

Table 34 (Appendix 5.2) shows the criteria for admission of new students to HU colleges according to the branch and the GPA of high school. For more details, see (Appendix 5.2).

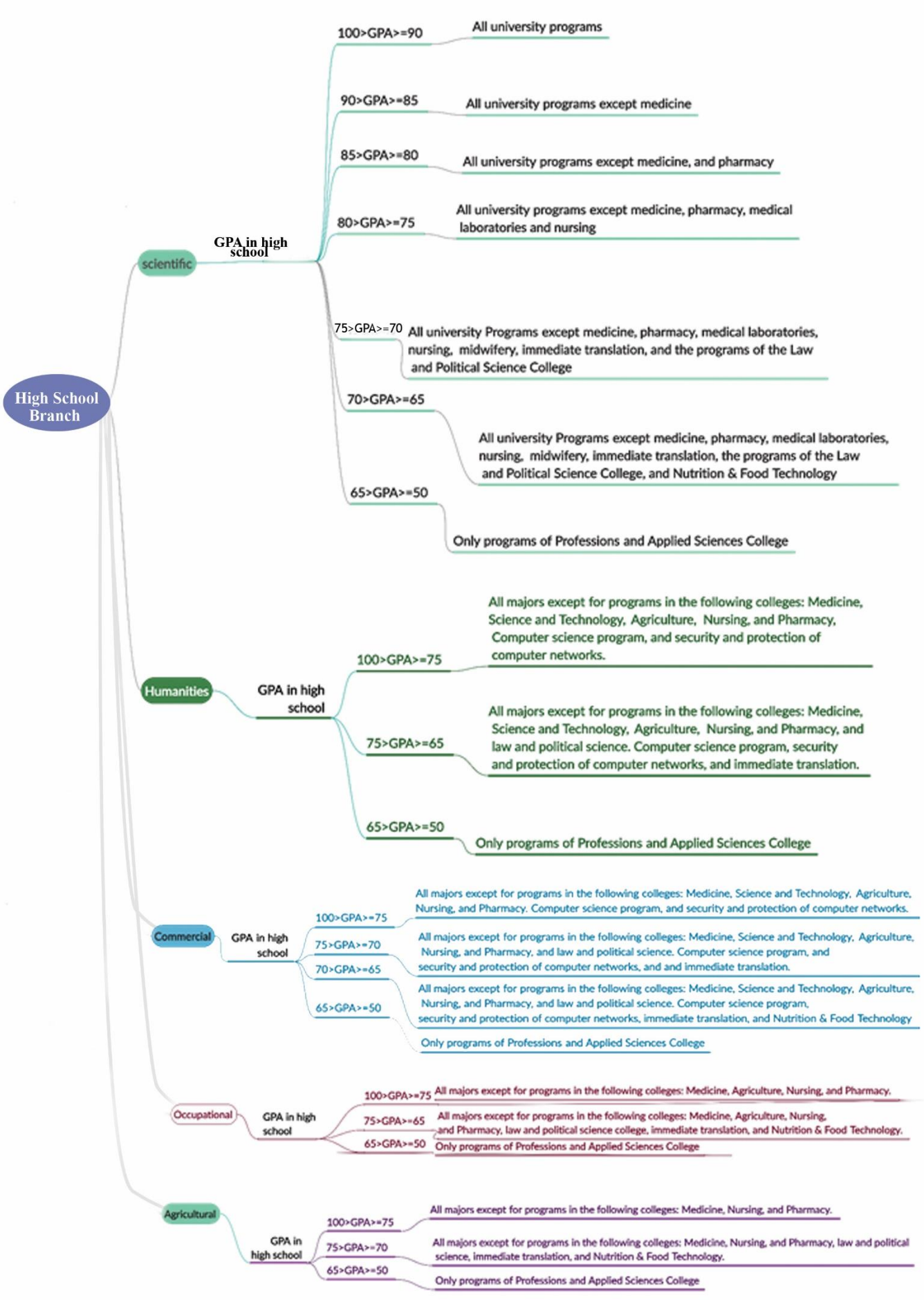


Figure 14. The Criteria for Admission of new Students to HU Colleges (HU - Colleges, 2018).

Figure 14 shows the decision tree used in the Admission and Registration Unit at HU according to the high school branch and GPA. For example, if a high school student registered in the scientific branch and obtained a GPA of 79%, he can register in any specialty at HU except for medicine, pharmacy, and nursing.

5.3.6 Student Personality Analysis

As previously indicated, Holland's theory will be followed in analyzing the student's personality and its compatibility with the disciplines at HU. It can be observed from the previous matrix shown in Figure 9, by joining the primary and secondary qualities, a certain symbol appears. Each symbol of this matrix has many university programs each of which is suitable according to the study conducted by Holland, and it must be pointed out that the study of Holland achieved great results in the process of helping students in choosing a university major.

To represent this matrix to students at HU, the student's snapshot that represents Holland's symbols should be calculated because the student might have more than a type of character. Therefore, the first two highest symbols of the final results that appear to the student will be taken into consideration.

To represent this knowledge, the student will be subjected to a set of questions proposed by Holland theory (Holland, 1987) which is around 60 questions (see Appendix 5.3) divided into a group of pages in which each character type has a set of questions. The student answers by choosing a number from 1-5 following his personality. At the end, scores are collected for each group in which the two highest groups determine the type of student shot. Accordingly, the appropriate major for this character is determined in the next section. It should be noted that if there is no university program associated with the student's special code consisting of two letters, then, during the analysis process, a single symbol will be noted as being close to the

student's personality and directed towards the college closest to his personality. The questions chosen to determine the personality of the student are distributed as follows:

- **Realists (R)**: This type consists of (10) paragraphs and indicates occupations that need muscle effort and are measured in paragraphs (1-10).
- **Investigators (I)**: This type consists of (10) paragraphs and indicates occupations that need mental effort and are measured in paragraphs (11-20).
- **Social (S):** This type consists of (10) paragraphs, and indicates the professions that need cooperation, and is characterized by the help of others and relieves their pain. It is measured in paragraphs (21-30).
- **Conventional (C):** It consists of (10) paragraphs, and indicates occupations that need accuracy in performance. It is measured in paragraphs (31-40).
- **Entrepreneur (E)**: It consists of (10) paragraphs and it indicates occupations that require exchange skills. It is measured in paragraphs (41-50).
- **Artistes (A)**: It consists of (10) paragraphs, It indicates occupations that need creativity and artistries capabilities. It is measured in paragraphs (51-60).

By applying Holland's test symbols on specialties at HU, the model shown in Table 14 is obtained. After the student answers 60 questions, the two symbols will be obtained with the highest total. The first symbol represents the primary personality type of the student, while the second symbol represents the secondary personality type. According to Table 14, the rows represent the primary symbol, and the columns represent the secondary symbol, while the intersection of the two symbols will represent the student’s personality so that the appropriate university program can be known through the intersection of the two symbols.

Table 14. Appling Holland Attributes to Programs at the HU.

	R	I	A	S	E	C
R	• Computer Science	• Plant Production & Protection • Protected agriculture and nurseries (Two years) • Electrical Installations Engineering (Two years)	• Media • Building Maintenance and Restoration (Two years)	• Pharmacy • Physical Training • Electrical Installations Engineering (Two years)	• Tourism and Antiquities • Mobile Phone Technology (Two years) • Computer Science-Mobile University programming	• Computer Science • Mobile Phone Technology (Two years) • Building Maintenance and Restoration (Two years)
I	• Human Medicine • Applied Geography • Mathematics • Chemistry • Chemistry-Industrial Chemistry	• Chemistry • Industrial Chemistry (Two years)	• Human Medicine • Nutrition & Food Technology • Psychology • Protected agriculture and nurseries (Two years)	• Human Medicine • Mathematics • Finance and Accounting • Nursing Science • Office Automation and	• Human Medicine • Chemistry • Soil & Irrigation • Pharmacy • Computer sciences • Industrial Chemistry (Two years)	• Human Medicine • Mathematics • Mobile Phone Technology (Two years) • Computer sciences ○ Mathematics-Computer

	• Major Chemistry- Minor Nutrition & Food Processing
	• Biology
	  ○ Biology- Medical Laboratory Science
	  ○ Biology- Public Health
	• Environmental Sciences & Technology
	• Plant Production & Protection
	• Animal Production & Protection
	• Protected agriculture and nurseries (two years)
				Administration (Two years)
				• Audio Engineering (Two years)
				• Psychology
				  ○ English Language & literature- Translation
						University programming
						• Agricultural Economics & Extension
						• Nutrition & Food Technology
						• Laboratory medical sciences
						• Biology- Medical Laboratory Science

	• Animal Production(two years) • Computer sciences • Tourism and Antiquities • History-Minor Geography • Electrical Installations Engineering (Two years)					
A	• Multimedia & Web Technology • Digital Design and Production (two years)	• English Language ○ English Language & literature-Translation • Arabic Language • Hebrew Language (Two years)	• Multimedia & Web Technology • Digital Design and Production (two years)	• Foundation of Education • Psychology • Digital Design and Production (two years) • Audio Engineering (two years)	• Media • Multimedia & Web Technology • Digital Design and Production (two years)	• Multimedia & Web Technology • Digital Design and Production (two years)

		• Tourism and Antiquities		• English Major- Minor French		
S	• Human Medicine • Psychology • Pharmacy • Biology- Public Health • Physical Training (two years)	• Human Medicine • Jurisprudence & Law • Nutrition & Food Technology • Nursing Science • Midwifery • Psychology • Medical Physics • Physical Training (two years)	• Nursing Science • Mathematics • Foundation of Education • Laboratory medical sciences • Biology- Medical Laboratory Science • Multimedia & Web Technology • Physical Training (two years)	• Business Administration • Office Automation and Administration (two years)	• Jurisprudence & Law • History ○ History-Minor Archaeology ○ History-Minor Geography • Major Chemistry-Minor Nutrition & Food Processing • Nutrition & Food Technology • Foundation of Education • Physical Training (two years)	• Media • Business Administration • Office Automation and Administration (two years) • Nursery and Kindergarten (two years)
E	• Business Administration	• Environmental Sciences & Technology	• Political Science	• Private Law • Jurisprudence & Law	• Business Administration	• Finance and Accounting

	• Office Automation and Administration (two years)	• Protected agriculture and nurseries (Two years) • Animal Production (Two years)	• Agricultural Economics & Extension • Protected agriculture and nurseries (Two years) • Animal Production (Two years) • Public Administration ○ History-Minor Archaeology	• Public Law • Fundamentals of Islamic Religion • Sharia and Jurisprudence • Media • Building Maintenance and Restoration (Two years) • Tourism and Antiquities • Business Administration • Finance and Accounting • Public Administration • Psychology • Public Law • Private Law		• Business Administration • Office Automation and Administration (two years) • Fundamentals of Islamic Religion • Sharia and Jurisprudence • Biology- Public Health • Marketing

				• Major Mathematics- Minor Finance & Accounting		
C	• Finance and Accounting • Jurisprudence & Law • Private Law • Public Law • Fundamentals of Islamic Religion • Sharia and Jurisprudence • English Language • Arabic Language • Hebrew Language (Two years)	• Mathematics • Computer Networks Security & Safety • Multimedia & Web Technology • Digital Design and Production (two years)	• Finance and Accounting • Computer Science • Mobile Phone Technology (Two years)	• Public Law • Private Law • Fundamentals of Islamic Religion • Sharia and Jurisprudence • Finance and Accounting • Computer science • Mobile Phone Technology (Two years)	• Animal Production & Protection • Business Administration • Office Automation and Administration (two years) • Finance and Accounting • Major Mathematics- Minor Finance & Accounting • Computer Networks Security & Safety	• Finance and Accounting

					• Fundamentals of Islamic Religion • Sharia and Jurisprudence	

5.3.7 Market Demand Analysis

As previously discussed, market analysis is an important factor in the process of choosing a university major because choosing the right university program leads to a successful career and job satisfaction. Therefore, the system displays the data collected regarding the previous graduates who worked in Palestinian institutions. The unemployment rate and salaries will be displayed. In addition, the system suggested the suitable jobs that the student can join after graduation.

The number of Palestinian higher education institutions graduates is about 40,000 annually (PCBS, 2020). To evaluate the rate of unemployment and salaries, we published a questionnaire (Appendix 5.4). The questionnaire was designed by Google form and it included two parts, the first of which includes general information about the graduate such as gender, age, year of graduation, and the university from which he/she graduated. If the graduate is from HU, he/she will answer the section regarding HU graduates. Otherwise, the graduate answers the section concerning the rest of the Palestinian universities. The second part of the questionnaire is answered by the employed graduate. This section is related to the job such as the salary rate, the sector in which he/she works, the job title, and others. If the graduate is not working, then he explains the reasons for not working. In addition, data sets were obtained from various sources, such as the Graduate Unit at HU and PCBS. Tables 15 and 16 respectively show the most prominent results obtained after analyzing the questionnaire and the data sets.

Table 15. Unemployment, Salary Rates, and Suggested Jobs Among Individuals (20-29 years) by Field of Study and Gender of Hebron University Graduates, 2020.

College	Unemployment rates			Salary rate (NIS)	Some suggested jobs
	Males	Females	Both sexes		
Islamic studies	69%	71%	70%	2000-3000	Legal lawyer, mosque imam, teacher, school principal
Arts	65%	66%	66%	1500-3000	Teacher, broadcaster, radio editor, public relations official, educational supervisor, administrative employee, school principal
Science & Technology	{64}%	59%	59%	2000-2500	Teacher, school principal
Agriculture	{51}%	59%	57%	2000-3000	In the Ministry of Agriculture, the Ministry of Education, the Environmental Quality Authority, the Ministry of Health, non-governmental

					institutions concerned with the development of the agricultural sector, relevant private sector institutions, and private projects.
Education	79%	80%	80%	1500-3500	Teacher, mentor, social researcher, administrative officer, director of public services
Law & Political Science	66%	76%	73%	2500-3500	Lawyer, Judge, Lieutenant
Finance & Management	59%	69%	65%	1000-3500	Bank employee, department head, sales representative, teacher, administrative employee, health administration, primary health care centers, maternity and childcare clinics, health education university programs, school health, occupational safety and environmental health institutions, hospitals, and others.

Nursing	{53}%	[48}%	{48}%	1500-2500	Nurse, midwife
Pharmacy & Medical Science	{25}%	47%	46%	1500-3000	General pharmacies, pharmaceutical industries and chemical analysis, medical advertising, pharmaceutical care and hospitals, academic work, and scientific research. Hospital laboratories, health centers, and medical clinics, private laboratories and medical research laboratories, pharmaceutical companies, biotechnology fields, food industry enterprises, medical product development areas, water laboratories
Information Technology	{64}%	44%	48%	1500-2500	IT department official, teacher, special project

Professions and Applied Sciences (Two years university program)	{50}%	69%	68%	1500-2000	Various jobs (depending on university program)
Total	**59%**	**62%**	**62%**		
:{ } Number of observations is relatively little so results in parentheses indicate the relatively high marginal error					

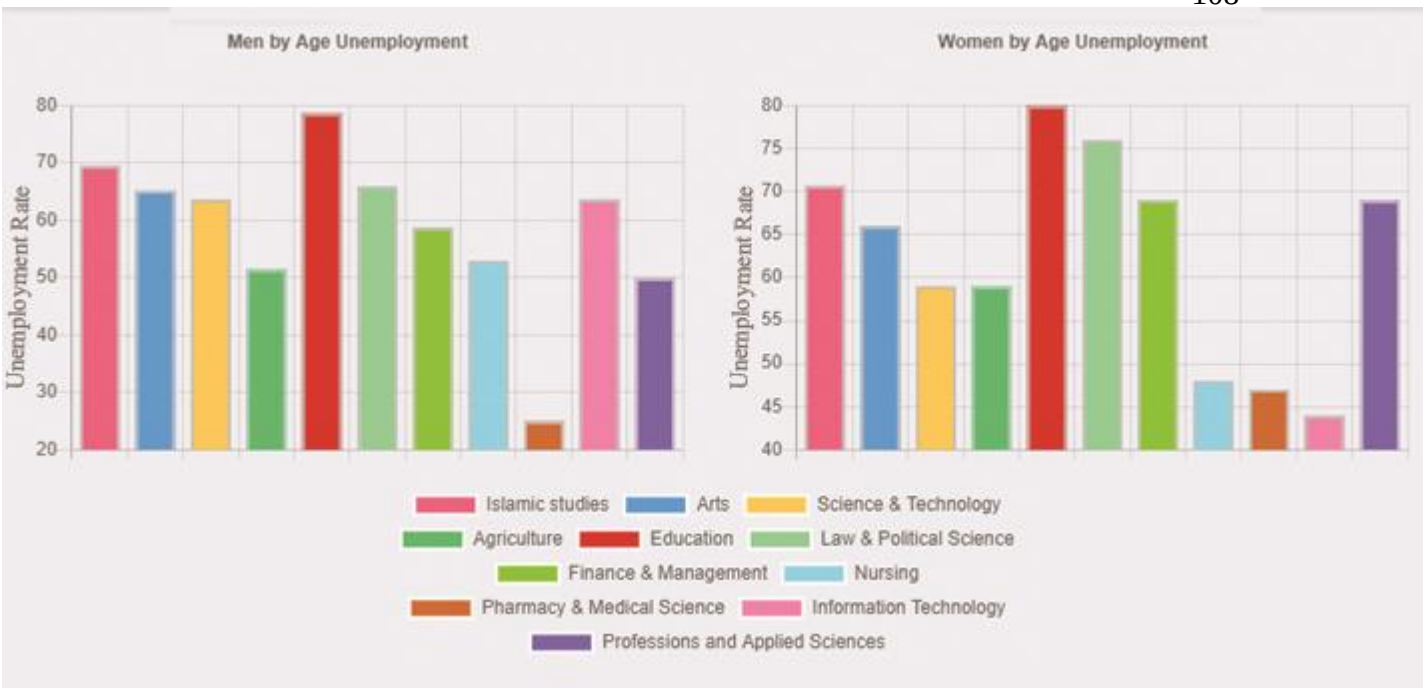


Figure 15. Unemployment Rates According to the Variable of Gender, Field of Study, and Age (20-29) Among Hebron University Graduates.

Figure 15 represent data shown in Table 15 which reflects upon the colleges of HU from which students graduate, and unemployment rates among graduates (ages 20-29) according to the gender variable. The table indicates that the unemployment rate of youth graduates at HU is 62% (20-29) years who hold associate diploma certificates and above, 62% for females compared with 59% for males. Moreover, the highest rates among males were in the Education College with 79% of the unemployment rate. While the highest rates of female unemployment were in the Education College is 80% of the unemployment rate. Table 15 also shows the salary rate for employees of HU graduates, and some of the proposed jobs for each college. Note that the expert system will provide these statistics in more detail, including details about each of the HU university programs.

Table 16. Unemployment Rates Among Individuals (20-29 years) by Field of Study and Gender of Palestinian Graduates, 2019**.**

Field of Education	Unemployment rates			Westbank Unemployment rates	Salary rate (NIS)
	Males	Females	Both Sexes		
Teacher training and education sciences	49%	78%	72%	57%	1908
Journalism and information	60%	86%	69%		1694
Humanities	44%	74%	65%	42.7%	2006
Social and behavioral sciences	40%	75%	63%	49.2	2125
Life sciences	(32}%	67%	57%	42.1%	3133
Mathematics and statistics	{30}%	56%	52%	47.7%	3084
Architecture and construction	43%	69%	48%	29%	2586
Computing	39%	67%	48%	39.6%	2065
Business and administration	31%	64%	45%	29.6%	1961
Health	35%	51%	43%	20.9%	2032
Engineering and engineering trades	29%	59%	38%	30.9%	2397

Personal services	37%	{37}%	37%	16.3%	2622
Law	28%	{54}%	36%	19.8%	2943
:{ } Number of observations is relatively little so results in parentheses indicate the relatively high marginal error					
Source: Palestinian Central Bureau of Statistics, 2020. Database of Labour Force Survey, 2019. Ramallah-Palestine					

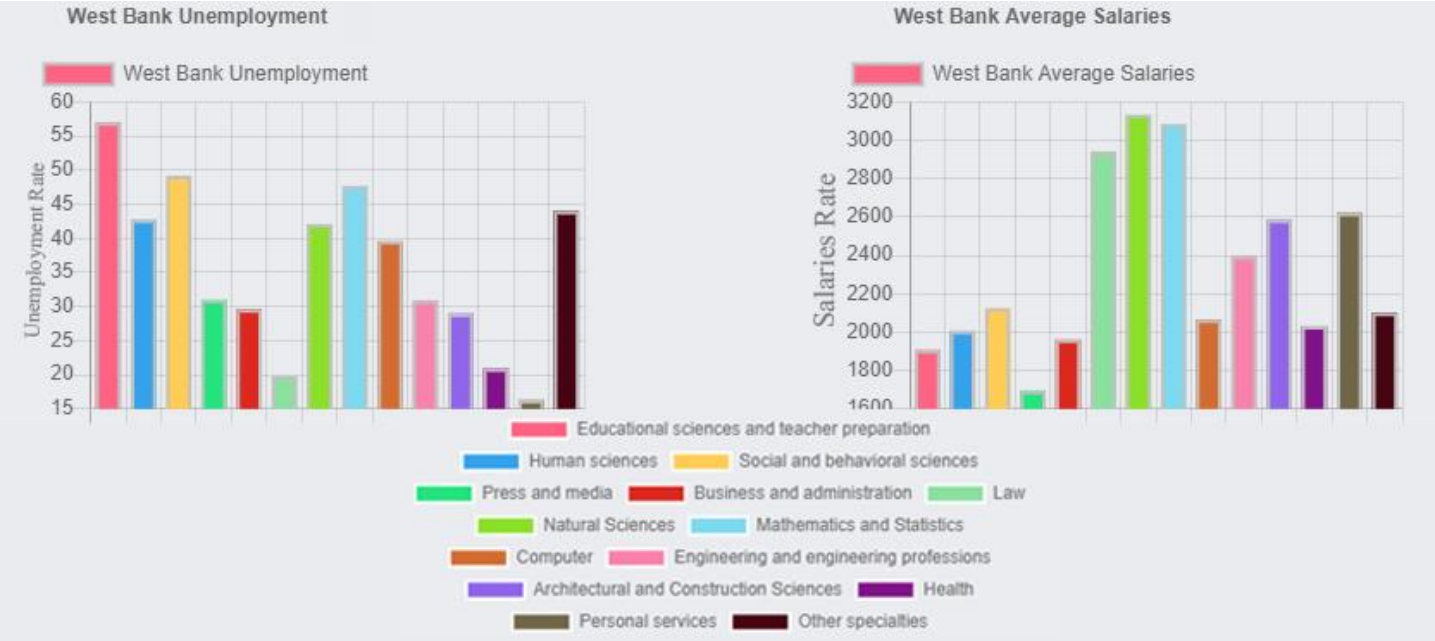


Figure 16. Unemployment Rates Among Individuals (20-29 years) by Field of Study and Gender of Palestinian Graduates (PCBS, 2020).

Figure 16 shows the fields of study from which Palestinian university graduates in general (ages 20-29), and unemployment rates according to the gender variable. Table 16 indicates that the highest rates of unemployment among males were in Journalism and information (60%). While the highest rates of unemployment among females in Journalism and information were (86%). All of this information will be provided by the expert system, in addition to a set of graphs.

D. Implementation

After the data has been represented in a set of models and decision tables to retrieve the required knowledge, the next step is to implement the system in a way that achieves its primary goal that helps high school students choosing their university program.

Figure 17 shows the major components of the expert system, which includes the components that were discussed in Chapter II. Yet, since the current expert system is web-based, it is necessary to have a database to store data about users and facilitate retrieval of any other data when needed. Including the knowledge base which is represented as a table in the database in which it contains the knowledge needed to understand, formulate, and solve problems. In addition to an inference engine that helps enrich the rules in the knowledge base while interacting with the user. Moreover, the user interface which is a very important component because most of the users are not experts in dealing with expert systems. Therefore, this interface should be easy to use and accessible to students. Finally, the machine-learning model, which predicts the best suitable university program (s) for the student through the DTC algorithm. Below is an explanation of all of these components.

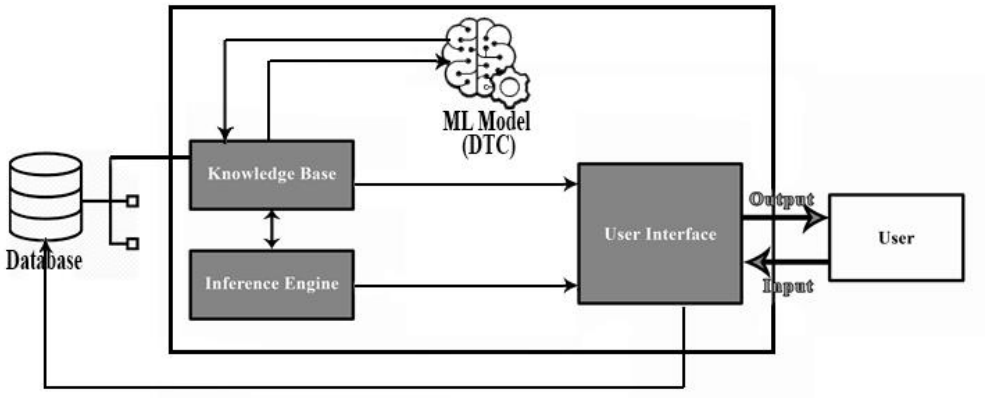


Figure 17. Basic Components of the current Expert System.

5.3.8 Database

Databases are a major component of web applications. It consists of tables that are made up of fields. MySQL was used to manage the database. However, MySQL is one of the most popular Relational Database Management Systems **(RDMS)** for web applications. It is used on Facebook and Twitter (Ahmed et al., 2019). Figure 18 shows the Entities Relationships Diagram **(ERD)** for the current expert system.

This ERD consists of ten tables, as follows:

- Users Table: Table 17 shows the fields that make up the Users table.

Table 17. Users Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	User serial number	Primary key
Created_at	Date	User join date (Default field)	
Email_verified_at	Date	Default field by Laravel Framework	
Update_at	Date	Default field	
Email	Varchar	User's email	
Name	Varchar	User's name	
Type	Varchar	This field specifies the type of user (student, admin)	
Branch	Varchar	This field identifies the student's high school branch	

Gender	Varchar	User gender	
GPA	Varchar	student's high school GPA	
Password	Varchar	User account password	
Photo	Varchar	User picture	
Remember_token	Varchar	Default field	
Role	Integer	1 for admin users. 2 for student users.	
Slug	Varchar	Default field	

- Reviews Table: Table 18 shows the fields that make up the Reviews table. This table stores users' answers about their opinions and evaluating of the system.

Table 18. Reviews Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Reviews serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
UserId	Integer	User's ID	Foreign key
Notes	Text	To store text feedback from the student	
Question1-3	Varchar	Question 1: student's gender.	

		Question 2: student's age. Question 3: Academic level.	
Question4-11	Integer	To store a student's numerical grades on questions related to the system evaluation.	

- Histories Table: Table 19 shows the fields that make up the Histories table.

Table 19. Histories Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Histories serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
UserId	Integer	User's ID	Foreign key
Optionsuggestionid	Integer	Option Suggestions serial number	Foreign key

- Option Suggestions Table: Table 20 shows the fields that make up the Option Suggestions table. This table represents the link between the result of the analysis of the student's abilities and tendencies with the appropriate university programs for him/her. It represents the knowledge base. This will be explained later.

Table 20. Option Suggestions Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Option Suggestions serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
Icon_id	Integer	Serial number of a specific university program icon.	Foreign key
Branches	Varchar	Student High school branch	
GPA	Varchar	Student GPA	
Parents	Varchar	Holland symbol	
Class	Varchar	University programs group codes appropriate for a specific personality type.	

- Icon Symbols Table: Table 21 shows the fields that make up the Icon Symbols table. This table represents the university programs.

Table 21. Icon Symbols Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Icon symbols serial number	Primary key

Created_at	Date	Default field	
Update_at	Date	Default field	
Title	Varchar	Specialty name	
Photo	Varchar	specialty image	
Slug	Varchar	Default field	

- Suggestions Table: Table 22 shows the fields that make up the Suggestions table. This table stores details about all university programs such as unemployment rates and salaries.

Table 22. Suggestions Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Suggestions serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
Icon_id	BigInteger	Icon symbols serial number	Foreign key
Active	Integer	University program Status	
Title	Varchar	Specialty name	
Avg_salary	Integer	market wage rate	
Character	Text	Description about personality type	
Sug-desc	Text	suggested description	

Sug-jobs	Text	suggested jobs	
Unemp_men	Integer	Male unemployment rate	
Unemp_women	Integer	Female unemployment rate	
Unemp_total	Integer	Unemployment rate	
External_url	Varchar	A link to describe the majors in detail (registration conditions, study plans, learning outcomes ....)	

- Options Table: Table 23 shows the fields that make up the Options table. This table to determine the degree of compatibility between the question and the user's personality

Table 23. Options Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Options serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
qustion_id	BigInteger	Qustion serial number	Foreign key
Active	Integer	Question Status	

OptionName	Varchar	The degree of compatibility of the question with the user's personality (1-5)	
OptionImg	Varchar	Default field	
IsCircle	Integer	Default field	
IsRadius	Integer	Default field	

- Questions Table: Table 24 shows the fields that make up the Questions table.

Table 24. Questions Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Question serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
Question	Varchar	Question text	
Parent	Varchar	The main character type the question represents (like r, c, e)	
Photo	Varchar	Question picture	
Position	Integer	picture position	
Slug	Varchar	Default field	
Step	Integer	Default field	

- Review Options Table: Table 25 shows the fields that make up the Review Options table. This table represents the answers to the questions that the user can choose on the system evaluation page.

Table 25. Review Options Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Review Options serial number	Primary key
Created_at	Date	Default field	
Update_at	Date	Default field	
qustion_id	BigInteger	Question serial number	Foreign key
Active	Integer	Review Options status	
OptionName	Varchar	All system evaluation question options	
OptionImg	Varchar	Default field	
IsCircle	Integer	Default field	
IsRadius	Integer	Default field	

- Review Questions Table: Table 26 shows the fields that make up the Review Questions table.

Table 26. Review Questions Table Fields.

Field Name	Data Type	Field Description	Field Type
Id	BigInteger	Review Questions serial number	Primary key

Created_at	Date	Default field	
Update_at	Date	Default field	
question	Varchar	Evaluation question text	
slug	Varchar	Default field	
photo	Varchar	Image of the evaluation question (default)	
Step	Integer	Default field	

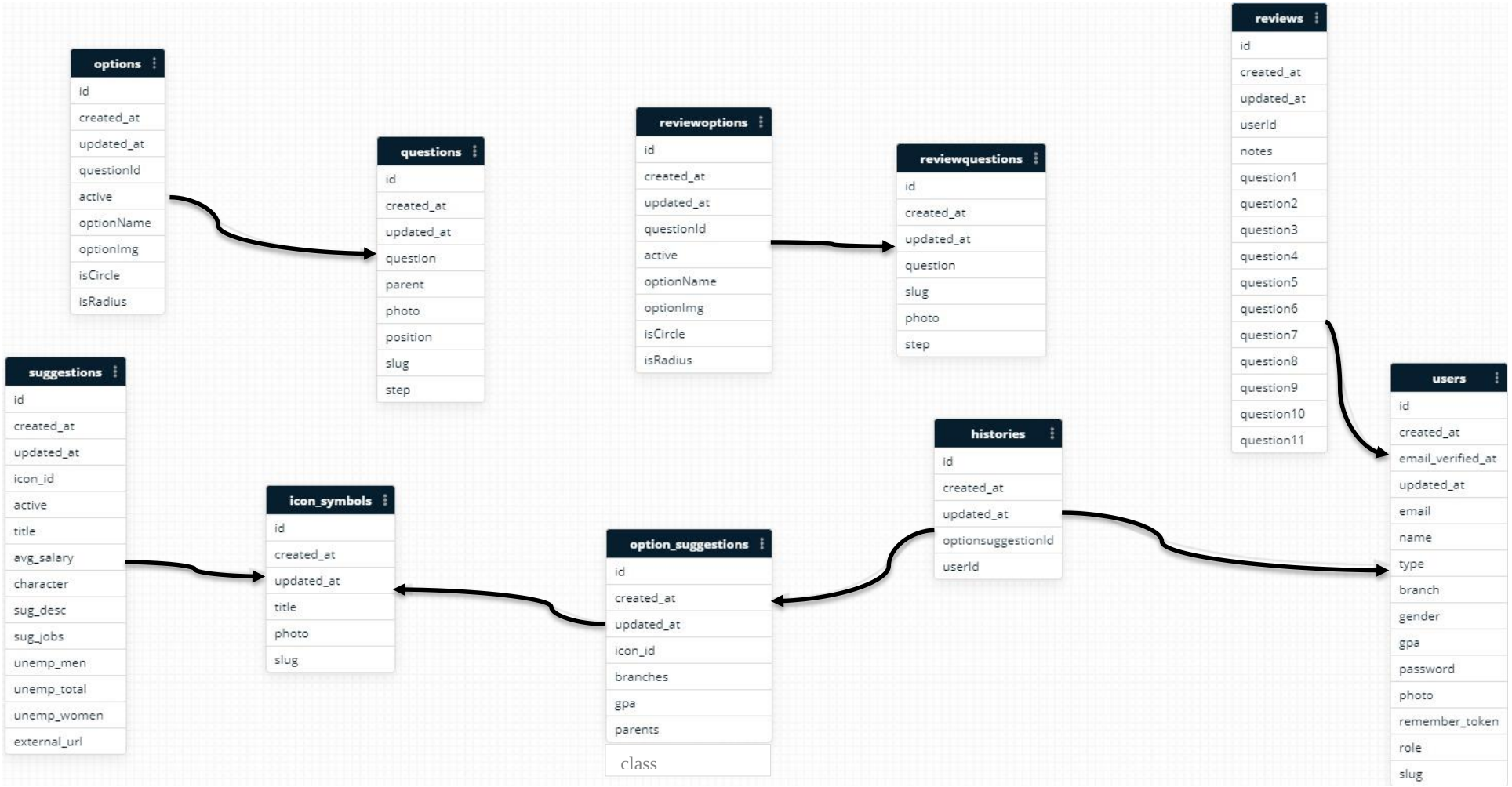


Figure 18. ERD for the current Expert System**.**

5.3.9 Knowledge Base

In the current expert system, the knowledge base contains the main Holland personality types, and the characters that consist of the overlapping of the two main types of characters as shown in the matrix in Table 27 which shows part of the knowledge base for the current expert system.

Table 27. Part of the Knowledge Base for the Expert System.

id	parents	icon_id	created_at	updated_at	branches	gpa	class
13	ir	4	31/01/2021 12:26	31/01/2021 12:26	[0,2]	85	L,Q,R,G,K,J,I
15	ir	3	31/01/2021 12:26	31/01/2021 12:26	[0,2]	85	LLL,LLLL,LL,L6,L,G1,KKK,KK,K2,E10,E11,G3,A,z,Z,F,D10
17	rr	3	06/02/2021 14:31	06/02/2021 14:31	[0]	65	LLL,LLLL,LL,L6,L,G1,KKK,KK,K2,E10,E11,G3,A,z,Z,F,D10
18	ri	5	06/02/2021 14:37	06/02/2021 14:37	[0]	65	G1,G,B
19	ri	6	06/02/2021 14:41	06/02/2021 14:41	[0,2,3]	50	WW,G2,XX,G1,G4,II,III,G3,W,G,I,X,X5,X4,IIII,XXX,B1,B
20	ri	7	06/02/2021 14:50	06/02/2021 14:50	[0]	50	G2,G1,G4,G3,G,B1,D,B
21	ra	8	06/02/2021 14:54	06/02/2021 14:54	[0,2,3]	65	Y3,C,V,P,Y,Y2,Y5
22	ra	9	06/02/2021 14:56	06/02/2021 14:56	[0,2,3]	50	C,F,Y,Y2,Y3,C1,FF,Y1,Y5,C1
23	rs	10	06/02/2021 14:59	06/02/2021 14:59	[0]	90	QQ,K2,Q,K,D
24	re	11	06/02/2021 15:02	06/02/2021 15:02	[0,2,3]	65	NN,N,Y3,G1,G4,F11,G2,G3,G,Y,Y2,Y5,E2,E
25	re	12	06/02/2021 15:04	06/02/2021 15:04	[0,2,3]	50	EE,LLL,LLLL,LL,L6,L,FF,E10,E11,E12,E13,F,D10,D11,E2,E
26	re	13	06/02/2021 15:07	06/02/2021 15:07	[0]	65	E
27	rc	3	06/02/2021 15:07	06/02/2021 15:07	[0]	65	LLL,LLLL,LL,L6,L,G1,KKK,KK,K2,E10,E11,G3,A,z,Z,F,D10
28	ir	14	06/02/2021 15:11	06/02/2021 15:11	[0,2,3]	65	G1,G4,G2,G3,G
29	ir	15	06/02/2021 15:14	06/02/2021 15:14	[0]	65	LLL,LLLL,LL,L6,C10,SS,G1,JJJJ,JJJ,JJ,G3,G,J,L,S
30	ir	16	06/02/2021 15:14	06/02/2021 15:14	[0]	65	G1,KKK,KK,K2,G3,G,K,H
31	ir	17	06/02/2021 15:16	06/02/2021 15:16	[0]	65	G,G1,G3
32	ir	18	06/02/2021 15:17	06/02/2021 15:17	[0]	65	G1,G3,W,G
33	ir	5	06/02/2021 15:17	06/02/2021 15:17	[0]	65	B,G,G1
34	ir	19	06/02/2021 15:18	06/02/2021 15:18	[0]	65	F10,G,G1
35	ir	6	06/02/2021 15:19	06/02/2021 15:19	[0,2,3]	50	WW,G2,XX,G1,G4,II,III,G3,W,G,I,X,X5,X4,IIII,XXX,B1,B
36	ir	20	06/02/2021 15:24	06/02/2021 15:24	[0,2,3]	50	WW,XX,W,X,X5,X4,XXX
37	ir	11	06/02/2021 15:25	06/02/2021 15:25	[0,2,3]	65	NN,N,Y3,G1,G4,F11,G2,G3,G,Y,Y2,Y5,E2,E

The previous matrix shows all types of personalities that are present in the knowledge base of the expert system, as each type is associated with the university program that suits it, in addition to the branch and the GPA.

Let us take the first row for clarity. The first field (id) indicates the serial number of the record. The Parents field indicates the personality type suggested by Holland where (ir) means the personality type which is investigator and realist. The icon field indicates the university program serial number that matches the (ir) character. Referring to the database, the number 4 refers to the human medicine university program. The next two fields are default fields that indicate when the record was created and modified. The branches field indicates the number of high school branches in which the student is

accepted where 0 means the scientific branch. The field GPA indicates the lowest rate at which a student is accepted into this major where 90 means that the lowest admission rate for a student in the human medicine university program is 90. Finally, the class field shows a set of symbols that were used in the machine learning section (it will be explained later).

5.3.10 Inference Engine

As previously mentioned, the inference engine is the mind of the expert system as it works to interpret and analyze the fact stored in the knowledge base. Further, it is the link between the knowledge base and the user interface. After the student answers the set of questions posed by the system, the inference engine will analyze the answers by working to find the summation of questions for each type of personality, then choosing the two highest types, and linking them to the types stored in the knowledge base. Finally, displaying the university program (s) that fit the results of the analysis of the student's personality. Figure 19 shows the Psudo Code of the inference engine for the expert system. In addition, Figure 20 shows part

```
declare map counters[6]
if(session try = 0)
    getquestions where position = session try
else
    getquestions where position = session try
    and parent = session c1 and session c2
endif
for j = 0 to count(answers)
    if(question[j][parent] == r
        counters[r] = counters[r] + answers[j]
    elseif(question[j][parent] == i
        counters[i] = counters[i] + answers[j]
    elseif(question[j][parent] == a
        counters[a] = counters[a] + answers[j]
    elseif(question[j][parent] == s
        counters[s] = counters[s] + answers[j]
    elseif(question[j][parent] == e
        counters[e] = counters[e] + answers[j]
    elseif(question[j][parent] == c
        counters[c] = counters[c] + answers[j]
    endif
endfor
if(session row exist)
    set max = session row
    session clear row
    set max2 = keys[0]
else
    max = keys[0]
    max2 = keys[1]
endif
```

Figure 19. Psudo Code of the Inference Engine for current Expert System.

```
if ($data = $request->allOption) {

    // type casting of array elemnt
    for ($j = 0; $j < count($data); $j++) {
        // $options[$j] = (int)$data[$j];
        if ($j < 2) {
            $factors['r'] = $factors['r'] + (int)$data[$j];
        } else if ($j < 4) {
            $factors['i'] = $factors['i'] + (int)$data[$j];
        } else if ($j < 6) {
            $factors['a'] = $factors['a'] + (int)$data[$j];
        } else if ($j < 8) {
            $factors['s'] = $factors['s'] + (int)$data[$j];
        } else if ($j < 10) {
            $factors['e'] = $factors['e'] + (int)$data[$j];
        } else if ($j < 12) {
            $factors['c'] = $factors['c'] + (int)$data[$j];
        }
    }
    arsort($factors);
    $keys = array_keys($factors);
    $values = array_values($factors);
```

Figure 20. Part of the Inference Engine for current Expert System.

of the inference engine written using PHP language.

The expert system, after finding the sum for each group of questions, works on arranging these groups from largest to smallest through a function (arsort). Then, after it matches the result with the knowledge stored in the knowledge base, it finds the symbol that expresses the student's personality, and the appropriate major for his personality type, high school branch, and GPA.

It should be noted that the expert system handles many cases as follow:

- **Equalities:** In the case that the results of the analysis of the questions that the student answered were equal between three or more types of characters, the expert system has been developed to work on asking more questions, and in the end, this equality will be solved.
- **Randomness:** In the case that the student answers randomly to the questions, the system deals with this case by displaying the majors offered for characters consisting of two identical letters, such as RR **(**Realists), CC (Conventional), etc.
- **University programs details:** after completing the previous analysis, the student will receive the university program (s) that suit his personality. Further, the student can view details about this university program (s), such as proposed jobs for graduates, unemployment rates, and salary rates. These details shown charts graph.

5.3.11 User Interfaces

Initially, the system logo shown in Figure 21 was designed. The logo for the current expert system consists of:

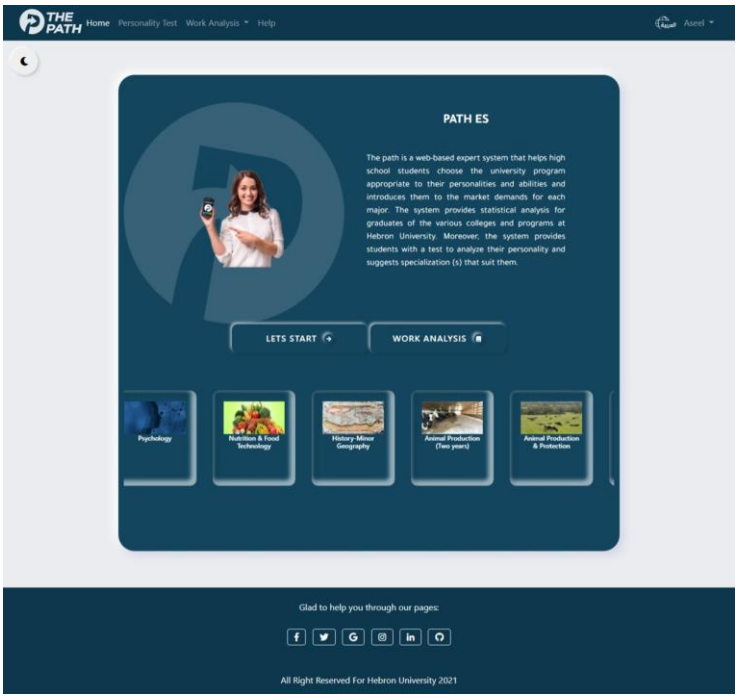
- P letter: the first letter of the Path word.

- Round shape: which indicates flexibility and free movement.
- Arrow: which indicates the direction. In case of the current system, it indicates the future.

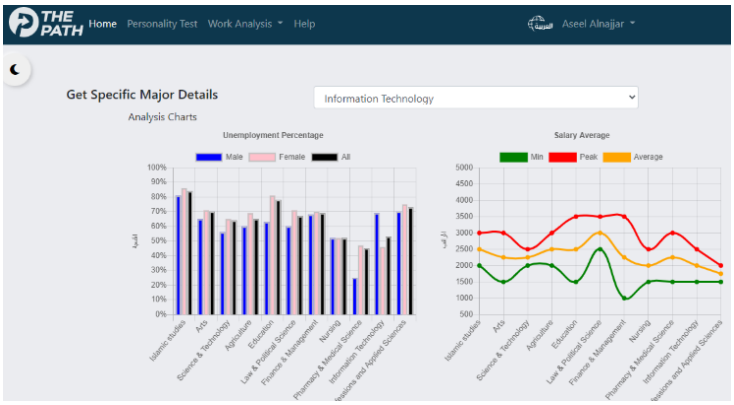
Figure 21. Expert System Logo.

About the development of the system interfaces, the Laravel framework (Laravel, 2021) was used. This is because it is a framework for developing professional web applications, as it supports the PHP language. See Figure 22, which reflects upon selected interfaces from the current expert system.

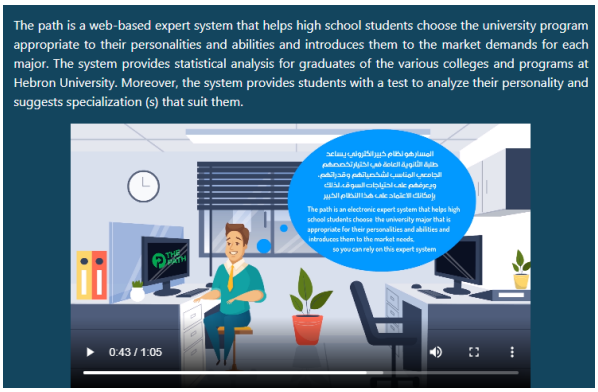
It should be noted that the system interfaces were designed based on the multimedia rules. This makes the interfaces easy to use and attractive to users . Moreover, various multimedia elements were used in the system such as text, graphics, animation, videos. To see the current expert system in detail, visit this site (**esaseel.com**).



A. The Main Interface of the Expert System.

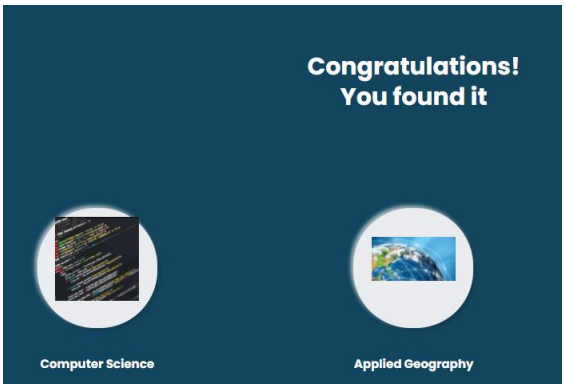


B. Analysis of Unemployment Rates and Salaries for Ggraduates of Hebron University.

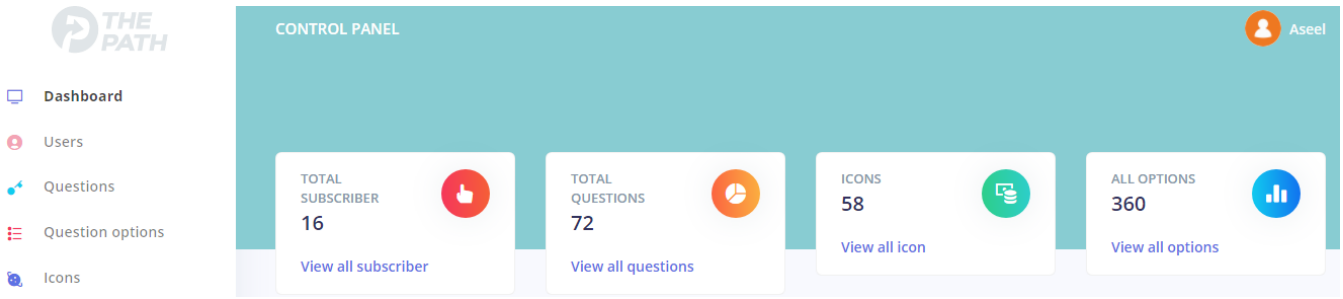


C. Help Page.

D. Personality Test Page.



E. Result Page.



F. Admin Dashboard.

Figure 22. Selected Interfaces for the Expert System.

5.3.12 Machine learning Model

As was indicated in chapter two, the current system used machine learning and not only made it rely on rules in analyzing results but also made it dynamic with the ability to predict the appropriate university program (s) for the student in proportion to the student's input. Below is an explanation of both the dataset and the DTC algorithm that the current expert system relies upon in the forecasting process.

5.3.12.1 Dataset Description

The current expert system analyzes some of the user-entered inputs: student GPA, high school branch, student character which is obtained in the form of Holland code (two letters) after the student answers the questions suggested by the current expert system. These entries have been placed as an attribute in a comma-separated values (CSV) file to create the dataset, which consist of 2520 records. It is important to note that these attributes are numeric in order to recognize them by the DTC algorithm. Table 28 shows a portion of the dataset.

Table 28. Sample of the Dataset.

Branch	GPA	Personality	Class	University program (s)
0	1	1	A	Computer Science
0	1	2	B	Plant Production & Protection Electrical Installations Engineering (Two years) Protected agriculture and nurseries (Two years)
0	1	3	C	Media

				Maintenance and Building Restoration (Two years)
0	1	4	D	Pharmacy Physical Training Electrical Installations Engineering (Two years)
0	1	5	E	Computer Science- Mobile University programming Tourism and Antiquities Mobile Phone Technology (Two years)/
0	1	6	F	Computer Science Mobile Phone Technology (Two years) Building Maintenance and Restoration (Two years)

The first column shows the high school branch, and it was expressed in a numerical variable as shown in Table 29.

Table 29. Description of High School Branch Attribute.

Numerical Variable	Representation
0	Scientific branch
1	Humanities branch.
2	Commercial branch

3	Agricultural branch
4	Industrial branch

The second column in the dataset indicates the high school GPA, and it was also expressed in a numerical variable according to the following table:

Table 30. Description of High School GPA Attribute.

Numerical Variable	Representation
1	100>GPA>=90
2	90>GPA>=85
3	85>GPA>=80
4	80>GPA>=75
5	75>GPA>=70
6	70>GPA>=65
7	65>GPA>=50

The third column shows a serial number from 1 - 36 to the Holland code for the student's character. For example, number 1 denotes the personality type r (realistic).

The fourth column in the dataset shows a text symbol representing HU major (s) that correspond to the entries in the previous three columns. This column represents the output of the machine learning analysis process.

The last column is not a real part of the dataset but represents the actual university program (s) that each symbol expresses. As the output of machine learning analysis is the text code mentioned in the previous column, the inference engine searches in the

knowledge base in the class field to display the university program (s) that represent this text code.

5.3.12.2 Decision Tree Classification

In order to analyze these inputs and obtain the best results, one of the machine learning algorithms was supposed to be used. Further, there are several types of these algorithms. In the current expert system, the supervised machine learning algorithms was used. The supervised learning is based on training a sample of data from a data source with the need to specify the correct classification (Alexandra & Florea, 2013). One of the most famous of these algorithms is the Decision Tree Classification **(DTC)** algorithm.

The DTC algorithm was applied, which divides data like a tree as it sorts the tree from the root to some leaf nodes up to the decision (Sarker, 2021). Nodes in a decision tree can be categorized into two types; the first is the Decision Node, which has many branches to reach the decision. The second type is the Leaf Node, which is the output of those decisions and does not contain any other branches. The decision nodes are divided into sub-nodes according to the specified conditions in a process called splitting. The splitting process results in a set of internal nodes that represent the features of the dataset, the branches represent the decision rules, and the outcome is the leaf nodes. This is perhaps the most important advantage of the algorithm, it breaks down the complex decision-making process into a set of simpler decisions, thus, providing an easy-to-interpret solution (Budhiraja & Mago, 2018; Chourasia, 2013).

Moreover, Python language was used to implement the machine learning model in the current expert system as shown in Figure 23. Whereas, the DTC algorithm divides the previous dataset into the training set and the test set, which was divided by 50% for the first set, and 50% for the second set.

```
from sklearn.model_selection import train_test_split
x_train, x_test, y_train, y_test = train_test_split(X, Y, test_size=0.70)
from sklearn.tree import DecisionTreeClassifier
classifier = DecisionTreeClassifier()
```

Figure 23. Python code for DTC Algorithm.

The process of developing the machine-learning model went through stages as follows:

- Determining the inputs in the data set: The inputs in the machine-learning model were the same factors that affect the process of choosing a university program, and they include the student's personality, high school branch, and GPA.
- Linking inputs to outputs: classes were created for each group of inputs so that each class represents a university program (s).
- Data storage: All inputs and outputs are saved in an excel file and a CSV file since this is a file type that the DTC algorithm can identify and analyze.
- Data conversion: All text inputs have been converted to numeric inputs since the DTC algorithm deals with numeric inputs.
- Choosing the most accurate machine learning algorithm: As explained in the second chapter, both the DTC and SVM algorithms were tested, and the accuracy of the DTC algorithm was higher (98%), thus, it was relied upon in the development of the machine learning model.

It should be noted that the current system is a combined system, in the sense that it consists of the integration of the following two methods:

- Rules-based expert system: to implement all previous decision tables, a rule-based method used. Since all major criteria are symbolic standards, this can be logically converted to IF-THEN format. As previously explained.
- Expert system that employs machine learning.

The previous two methods have been developed so that the student can see the most appropriate university programs for his personality twice. Moreover, Table 31 shows a comparison between these two methods.

Table 31. Comparison Between the current Composite Expert System.

	Rule- based	**Machine learning**
Inputs	GPA, Branch, Holland Code	GPA, Branch, Holland Code
The input is stored in	Database and Knowledge base	Dataset as CSV file
Algorithm	An algorithm based on if-then statements has been developed	DTC
Language	PHP	Python
Output	The university programs offered by HU and suitable for the student's personality. If more than 6 majors appear, they are categorized into major and minor, based on the GPA.	The university programs offered by HU and suitable for the student's personality.
Accuracy of results	100%	98%
Properties	Static	dynamic, categorize, predict

In addition, Figure 24 below shows the flowchart of the current expert system. Also, Figure 25 shows the flowchart of Holland's test and the selection of an appropriate university program (s) in more detail. Figure 26 shows The Flowchart of Machine Learning Process in the Selection of an Appropriate University program (s) in the current Expert system.

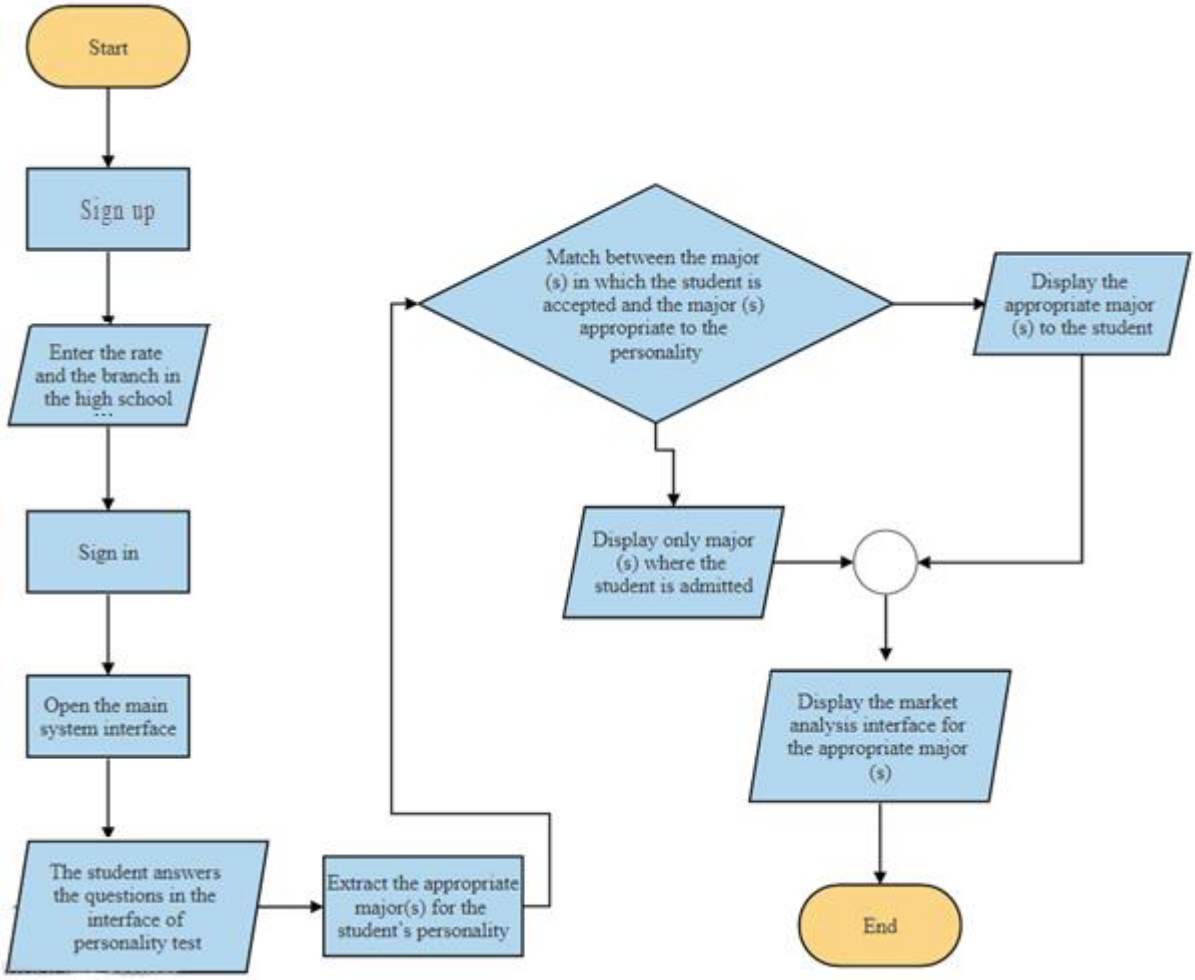


Figure 24. The Flowchart of the current Expert System.

The previous diagram shows the flowchart of the expert system that goes through it when it is used by a student. First, the student must log into the system, and in case he does not have an account, he must create an account through the registration page. Then the student is transferred to the personality analysis page by pressing the Personality Analysis button, and he must have 60 questions as usual. Then the results page appears

for him on which the expert system displays the university program (s) at HU that are appropriate for the student's personality. The student can also view the university programs predicted by the machine-learning model. The student can view the details about each major by clicking on the View Details button. Accordingly, a page will appear for him indicating the student's personality type, the most prominent jobs proposed for him after graduation, unemployment rates among graduates of this specialty by gender, and an illustrative graph. In addition, the salary rate for graduates of this university program will be displayed.

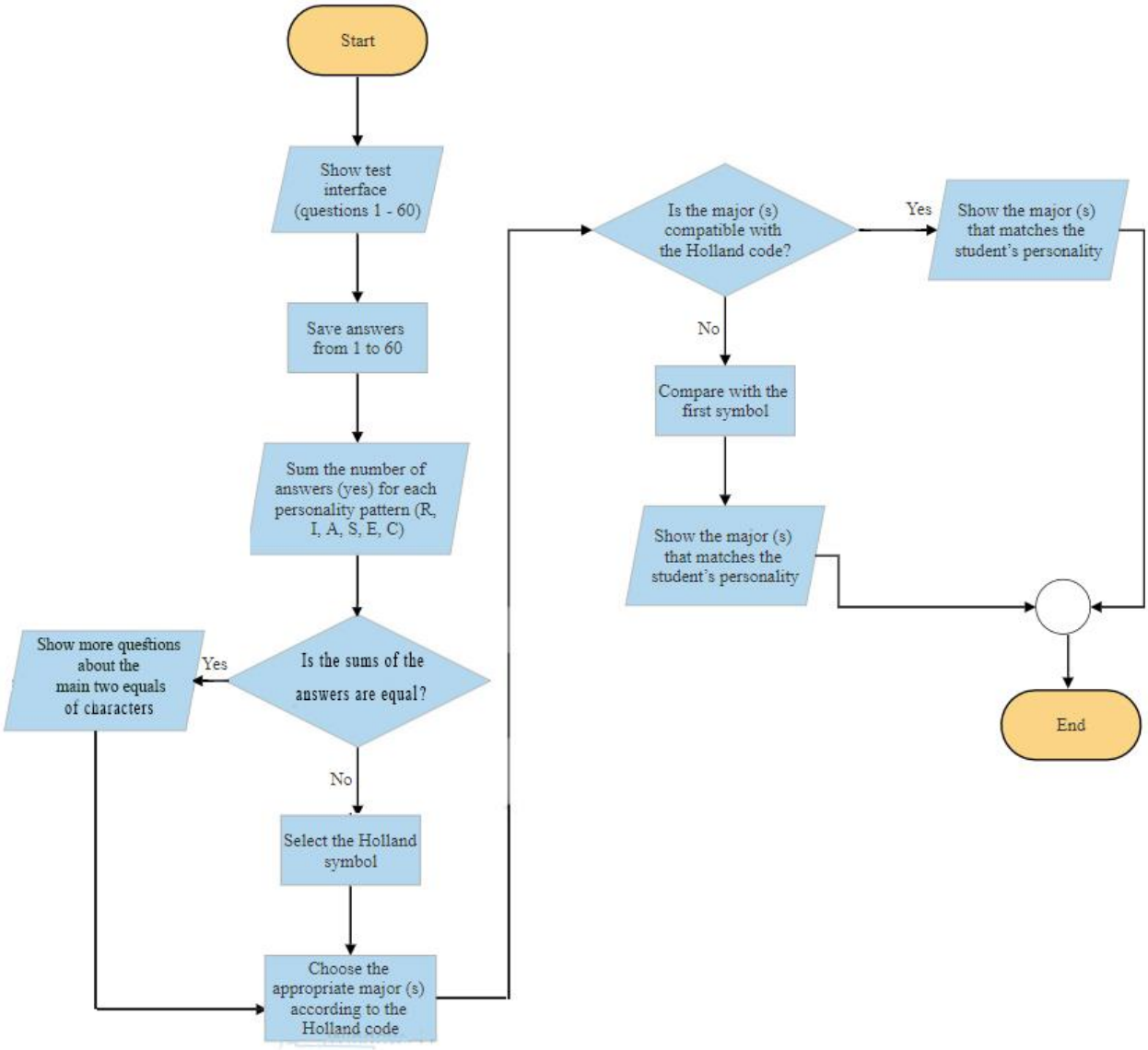


Figure 25. The Flowchart of Holland's Test and the Selection of an Appropriate University program (s) in the current Expert system.

Figure 25 shows the sequence of operations that the system goes through when the student enters the personality analysis page. Whereas, the system shows 60 questions (see Appendix 5.3) on a scale ranging from 1-5, with 5 indicating the highest score. These questions are divided into six groups. Each group expresses a specific personality type, and each group is assigned 10 questions. The expert system finds the sum of the answers for these groups and selects the two highest groups as these two groups form Holland's symbol which expresses the personality of the student. The system, through the inference engine searches in the knowledge base for the most appropriate university program (s) that suit this type of personality. If the student answers the questions randomly, the system takes the first letter of the character, and it shows the student the appropriate university program for this type.

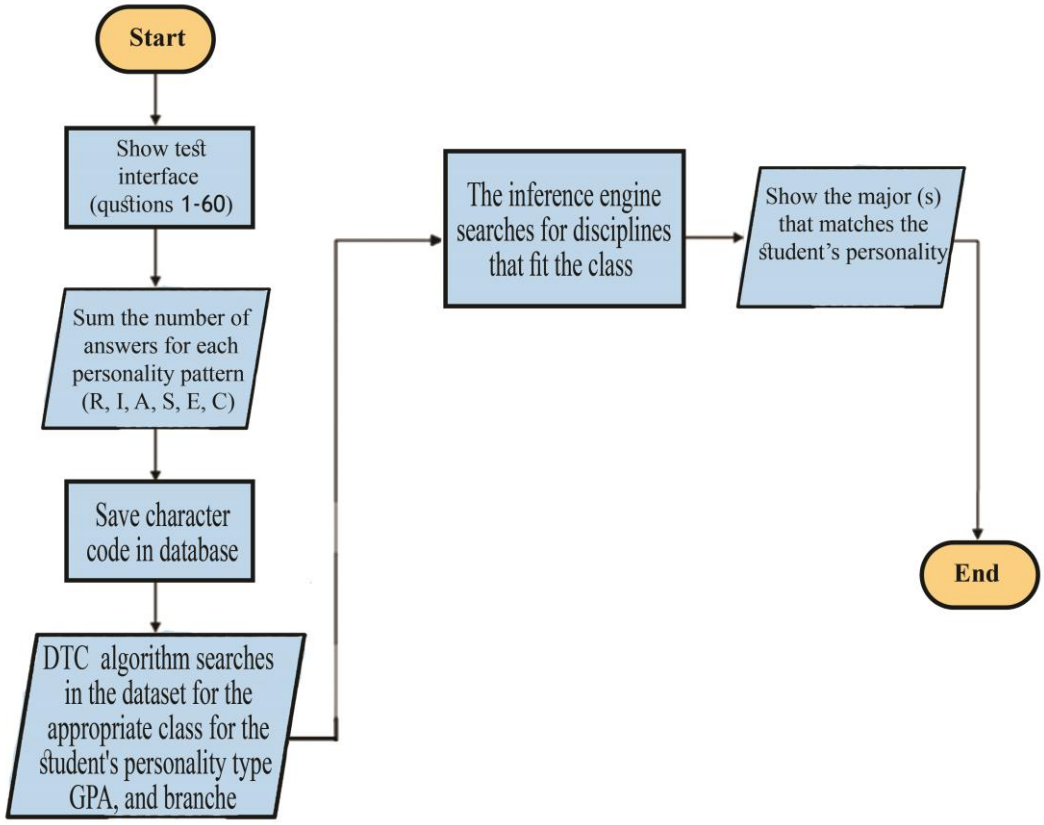


Figure 26. The Flowchart of Machine Learning Process in the Selection of an Appropriate University program (s) in the current Expert system.

Figure 26 shows the sequence of steps the system goes through when it predicts the appropriate university program (s) for a student. After the student answers the 60 questions, the system finds the code for the student's personality. This code is stored in the database. Then comes the role of the machine-learning model, through the DTC algorithm, which searches in the dataset for the class that fits the student's personality, GPA, and high school branch. Then the inference engine searches in the database for the most suitable university program (s) for this class. Finally, these university programs are presented to the student.

5.3.13 Pseudo Code for Expert system Algorithm

An algorithm can be defined as a set of steps executed sequentially to solve a specific problem or achieve a specific goal. These algorithms are written in languages that computers can understand. However, sometimes these algorithms can be ambiguous to humans. Therefore, university programmers resort to using pseudo code, which can be defined as the expression of an algorithm more accurately and less ambiguously.

Figure 27 shows the pseudo code of the rule-based expert system of student personality test process. Section A of the algorithm in Figure 27 shows the states that a user goes through when entering the system. For example, the system asks the user to log in if he/she wants to take a personality analysis test, and if he/she does not have an account, the system will ask him/her to create a new account. In addition, Section B shows the sequence of steps that the registered user follows when entering the personality test page, where he/she has to answer 60 questions in the normal situation. However, if the system finds that the student has similarity between more than one types of personality, it will present 4 additional questions so that the system can accurately analyze the student's personality. Moreover, Section C explains the role of

the inference engine, which works to find the letters that make up the student's personality by finding the sum of the answers for all types of characters stored in the knowledge base. Then works to arrange them descending to store the two highest letters of the student that constitute Holland's symbol for the student's character. Additionally, Sections D and E show the cases handled by the system, and the sequence of steps that the inference engine takes to display the appropriate disciplines for the student. Inference engine searches in the knowledge base for the most appropriate university programs for the high school branch, the student's GPA, and the type of his/her personality. The figure also shows the cases handled by the system, such as the case of random responses by the student. Further, the system displays the first 6 majors by comparing the accepted GPA for all majors suitable for the student. The rest of the majors (if any) are displayed as minor majors.

A

```
BEGIN
    show userinterface
    main()
        if(userclick == start)
            if(userloggedin)
                Test()
            else
                if(user has account)
                    Login()
                else
                    Signup()
                endif
            endif
        elseif(userclick == webanalysis)
            showanalysis
        elseif(userclick == help)
            showhelp
        elseif(userclick == language)
            changeLanguage(lang)
        endif

    Signup()
        show registerpage
        input name,email,password,gender,gpa,branch
        onclick(register)
            redirect main()

    Login()
        show loginpage
        input email,password
        onclick(login)
            redirect main()

    changeLanguage(lang)
        language = lang
```

B

```
Test()
    declare answers[60]
    getquestionslist
    getanswerslist
    for i = 0 to 59
        input answer
        answers[i] = answer
        next i
    endif
    onclick(getresult)
        redirect Result(answers)

Test1(questionslist,try)
declare answers[4]
getanswerslist
for i = 0 to 4
    input answer
    answers[i] = answer
    next i
endif
onclick(getresult)
    redirect Result(answers)


Result(answers)
    if(try has not been stored in session)
        set session try = 0
    end if
```

C

```
declare map counters[6]
if(session try = 0)
    getquestions where position = session try
else
    getquestions where position = session try
    and parent = session c1 and session c2
endif
for j = 0 to count(answers)
    if(question[j][parent] == r
        counters[r] = counters[r] + answers[j]
    elseif(question[j][parent] == i
        counters[i] = counters[i] + answers[j]
    elseif(question[j][parent] == a
        counters[a] = counters[a] + answers[j]
    elseif(question[j][parent] == s
        counters[s] = counters[s] + answers[j]
    elseif(question[j][parent] == e
        counters[e] = counters[e] + answers[j]
    elseif(question[j][parent] == c
        counters[c] = counters[c] + answers[j]
    endif
endfor
```

D

```
    return resultview(allicons)
elseif(values[0] == values[1]
    get questionslist where position = 1 and parents = keys0 and keys1
    set session c1 = keys[0]
    set session c2 = keys[1]
    set session try = 1
    return Test1(questionslist,try)
elseif(values[1] == values[2]
    get questionslist where position = 1 and parents = keys1 and keys0
    set session row = keys[0]
    set session c1 = keys[1]
    set session c2 = keys[2]
    set session try = 1
    return Test1(questionslist,try)
endif

if(session row exist)
    set max = session row
    session clear row
    set max2 = keys[0]
else
    max = keys[0]
    max2 = keys[1]
endif

set parents = max and max2
set j=0
declare array allicons[]
get icons where parents = parents and order by desc
```

E

```
  for i=0 to count(icons)
      if(icon[i] branches contains loggeduser branch and
      loggeduser gpa > icon[i] gpa)
            allicons[j] = icon[i]
            j++
        endif
    endfor
    return resultview(allicons)

sort(counters)
    declare map c [6] = counters
    declare map result [6];
    for counters as key => value
        set max_value = null
        set max_key = null
        for c as key2 => value2
            if( max_value == null or value2 > max_value)
                max_key=key2
                max_value=value2
            endif
        endfor
        result[max_key] = max_value
        unset(c[key])
    endfor
    return result
END
```

Figure 27. The Pseudo Code of the Student Personality Test.

5.4 Testing and Evaluation

A precision testing process is applied to ensure that the expert system achieves its primary objective and provides accurate results. Therefore, part of the system is dedicated to assessing the students' level of satisfaction with the results provided by the system. Moreover, a random sample of the data was collected from high school students wishing to enrol in one of Hebron University's university programs in the first semester of 2021 to apply the testing process.

The researcher chose a sample of 200 high school students to conduct the test process. Table 32 shows the test process questions presented by the system, and an analysis of the students' answers.

Table 32. Evaluation Process Analysis.

Numb	**General Questions**	**Percentage**
1.	Gender	• 64.5% Female • 35.5% Male
	Evaluation Questions	
1.	I think this system is useful for me.	85%
2.	I see that the result of the personality analysis test is logical and realistic.	81%
3.	I believe that the Palestinian Market Analysis pages provided by the system are useful and necessary in choosing my university major.	76%
4.	I believe that the analysis of the admission and registration requirements	83%

	(such as average, University branch) provided by the system is essential.	
5.	I think that the system is easy to use.	90%
6.	I like the system`s design, colors, and icons.	85%
7.	I believe I can trust the results provided from the system.	77%
8.	I advise others to use this system.	86%
9.	If you have any comments or suggestions, please write them below.	The most important suggestions from the students: • Add intelligence tests. • Add in-depth questions in some areas.

The previous table shows the types of questions that the system asks the user in the evaluation process. It includes general questions, closed questions, and an open question for the student to suggest any additions he/she feels are useful. The analyses of the results shows that 85% of high school students believe that the system is useful to them in choosing their university program. Moreover, 81% of them are satisfied with the results of their personality analysis. In addition, 76% of these students believe that the market needs analysis pages provided by the system are necessary in the process of choosing their university major. Furthermore, 90% of the students liked the designs and colors of the system. Finely, 86% of the students advise others to use the current expert system. These percentages are shown in Figure 28.

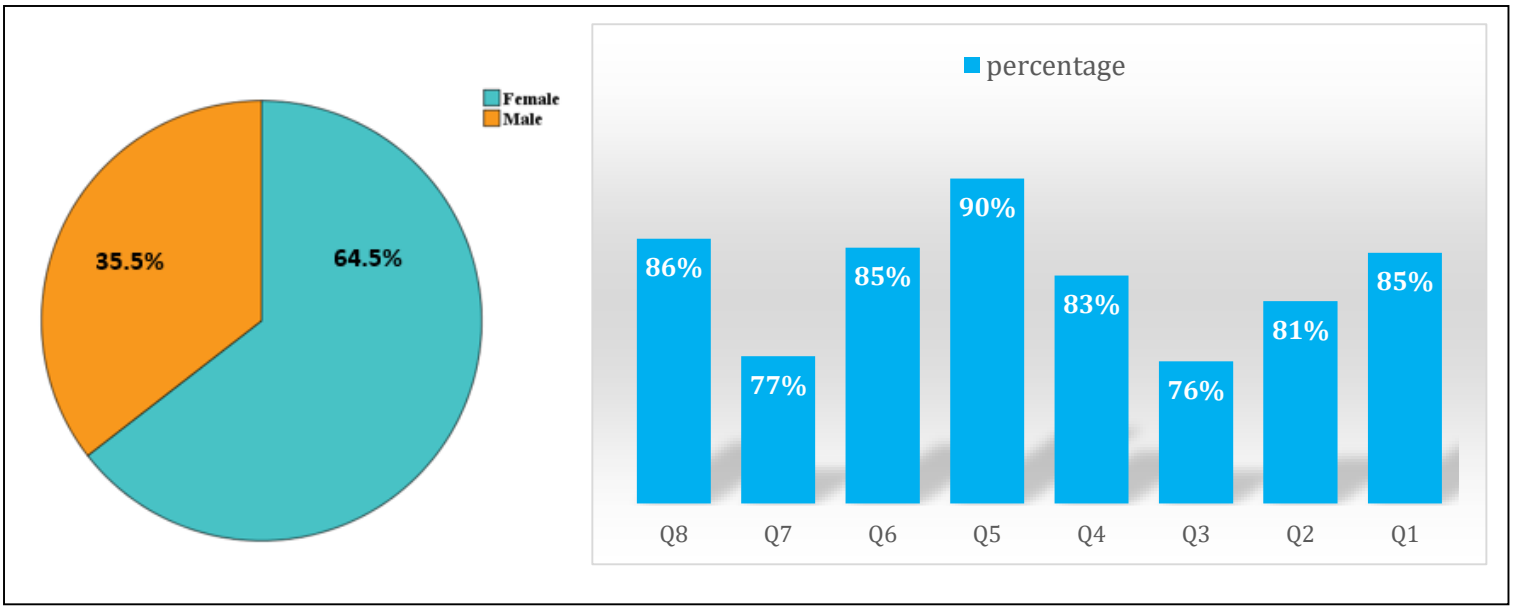


Figure 28. Percentages of test sample answers to system evaluation questions.

We note that the previous percentages are all high and is an indication of the users' satisfaction with the current expert system. Thus, the success of this system in achieving the goal aiming at helping high school students choose the appropriate university program.

5.5 Summary

In this chapter, the methodology used in developing the current expert system is explained. This methodology has been followed as proven in previous studies that are effective in developing expert systems. In addition, in this chapter, we discussed the components of the current expert system, which are composed of two development methods: rule-based expert system, and machine learning. Furthermore, this chapter clarified the viewpoint of a sample of high school students in their use of the current expert system. The results showed that 85% of high school students who used the system find it useful in choosing their university major. In the next chapter, future work and recommendations for this research will be discussed.

6 Chapter Six: Conclusion and Future Work

6.1 Introduction

In the previous chapter, we discussed how to develop present expert system and the extent to which high school students are willing to use it when choosing their university major. The results showed that 85% of the system users expressed their satisfaction with the expert system.

It is a common thing that, many versions of electronic systems are released every once and awhile. The present research is the first version of the current expert system. In this chapter, the conclusions for this research can be explained. In addition, research results and future directions for the upcoming issues will be discussed.

6.2 Conclusions

In the previous chapters, the problem that the current thesis addresses were discussed, as the problem was the difficulties that high school students face when choosing their university program. Since there are many factors affecting their selection process, including social, psychological, economic and other factors. Therefore, the main objective of this study was to work on developing an expert system that would assist these students in choosing the appropriate university major for them. This system was built on scientific foundations, it began by studying the most important factors that students see as affecting their choice of majors. These factors were: the abilities and inclinations of students, the Palestinian labour market demand, the requirements for admission and registration at HU.

This expert system has been developed taking into account all these factors where the expert system analyzes the student's personality based on Holland's model. In addition, to analyzing the student's high school branch and GPA in order to suggest the most appropriate university programs suitable for his personality. Moreover, the current

expert system provides a full explanation about the market needs of all university programs, and suggests some of the job opportunities that the student can work in after graduating.

The current expert system is characterized as a combined system of two development methods:

Rules-based expert system: Holland's model and all decision tables have been converted into a set of IF-THEN statements. It is true that the accuracy of this method of development is very high, but the expert system here cannot learn, in the sense that it is stable.

The expert system based on the machine learning model: In this part, the DTC algorithm is used, which is one of the most famous supervised machine learning algorithms. It predicts the best disciplines that suit the students' personalities by analyzing the dataset that was generated. The results show that there is a great convergence in the results shown by the machine-learning model and the rule-based expert system where the accuracy of the machine-learning model was 98%. In addition, this part of the system makes it a dynamic, learnable expert system so that, in the future, when there are thousands of responses from the students, the training feature will be easily added to the system. Meaning that when there are new cases that are similar to the old ones, the system will take advantage of the old cases in presenting the results without the need to perform processing operations.

The testing process for the expert system was carried out by taking a random sample of high school students wishing to register in one of Hebron University's university programs, to evaluate the system. The results showed that 85% of these students find the current expert system useful, and it helps them in choosing their university major.

This means there is a great demand by high school students to use the current system to direct them, accordingly, it is necessary to work continuously in updating the system data.

The current expert system has a great benefit to high school students by helping them to choose their appropriate major and the area in which they can innovate. Thus, it contributes to the formation of their promising future and helps universities by:

- Guiding high school students.
- Obtaining statistics and indicators that support and assist in the process of selecting the university major.
- Reducing unemployment in some majors.
- Finding specialists in fields within scientific studies and according to the market's needs.

Moreover, the current system will contribute to increasing the quality of education, in which with the right choice being present, the number of students transferred or leaving for a particular major will be reduced. Furthermore, this system is important to the community and its institutions since it helps to place the right person in the right place, the matter that would elevate the institution's name and status. Quite frankly, we need to put the right person in the right place to reduce and avoid errors in all areas.

6.3 Research Results

The current study results were divided into two parts. The first section is about the results of the study related to the student's views on the factors affecting the choice of university major, and their opinion about the development of the current expert system. While the second section relates to the development and testing of the expert system and analysing market demand. The results were as follows:

1. From the viewpoint of the HU students, the process of choosing their university major is highly influenced by the needs of the Palestinian market (70%). Moreover, it is moderately affected by both admission and registration requirements (52) and social conditions (50%).
2. From the viewpoint of HU students, they greatly support (78%) the idea of the thesis and wanted to develop an expert system that would help high school students in choosing the appropriate university major for them.
3. From the viewpoint of high school students wishing to enrol at HU, the system is highly beneficial to them (85%) and helped them choose their university major.
4. In measuring the accuracy of machine learning algorithms, it was found that the accuracy of the DTC learning algorithm is 98%. In contrast, the accuracy of the SVM algorithm was 78%. Therefore, the DTC algorithm was chosen to develop the machine learning model in the current expert system.
5. The results of the Palestinian market analysis showed the following:
    - The highest unemployment rates in Palestine were among graduates of journalism and media. Where the unemployment rate for males was 60% and for females 86%.
    - The lowest unemployment rates in Palestine among males were among law graduates (28%). The lowest unemployment rates in Palestine among females were among graduates of the Personal Services major (37%).
    - The highest unemployment rates in the West Bank were among graduates of the majors of Teacher training and education sciences (57%).
    - The lowest unemployment rates in the West Bank were among graduates of personal services majors (16.3%).

- The highest wage majors in Palestine are natural sciences, mathematics and statistics, and law. The average monthly wage in NIS was 3133, 3084, and 2,943, respectively

6.4 Recommendations

Based on the previous analysis and results, the researcher proposes several recommendations that she considers necessary and will be worthy in helping high school students choose their university programs. These recommendations can be summarized as follow:

- It is recommended that the system be adopted mainly for all students wishing to enrol in HU since it is based on scientific grounds.
- It is recommended to abandon random methods in the selection of university major because of its negative effects and referring to the employment rates that will be provided by the system.
- It is also recommended that the system be adopted by the competent authorities in Palestine, and be included in the websites of universities as it would mark a difference in contrary to what is available from the traditional methods compared to the expert systems used globally.
- It is also recommended to update the system frequently because market data is continuously changing. The researcher also recommends the necessity of providing data on all sectors related to the Palestinian market through the cooperation of the various institutions that own these data in order to obtain accurate results that are considered an influential indicator of the student's post graduation life.

- It is also recommended to develop awareness and training university programs on expert systems due to the importance of using them in various educational institutions for their effective role in the decision-making process.
- It is also recommended to update the study plan of Information Technology and Management System master university program due to the necessity of having a course regarding machine learning and the use of Python language in developing more expert systems in different fields.

6.5 Future Work

This is the initial version of the current expert system because, in the future, many features and characteristics of the system will be added, including:

- Developing a mobile application. The students can download the application on their smartphone, thus, accessing the system would be easier.
- Developing the system to include all colleges and majors in all of the Palestinian universities.
- Adding a set of other tests to the expert system such as Intelligence Quotient (IQ) tests. In addition, the expert system will be developed to analyze more factors that influence the process of selecting students for their university program. These factors include physical and financial abilities, geographical distance from the university, and others.
- Adding the feature of learning from old cases to the machine learning system. This is after obtaining thousands of responses from high school students so that the system can learn from these cases.

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8 Appendices

Appendix 2.1: Terminology and theories

- Student’s abilities and Motivation:

Two basic characteristics that distinguish a student's personality and they are abilities and motivation. As the abilities refer to the physical, mental and psychological energy, qualifications, and capabilities available to the student which are commensurate with the major. In addition, abilities are the work that is distinctly performed by the student compared to his/her peers. While motivation can be defined as the desire, tendencies, and willingness to learn and continue in it which enables the student to benefit from his abilities and capabilities in excellence and achievement (Faloh, 2018). Knowing their abilities and motivation, students will be able to determine their university program after high school, and they will have the opportunity to build their development plan (Maysa & Maysa, 2014**).**

- University program:

"The scientific orientations are chosen by the students at the undergraduate level and determines the course of their scientific and practical life. This choice must be consistent with their abilities and talents, and should not be the result of pressure from any party" (Sa’da, 2016).

- Knowledge

Knowledge may be innovative, about which we do not know anything before, or it may be new knowledge adding something new that extends or modifies the previous knowledge. Knowledge is actionable information that allows for better and more timely decisions. Nowadays, the one who knows possesses the power.

Knowledge is the full use of information and data with the possibility of merging with the skills, ideas, intuition, and motives inherent in the individual, thus, knowledge is necessary for the continuation of the organization as it provides the ability to respond to new situations and creativity. Knowledge is information that can be used to reach useful results, meaning that it is the effective and optimal use of information (Abuali et al., 2010; Qandilji, 2006). Sources of knowledge acquisition can be classified into two sources:

- External sources: It includes explicit knowledge, and external sources of knowledge are varied. It may include books, magazines, scientific papers, and materials published on the World Wide Web, newspapers, television, etc.
- Internal Sources: It includes the tacit knowledge of the individual. Such as the internal processes of individuals through intelligence, reason, experience, and skill, or learning by doing or research, and others (Abuali et al., 2010).

- Expertise

Cognitive accumulation and advanced thinking are based on a person's values and commitment. It is looking forward and thinking based on one's values and commitment (Qandilji, 2006).

- Decision Support System:

Computer applications enable decision-makers to use information and models and solve unconventional and unusual problems. The concept of Decision Support Systems (DSS) that emerged in the early 1970s was designed to develop and expand the potential of decision-makers. DSS is considered as one of the expert systems since it consists of databases and logical models that interact with each other through the computer. Also, these systems consist of interfaces that are linked with the users and enable them to deal

with other systems through it. DSS is any tool that is activated to enhance decision-making in complex systems, and it is often used when information is inconclusive or partial. These systems aim at assisting middle-level and senior managers in issuing complex decisions. Recently, there is a growing interest in machine learning and its role in educational systems, and this opens up a new field for research. Machine learning practices can make a significant contribution by providing support for users to choose the appropriate field of education to shape their careers (Mundra et al., 2014; Fakeeh, 2015;).

- Knowledge-Based Systems

One of the techniques of artificial intelligence research in which human knowledge and experience are expressed to perform the tasks performed by human experts. These systems have two basic and distinct components: the knowledge base and the inference engine. the first part stores facts about a specific topic. The second part allows the knowledge to be deduced. It can take the form of IF-THEN rules along with forward or backward chaining approaches which are the two main inference methods used in the inference engine. (Ahmed et al., 2019; Kapoor & Bahl, 2016).

- Knowledge Elicitation (KE)

Knowledge Elicitation is the process in which all information and facts related to a specific field are extracted from relevant human experts (Albakri et al., 2017).

- Neural Network:

Gurney defines a neural network, as "A neural network is an interconnected assembly of simple processing elements, units or nodes whose functionality is loosely based on the animal neuron. The processing ability of the network is stored in the inter

unit connection strengths, or weights obtained by a process of adaptation to, or learning from a set of training patterns." (Gurney, 2004).

Appendix 3.1: The questionnaire about Factors Affecting Choiring University Major

In the name of Allah, the All-Merciful, the Bestower of mercy

Hebron University

College of Graduate Studies / majoring in Information Technology and Management Systems

Dear student,

Peace be upon you and the mercy of Allah and His blessings:

The researcher conducts a study entitled:

Developing a Novel Expert System to Assist High School Students in Selecting their Appropriate University program: A Case Study of Hebron University

Kindly answer the paragraphs of the questionnaire honestly and objectively bearing in mind that the information received will be treated with complete confidentiality and will only be used for the purposes of this scientific research.

Thank you for your cooperation ... and accept the respect.

Researcher: Aseel Al-Najjar

Supervisions: Dr. Nabil Hassasna

Prof. Mario Macedo

Part one: general information:

1. Gender:
   - Male
   - Female
2. The area of residence:
   - City
   - Village
   - Camp
3. The college:
   - Islamic studies college
   - Medicine
   - Arts
   - Science & Technology
   - Agriculture
   - Education

   Law & Political Science

   Finance & Management

   Nursing

   Pharmacy & Medical Science

   Information Technology

   Professions and Applied Sciences
4. University program: ……
5. academic year:

- First
- The second
- The third
- Fourth.
- The fifth

Part Two: Deciding on the student's university major

Below is a set of paragraphs related to the dimensions affecting your choice of university major, please place a (✓) sign in the place that matches your opinion.

Numb	Dimensions and clauses for making a decision on the student's university major	Very few	few	Medium	Large	Very
	The social dimension					
1.	I was influenced by my father's opinion in choosing my college major					
2.	I chose my college major influenced by friends' opinions.					
3.	I chose my college major according to the opinion of relatives.					
4.	In my pursue of choosing my university program, I relied on the consultations of specialists and faculty professors.					

5.	I feel that I chose my university major according to my desire and abilities, and without consulting anyone.					
6.	I think that my college major was in my mind before the high school results came out.					
7.	I think that my family's economic condition took part and helped me in choosing my university major.					
8.	I chose my college major based on the father/mother career.					
9.	I chose my university major because I aspire to have a specific job.					
10.	I chose my college major to manage the profession of my family (as a business).					
	The labor market dimension					
11.	I see that the market needs to guide the students to choose their university major.					
12.	I feel that employment opportunities after graduation determine the type of university major.					
13.	Job's financial income contributes to choosing a university major.					
14.	I see that the social position of the major that I chose influenced my university major.					

15.	I feel that the specialist job I've chosen is comfortable and not difficult.					
16.	I think that providing data from the labor market about different jobs affects the choice of university program.					
17.	I feel that I have chosen a major that qualifies me to work in more than one job.					
18.	I believe that I chose the major that allows me to combine two jobs with two shifts (morning and evening).					
19.	I see that I chose my specialty because I believe that it contributes to the development of my community.					
20.	I think that I chose a major that qualifies me to work in a specific sector (such as the government sector, the private sector ...)					
	The university dimension					
21.	The admission requirements (such as the GPA and the branch of high school) in universities affected my choice of university major.					
22.	The promotion of university programs has affected my college major.					
23.	The advisory services provided by the university have affected my university major.					

24.	The availability of qualified professors at the university contributed to choosing my university major.					
25.	The modern technological tools provided by the university have influenced my university major.					
26.	The difficulty level of the majors influenced my college major.					
27.	Providing networking opportunities (student exchange, practical training ...) between the university and other institutions influenced the choice of my university major.					
28.	The variation in registration fees for university majors affected the choice.					
29.	I think that the length of study (academic years) affected the choice of university major.					
30.	I think that the novelty/the modernity of the major influenced my choice of my university major.					

Part three: Expert Systems

An expert system is an application of artificial intelligence, which simulates human experts, by collecting and using information from one or more experts in a specific field. These systems are characterized by the ability to make decisions.

The following is a set of paragraphs related to expert systems that help the student choose his university major, please place a sign (✓) in the place that matches your opinion.

Numb	The dimension of expert systems	Very few	few	Medium	large	Very
31.	I think that if an expert system is available that analyses the admission requirements at the university will assist the student in choosing his university major.					
32.	I feel that if an expert system is available that provides statistics and predicts the jobs that will be in demand in the market in the future will assist the student in choosing his university major.					
33.	I believe that if an expert system is available that analyses the student's personality (his desires and abilities) will help him choosing his university major.					
34.	I think that personality analysis tests (desires and abilities) have a role in choosing the appropriate university major.					
35.	Providing expert systems will be more useful to me than traditional methods (such as family and					

	friends opinions, professional advice ...) in a student's choice of his university major.					
36.	I can trust the results provided by expert systems when choosing a university major.					
37.	If expert systems are available, it reduces my need to visit the university to inquire about the available majors.					
38.	Electronic systems supported by various multimedia elements (such as videos, pictures, graphics, texts ...) contribute to drawing the student's attention when choosing his university major.					
39.	I think that the ease of using expert systems will encourage the student to use it when choosing his university major.					
40.	I believe that the easy access to the online expert system will encourage the student to use it when choosing his university major.					
41.	I believe that providing security and maintaining the privacy of information in the expert system will increase the student's confidence in using the system when choosing to pursue his university major.					

42.	I believe that the speed of the expert data analysis system will encourage the student to use it when choosing his undergraduate major.					
43.	I believe that the availability of graphs in the expert system will encourage the student to use it when choosing his undergraduate major.					
44.	I believe that if expert systems are available that help the student choose his major reduces stress that negatively affects the student.					
45.	I believe that the expert systems contribute to saving effort when choosing a university major.					
46.	I feel that if the student uses expert systems when choosing his university major will limit the influence of those around him.					
47.	I believe that the availability of an expert system that informs the student of details about the university programs that suit him (such as study plans, credit hours ...) will affect the choice of his university major.					
48.	I believe that the expert system that explains to the student details about future jobs (such as salaries, qualifications ...) will help the student choose his university major.					

49.	I believe that the presence of the expert system by assigning a page for it on the university's website will facilitate the student's access to the system when choosing his university major.					

Thanks

Appendix 3.2: Questionnaire arbitration letter

Doctor: .....

Workplace: .....

Subject: Arbitration Questionnaire

Dear Sir,

I offer you my warmest congratulations and I wish you good health and continued wellness, and may God preserve you as a beacon for knowledge and of its people.

I request you to kindly review the questionnaire, which is the main tool in the study of:

Developing a Novel Expert System to Assist High School Students in Selecting their Appropriate University program: A Case Study of Hebron University.

This is a complement to the requirements for obtaining the master's degree in the information technology and management systems university program and the joint systems department between Hebron University and the Portuguese University of Atlantic.

I ask you to provide me with directions and instructions to amend, delete, add, and clarify what you think is appropriate and to clarify the suitability of the paragraphs to

their dimensions, and to judge them in terms of the integrity of the phrasing and the length or shortness of the paragraphs to be a good tool and measure what I have put.

With all due respect and appreciation

Researcher: Aseel Al-Najjar

Appendix 3.3: The names of the questionnaire arbitrators

Numb	The name of the arbitrator	Workplace
1.	Prof. Mohamed Shaheen	Al-Quds Open University
2.	Dr. Nabil Al-Jundi	Hebron University
3.	Dr. Abdullah Al-Najjar	UNRWA
4.	Dr. Ishaq Al-Jabari	Hebron University

Appendix 5.1: Colleges and University programs at Hebron University

Table 33. Colleges and University programs at Hebron University.

Source: (Hebron University - Colleges, 2018)

College	University programs
Islamic studies	• Fundamentals of Islamic Religion. • Sharia and Jurisprudence.
Medicine	• Human Medicine
Arts	• Arabic Language and literature • English Language and literature • English Language & literature-Translation

	• English Major- Minor French • History • History-Minor Geography • History-Minor Archaeology • Media • Applied Geography • Tourism and Antiquities
Science & Technology	• Mathematics • Mathematics- Computer University programming • Major Mathematics- Minor Finance & Accounting • Chemistry • Chemistry- Industrial Chemistry • Major Chemistry- Minor Nutrition & Food Processing • Biology • Biology- Medical Laboratory Science • Biology- Public Health • Environmental Sciences & Technology
Agriculture	• Plant Production & Protection • Animal Production & Protection • Soil & Irrigation

	• Nutrition & Food Technology • Agricultural Economics & Extension

Education	• Psychology
	• Foundation of Education
	  ○ Upper Basic Level Teacher - Teaching Islamic Education
	  ○ Upper Basic Level Teacher - Teaching the Arabic Language
	  ○ Upper Basic Level Teacher - Teaching the English Language
	  ○ Upper Basic Level Teacher - Teaching Social Sciences
	  ○ Upper Basic Level Teacher - Teaching Mathematics
	  ○ Upper Basic Level Teacher - Teaching Science
	  ○ Upper Basic Level Teacher - Teaching Technology
	  ○ Lower Basic Level Teacher

Law & Political Science	• Public Law • Private Law • Jurisprudence & Law

	• Political Science
Finance & Management	• Business Administration • Finance and Accounting • Public Administration • Marketing
Nursing	• Nursing Science • Midwifery
Pharmacy & Medical Science	• Pharmacy • Medical Science • Medical Physics
Information Technology	• Computer Science • Computer Science- Virtual Reality • Computer Science- Mobile University programming • Major Computer Science- Minor Business Administration • Multimedia & Web Technology • Computer Networks Security & Safety
Professions and Applied Sciences ((Two years university program)	• Mobile Phone Technology • Physical Training • Protected Agriculture and Nurseries • Animal Husbandry

	• Hebrew Language • Audio Engineering • Electrical Installations Engineering • Building Maintenance and Restoration • Digital Design and Production • Office Automation and Administration • Nursery and Kindergarten • Industrial Chemistry

Appendix 5.2: Admission and Enrollment Criteria in Hebron University

Table 34. Admission and Enrollment Criteria in Hebron University.

Branch / College	Scientific	Humanities	Commercial	Occupational	Agricultural
Islamic studies	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%
Medicine	Accepted with an average score above 90%	Not Accepted	Not Accepted	Not Accepted	Not Accepted
Arts	Accepted with an average score above 65%	Accepted with an average score above 65%	Not Accepted	Accepted with an average score above 65%	Accepted with an average score above 65%

Science & Technology	Accepted with an average score above 65%	Not Accepted	Not Accepted	Accepted with an average score above 65%	Accepted with an average score above 65%
Agriculture	Accepted with an average score above 65%	Not Accepted	Not Accepted	Not Accepted	Accepted with an average score above 65%
Education	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%
Law & Political Science	Accepted with an average score above 75%	Accepted with an average score above 75%	Not Accepted	Accepted with an average score above 75%	Accepted with an average score above 75%
Finance & Management	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%	Accepted with an average score above 65%

Nursing	• **Nursing**: Accepted with an average score above 80% • **Midwifery**: Accepted with an average score above 75% (female only)	Not Accepted	Not Accepted	Not Accepted	Not Accepted

Pharmacy & Medical Science	• **Pharmacy**: Accepted with an average score above 85% • **Medical Laboratory Sciences:** Accepted with an average score above 80% • **Medical Physics** : Accepted with an average	Not Accepted	Not Accepted	Not Accepted	Not Accepted

	score above 65%.				
Information Technology	Accepted with an average score above 65%	• **Multimedia and Web Technology (MMWT):** Accepted with an average score above 65%	Not Accepted	Accepted with an average score above 65%	Accepted with an average score above 65%

Professions and Applied Sciences ((Two years university program)	Accepted in all college majors with average scores above 50%	Accepted in this majors with average scores above 50%. • Physical Training • Hebrew Language • sound engineering • Digital design and production • Office Automation and Administration • Industrial chemistry	Accepted in this majors with average scores above 50%. • Physical Training • Hebrew Language • sound engineering • Digital design and production • Office Automation and Administration • Industrial chemistry	Accepted in all college majors with average scores above 50%	Accepted in this majors with average scores above 50%. • Protected agriculture and nurseries • Animal Production • Physical Training • Hebrew Language • sound engineering • Digital design and production

		• Nursery and Kindergarten (female only)	• Nursery and Kindergarten (female only)		• Office Automation and Administration • Industrial chemistry • Nursery and Kindergarten (female only)

Appendix 5.3: The Questions Selected for the Expert System to Analyze the Students' Personality.

Table 35. The Expert System Qustions.

No	Question in English	Question in Arabic	1	2	3	4	5
	R						
1.	I love building and repairing hardware.	أحب تركيب واصلاح الأجهزة.					
2.	I prefer working outdoors than working inside the office	أفضل العمل في الهواء الطلق على العمل داخل المكاتب					
3.	I enjoy making wooden crafts such as wooden toys, and furniture.	أستمتع بعمل مصنوعات خشبية مثل الأثاث الألعاب الخشبية.					
4.	I enjoy working in fields that require physical effort.	استمتع بالعمل في المجالات التي تتطلب بذل جهد بدني.					
5.	I like to work on solving mechanical problems such as the maintenance of refrigeration devices.	أحب العمل على حل المشكلات الميكانيكية مثل: صيانة أجهزة التبريد.					
6.	I like practising sports.	أحب ممارسة الألعاب الرياضية.					
7.	I enjoy the natural scenery.	أستمتع بالمناظر الطبيعية.					
8.	I enjoy learning how different tools work.	أستمتع بتعلم كيفية عمل الأدوات المختلفة.					

9.	I avoid situations in which I have to deal with others	أتجنب المواقف التي لها علاقة بالتعامل مع الآخرين.					
10.	I enjoy planting and taking care of the home garden.	أستمتع بزراعة النباتات والعناية بحديقة المنزل.					
I							
11.	I love biology.	أحب علم الأحياء.					
12.	I love chemistry.	أحب علم الكيمياء.					
13.	I love physics.	أحب علم الفيزياء.					
14.	I enjoy taking care of animals.	أستمتع برعاية الحيوانات.					
15.	I enjoy collecting, analyzing, and interpreting data.	أستمتع بجمع البيانات وتحليلها وتفسيرها.					
16.	I like figuring out how to solve problems	أحب التفكير العميق للتوصل إلى حلول للمشكلات					
17.	I enjoy working in a job that requires new thinking styles.	أستمتع بالعمل الذي يتطلب أساليب تفكير جديدة.					
18.	I love the work that allows me to perform calculations	أحب العمل الذي يتيح لي إجراء العمليات الحسابية					
19.	I like working in a laboratory or research and studies center	أحب العمل في مختبر أو مركز أبحاث ودراسات					

20.	I enjoy studying and discovering antiquities.	أستمتع بدراسة و اكتشاف الآثار.					
S							
21.	I like to give people religious lessons such as belief in God and faith (preacher).	أحب أن أعطي الناس دروس دينية مثل: الايمان بالله والعقيدة (داعية).					
22.	I am an excellent communicator and have excellent communication skills.	أتميز بمهارات الاتصال والتواصل مع الآخرين.					
23.	I love the work that is directly related to the audience.	أحب العمل الذي له علاقة مباشرة بالجمهور.					
24.	I like to participate in volunteer work.	أحب المشاركة في الأعمال التطوعية.					
25.	I love to work as a doctor in treating patients.	أحب عمل الطبيب في علاج المرضى.					
26.	I like to help my colleagues solve their problems.	أحب مساعدة زملائي في حل مشكلاتهم.					
27.	I love to work in a team.	أحب العمل ضمن فريق.					
28.	I have the skill of training and teaching others.	أمتلك مهارة تدريب وتعليم الآخرين.					
29.	I enjoy taking care over others.	أستمتع برعاية الاخرين.					

30.	I love work related to improving social conditions.	أحب العمل الذي له علاقة بتحسين الأوضاع الاجتماعية.					
C							
31.	I like the work that requires dealing with numbers.	أحب العمل الذي يتطلب التعامل مع الأرقام.					
32.	I prefer to complete projects meticulously.	أفضل انجاز المشاريع بدقة.					
33.	I prefer the work in which I know what is expected from me to do.	أفضل العمل الذي أكون فيه على دراية بالمتوقع مني إنجازه.					
34.	I prefer having clear and defined systems and guidelines to work according.	أفضل وجود أنظمة وإرشادات محددة وواضحة للعمل بها.					
35.	I love paying attention to fine details.	أحب الاهتمام بالتفاصيل الدقيقة.					
36.	I like organizing my workplace before starting the work itself.	أحب تنظيم مكان العمل قبل البدء في العمل نفسه.					
37.	I like working inside an office.	أحب العمل في مكتب.					
38.	I love working in the field of buying and selling homes and properties.	أحب العمل في ببيع وشراء البيوت والأملاك.					

39.	I like defending people in court (lawyer work).	أحب أن أدافع عن الأشخاص في المحكمة (عمل المحامي).					
40.	I like to work as a TV director and set up TV university programs.	أحب عمل مخرج التلفزيون واعداد البرامج التلفزيونية.					
		E					
41.	I enjoy being the leader of teams.	استمتع بترؤس فرق العمل.					
42.	I can persuade others of my opinions.	أتمتع بالقدرة على اقناع الاخرين بآرائي.					
43.	I feel I am of high confident.	أشعر بثقة كبيرة بذاتي.					
44.	I prefer working in a private business.	أفضل العمل بمشروع تجاري خاص.					
45.	I love to work as a bank auditor.	أحب العمل كمدقق حسابات في البنك.					
46.	I prefer taking responsibility for activities and events.	أفضل تحمل مسؤولية الأنشطة والفعاليات.					
47.	I prefer working on preparing the employees' salaries at the end of the month.	أفضل العمل على تجهيز رواتب الموظفين في نهاية الشهر.					
48.	I enjoy directing others in their work or activities.	أستمتع بتوجيه الأخرين في أعمالهم أو نشاطاتهم.					

49.	I prefer the work that gives me to provide specific ideas or opinions.	أفضل العمل الذي يتيح لي تقديم أفكار أو آراء معينة.					
50.	I like the tasks that allow me to plan and organize the work of others.	أفضل المهام التي تتيح لي التخطيط والتنظيم لعمل الاخرين.					
A							
51.	I enjoy playing an instrument.	استمتع بالعزف على آلة موسيقية.					
52.	I love writing stories and articles.	أحب كتابة القصص والمقالات.					
53.	I love fashion design and decoration.	أحب تصميم الأزياء والديكور.					
54.	I like to write literature like literary books and plays	أحب تأليف الأدب مثل الكتب الأدبية والمسرحيات					
55.	I love writing poetry.	أحب كتابة الشعر.					
56.	I enjoy working in crafts.	أستمتع بالعمل في الحرف اليدوية.					
57.	I love working as an advertising designer.	أحب العمل كمصمم إعلانات.					
58.	I love singing.	أحب الغناء.					
59.	I enjoy drawing and coloring.	أستمتع بالرسم والتلوين.					
60.	I love theatrical acting	أحب التمثيل المسرحي					

Appendix 5.4: The Questionnaire to Analyze the Market Demand

In the name of Allah the Merciful

Hebron University

College of Graduate Studies / majoring in Information Technology and Management Systems

Dear student,

Peace be upon you and God's mercy and blessings are upon you:

The researcher conducts a study entitled:

Developing a Novel Expert System to Assist High School Students in Selecting their Appropriate University program: A Case Study of Hebron University

Kindly answer the paragraphs of the questionnaire honestly and objectively bearing in mind that the information received will be treated with complete confidentiality and will only be used for scientific research.

Thank you for your cooperation... and accept the respect.

Researcher: Aseel Al-Najjar

Supervisions: Dr. Nabil Hassasna

Prof. Mario Macedo

Part one: general information:

1. Gender:
   - □ Male
   - □ Female
2. The area of residence:
   - □ City
   - □ Village
   - □ Camp
3. Qualification:
   - □ Diploma
   - □ BA
   - □ Higher Diploma
   - □ M.A.
   - □ PhD
4. Graduation Year:…….
5. The university you graduated from:
   - □ Hebron University
   - □ Al-Azhar University of Gaza
   - □ Al-Najah University
   - □ Al-Quds University
   - □ Al-Quds Open University
   - □ Arab American University - Palestine (AAUP)
   - □ Behtlehem Bible College
   - □ Bethlehem University
   - □ Birzeit University
   - □ Ibrahim College
   - □ Islamic University
   - □ Palestine Polytechnic University - PPU
   - □ Gaza University

- Palestine Technical University Kadoorei

If your previous answer was not Hebron University

6 . Field of study

- Business and administration
- Teacher training and education sciences
- Health
- Social and behavioral sciences
- Humanities
- Engineering and engineering trades
- Computing
- Architecture and construction
- Law
- Journalism and information
- Life sciences
- Mathematics and statistics
- Personal services
- Other disciplines

If your previous answer was Hebron University

6. The college:
   - Islamic studies college
   - Medicine
   - Arts
   - Science & Technology
   - Agriculture
   - Education
   - Law & Political Science
   - Finance & Management
   - Nursing
   - Pharmacy & Medical Science
   - Information Technology
   - Professions and Applied Sciences
7. University program:

   ……

Part two: About the job:

1. Are you currently working?

   - Yes
   - No

If your answer is yes:

2. Are you working in your field of study?
   - Yes
   - No
3. Works for the sector:
   - Government
   - The private
   - Your project
4. The name of the company/institution in which you work:……
5. Job title:……..

If your answer is No:

2. Have you worked before?
   - Yes
   - No
3. Have you worked in your field of study?
   - Yes
   - No

If your answer is yes:

4. I worked for the sector:
   - Government
   - The private
   - Your project
5. Name of the company/organization

If your answer is No:

4. Did you search for a job during the previous years?
   - Yes
   - No
5. Have you searched for a job during the past two weeks?
   - Yes
   - No
6. The reason for not working previously (you

6. Monthly Salary:
   - □ Less than 1,000 shekels.
   - □ 1000-1500 shekels
   - □ 1500-2000 shekels
   - □ 2000-2500 shekels
   - □ 2500-3000 NIS
   - □ 3000-5000 NIS
   - □ More than 5,000 shekels

you worked for:…… .....

6.Job title:…….....

7. Salary for your previous occupation (per month):
   - □ Less than 1,000 shekels.
   - □ 1000-1500 shekels
   - □ 1500-2000 shekels
   - □ 2000-2500 shekels
   - □ 2500-3000 NIS
   - □ 3000-5000 NIS
   - □ More than 5,000 shekels

can choose more than one answer):
- □ The salary is not suitable.
- □ There is no vacancy available.
- □ I don't want to work.
- □ My preoccupation with higher studies.
- □ I could not find a job that fits my ambition.
- □ I could not find the right job for my major.
- □ Travel.

8.Have you searched for a job during the past two weeks?

- Yes
- No

- Other.

Thank you