Towards Fostering Interoperability Between Information Systems of Higher Education Institutions in Palestinian Universities

نحو تعزيز التبادل بين نظم المعلومات لمؤسسات التعليم العالي في الجامعات الفلسطينية

by

Isra' Shawar

Supervisor:

Dr. Mohannad Omar Jabari

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master in Information Technology

Hebron University

May, 2024

"وَلَسَوْفَ يُعْطِيكَ رَبُّكَ فَتَرْضَى"[1]

الضحى – آية "5"

---

[1] القرآن الكريم، سورة الضحى، الآية رقم.(5)

Dedication

To my parents, brothers, and sisters for their unlimited support

Isra

Acknowledgements

All admiration and glory are due to **ALLAH** for the entire support granted to me. This effort would not be reached without limitless guidance and support of Allah.

I would like to express my heartfelt gratitude and admiration to my direct supervisor **Dr. Mohanad Omar Jabari** for his steady help, guidance, and endless support. In addition, he has been endowing me with his constructive observations at every stage of this study.

Finally, I would like to thank my parents, my brothers, my sisters, and my friends, for their support and for tolerating the time I spent working on my study.

Towards Fostering Interoperability between Information Systems of Higher Education Institutions in Palestinian Universities

By

Isra Shawar

Supervisor:

Dr. Mohanad Omar Jabari

Abstract

This study aimed to propose and construct a suitable model for interoperability in joint programs among Palestinian Universities. Additionally, it aimed to identify the data exchanged between different systems in joint programs, evaluate proposed alternatives for establishing a common system, and review the main obstacles related to implementing the proposed models. The study adopted a mixed-method approach to develop an understanding of the reality of joint programs between Palestinian Universities, employing personal interviews and analyzing cooperation agreements between the universities. These methods yielded qualitative data utilized in formulating the proposed model and identifying the data exchanged between the joint programs. Furthermore, the study also applied a questionnaire to obtain quantitative data. The population for the questionnaire comprised deans of admission, directors of registration departments and the instructors involved in joint programs. The study employed a comprehensive survey method to explore the state of inter-University interoperability in joint programs. Based on the analysis of the study's tools, the data exchanged between partner Universities in joint programs were classified into three categories (similar, partially similar, and different). Results of the study indicated that Palestinian Universities primarily rely on traditional methods in data exchange, such as email and hard-copy record exchanges, with no established electronic system for inter-transmitting student data. The key finding of the study was the proposal of a digital model for inter-University operation between Palestinian Universities, relying on a centralized system for exchanging student data in joint programs. As for recommendations, the study emphasized the significance of Palestinian educational institutions agreement on a common protocol for data exchange under the auspices of the Palestinian Ministry of Higher Education and Scientific Research.

"نحو تعزيز التبادل بين نظم المعلومات لمؤسسات التعليم العالي في الجامعات الفلسطينية"

إسراء شاور

إشراف:

د. مهند عمر الجعبري

الملخص

هدفت هذه الدراسة إلى اقتراح وبناء أنموذج ملائم للتشغيل البيني في البرنامج المشتركة بين الجامعات الفلسطينية، بالإضافة إلى تحديد البيانات التي يتم تناقلها بين الأنظمة المختلفة في البرامج المشتركة، وتقييم البدائل المقترحة لإنشاء نظام مشترك، بالإضافة إلى استعراض أهم المعيقات المتعلقة بتطبيق النماذج المقترحة. اعتمدت الدراسة على المنهجية المختلطة لبناء تصور عن واقع البرامج المشتركة بين الجامعات الفلسطينية، وذلك باستخدام أدوات المقابلة الشخصية وتحليل اتفاقيات التعاون في الجامعات الفلسطينية والتي أفرزت مجموعة من البيانات النوعية التي تم الاستعانة بها في صياغة الأنموذج المقترح وتحديد البيانات التي يتم تناقلها بين البرامج المشتركة، بالإضافة إلى تصنيف هذه البيانات بناءً على مدى تشابهها بين الجامعات الشريكة، أيضاً اعتمدت الدراسة على أداة الاستبانة للحصول على بيانات كمية وقد مثل عمداء دوائر القبول والتسجيل والمدرسين في البرامج المشتركة مجتمع الدراسة لأداة الاستبانة، واتبعت الدراسة أسلوب المسح الشامل لاستكشاف واقع التشغيل البيني بين الجامعات في البرامج المشتركة. بناءً على تحليل نتائج أدوات الدراسة تم تصنيف البيانات التي يمكن تناقلها بين الجامعات الشريكة في البرامج المشتركة إلى ثلاث فئات (متشابهة، شبه-متشابهة، ومختلفة)، أشارت نتائج الدراسة إلى اعتماد الجامعات الفلسطينية بشكل رئيس على الأساليب التقليدية لتبادل البيانات باستخدام البريد الإلكتروني والتبادل

الورقي لسجلات وبيانات الطلاب وعدم وجود نظام إلكتروني معتمد لتناقل البيانات الطلابية فيما بينها. وأما أبرز نتائج الدراسة كانت اقتراح أنموذج رقمي للتشغيل البيني بين الجامعات الفلسطينية بالاعتماد على نظام مركزي لتبادل البيانات الطلابية في البرامج المشتركة في الجامعات الفلسطينية، فيما كانت أبرز التوصيات أهمية اتفاق المؤسسات التعليمية الفلسطينية على بروتوكول مشترك لتبادل البيانات فيما بينها، تحت مظلة وزارة التعليم العالي الفلسطينية.

Table of Contents

List of Tables

List of Figures

List of Abbreviations:

BEPCON	Building, Electrical and Plumbing Control
MS	Malaysian code
NGO	Non-Governmental Organization
PAPP	Program of Assistance to the Palestinian People
SOAP	Simple Object Access Protocol
ESR	Electronic Students Record
XML	Extensible Markup Language
HTML	Hyper Text Markup Language
JSON	JavaScript Object Notation
SOA	Service-Oriented Architecture

CHAPTER I. INTRODUCTION

1. Introduction

1.1 Background and Context

The world is witnessing a wide range of life-rapid development, which Man ever seeks to adhere and keep up with. Prosperity through information technology is one of the most important areas that have changed and facilitated many aspects of real-world life, especially in the management of institutions; e.g., education, government, health institutions, etc., as it helps in the process of changing such institutions' administration structure, functions, and facilitating methods of planning and implementing activities. Therefore, the institutions usually try their best to improve, develop and apply technology in managing their processes. (Jakimoski, 2016)

Nowadays, there is an increasing demand for linking departments of an institution as well as linking institutions for exchanging information; saving much efforts and time without physically moving to the other institution's campus to obtain such information. Technological development has facilitated the process of information exchange between information systems in various ways (Luna, Campos, & Otero, 2019). The simplest and most effective way is to use common information system between departments/institutions that need to exchange information, However, this solution is not feasible as departments/institutions still use information systems that are developed from various vendors and do not follow a common standard. (Ribeiro, Pereira, Pacheco, Bernardes, & ,Martins, 2016)

Another option is to make a mapping between information that has to be exchanged through information systems. (Castronova, Goodall, & Ercan, 2013). In this sense, the mapping process must consider the interoperability issue.

Interoperability is defined as the ability to communicate between information systems, to share and to exchange data/information on syntactic and semantic levels. (Subosa & West, 2018)

Syntactic interoperability refers to the ability of exchanging data/information between systems using common data formats and common communication protocols. XML language and SOAP messages are examples of common data formats and common protocols, respectively. (Zach & Peri, 2010)

Semantic interoperability, however, refers to the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results as defined by the end users of communicated systems. (Ngulube & Chinyemba, 2005)

1.1.1 Joint academic programs in Palestinian Universities

The Palestinian Ministry of Higher Education and Scientific Research is an official governmental institution responsible for higher education in Palestine. The number of higher education institutions in Palestine is 53 educational institutions divided into 21 public and private Universities, 15 University colleges and 17 intermediate colleges, which include 225,975 students. (MOHE, 2022)

By looking into postgraduate studies, Palestinian Universities work on supplying their own programs with a special name approved by a given university, depending on the presence of the competencies and full capabilities available, for example, the availability of the appropriate educational staff for this program (Arar, Abdallah & Shana'ah, 2021).

We may find a program being applied in one of the Palestinian Universities with a similar name in another University, whereby the program may include one topic under a different name for either University, as each University works to present its program under its own name that it decides, for example “Systems Design and Programming” and “Software Development and Applications”. (Arar & Riahi, 2021)

Thus, we find one program that includes one topic offered in two Palestinian Universities with a different name for each University. Furthermore, the rate of turnout and registration for this program is few and limited in one or both Universities. (Arar & Riahi, 2021)

Recently the Palestinian Universities have considered the adoption of programs in many Universities as joint programs; Universities cooperate in a proposal under the same name, so that universities cooperate utilizing heir scientific capabilities, teaching staff, and scientific competencies. Moreover, put the capabilities and expertise available in each University in the service of the other partner university to achieve the greatest benefit for students registered in these joint programs, and achieve a common benefit for the universities involved, taking into account their mutual respect for the specificity of each university's special programs. (Qeshta & Najim, 2020)

The existence of joint academic education programs between Palestinian Universities helps in exchanging scientific experiences and providing scientific cadres with a variety of experiences, as well as agreement between universities, thus, taking into account the privacy of each University and ensuring that programs and University specializations not repeated. (Shalabi, 2017)

In this study, work will be done to link Palestinian Universities that have joint academic programs through proposing of an interoperability system for linking data by electronic means. In order to facilitate information exchange between these universities, information is expected to be easily and smoothly inter-exchanged in any time without the need for face-to-face communication between the parties. This system will enable the universities involved to obtain information in the least time, effort, cost, with most accuracy. This also helps to solve all the problems of exchanging information within joint programs between Palestinian and international universities.

1.1.2 Information systems in Higher education institutions

Higher education is one of the main drivers for progress and development around the world through the provision of all public services and the provision of academic training and research. With the development of technology and computer systems, higher education institutions have increasingly sought for using information systems as a strategic tool that supports their management and business towards improving and increasing their efficiency and the use of information systems for the integration of their operations and make its structure clear, even more flexible and innovative. (Subosa & West, 2018)

Higher education information systems assume several functions of resource planning and campus management systems. They also represent a standard system based on several functions, designed to support higher education institutions in their administrative and service operations on a large scale. (Shalabi, 2017)

1.1.3 Interoperability among information systems in higher education institutions

The main goal of consolidation of information systems is the process of collecting information and obtaining it from a number of systems. Some supposed systems requesting this information as well as the focus on continuous communication and exchange of information between cooperative systems. Interoperability refers to the capability of various systems and organizations to collaborate and function cohesively. It encompasses the seamless exchange and utilization of information across disparate systems or domains, ensuring that these systems can effectively operate together despite variations in their underlying technologies, data formats, and communication protocols (OASIS, 2022).

1.2 Statement of the Problem:

Statistics from the Palestinian Ministry of Education indicate a steady increase in the number of joint programs at Palestinian universities since the inception of the first joint program in 2008. (MOHE, 2022)

As the number of joint programs has grown, several issues have emerged related to the differences in systems and regulations between partner universities, as well as the lack of interoperability between student record management systems. The incompatibility of systems among partner universities has led to various issues before, during, and after the transfer of student records; such as the need for redundant data entry in each system, errors that may occur during manual processes, delays in data transfer between partner universities, and other administrative and academic problems. (Bencheva, Zahariev, & Takruri-Rizk, 2017)

Joint education programs between Palestinian Universities are among the important present time issues, which must be developed to meet the needs of the Palestinian community and to develop better-qualified scientific cadres. These programs between more than one Palestinian University help to exchange experiences and make education better in terms of the exchange of teaching staff and scientific expertise, avoiding the offering similar specializations or programs in more than one university within the same region; as repeating the same program may result dispersal of scientific capabilities or insufficient benefit from a given educational program.

Palestinian Universities look for the development of joint educational programs with various higher education institution partners, being Palestinian or non-Palestinian universities, in or outside the country. The Palestinian universities also work out a unified plan and cooperation to provide a better educational program, with joint and diverse scientific experiences. The problem in this research lies in the process of communication and information exchange between joint Universities Whereby information is exchanged between Universities using joint systems and traditional methods, encountering difficulty of linking joint University programs with each other, as each University has a special system that differs from other Universities', in addition to the lack of an interoperability platform in Palestine between Palestinian Universities.

The information systems used in Palestinian Universities do not depend on specific standards as they were developed by different development companies. Therefore, these systems do not support eligibility to exchange information on semantic and syntactic levels: it seems that there is no electronic-based system or mechanism for information exchange between the Palestinian higher education institutions and the Palestinian Ministry of Higher Education. At the present time, universities have started adopting joint educational programs in addition to applying student exchange programs. Therefore, it has become necessary to exchange information between universities as well as to exchange information with the Ministry of Higher Education.

Here, problem of the study can be summarized as follows:

1. Each University has a special information system that differs from the other Universities'.
2. The difficulty of linking (exchanging information between joint programs that exist in Palestinian Universities) inter-University programs with each other.
3. The lack of an interoperability platform in Palestine between Palestinian Universities.
4. Information exchange between Universities traditionally takes place using papers-based records

1.3 Questions of the Study

The main question of the study will be answered through responding to the following sub-questions:

1. What information and data are exchanged between Universities having joint education programs? Is there a standard that defines this information?
2. What is the level of interoperability between Universities' information systems?
3. What is the ideal model for enhancing interoperability between information systems used across Palestinian Universities?
4. What are the obstacles and challenges that hinder the implementation of this framework at the interoperability level?

1.4 Objectives of the Study

The main objective of this study is to create an operating platform between Palestinian universities in order to exchange data. To achieve this goal, we need to achieve the following objectives:

1. Determining the information that must be exchanged between Palestinian Universities with joint education programs.
2. Assessing the level of interoperability between the Palestinian Universities' information systems.
3. Presenting the ideal model to enhance the interoperability between information systems used in higher education institutions and the joint programs between them.
4. Identifying the obstacles and challenges that hider the implementation of this framework at the interoperability level.

1.5 Relevance and Significance of the Study

The present study focuses on investigating the situation of interoperability between academic information systems in Palestine. Thus, providing an insight view into what is the most appropriate approach to exchange academic data for real-time usage appears of significance. We expect that achieving semantic interoperability in the Palestinian community will enhance the quality of academic learning, save time, and reduce costs through facilitating the obtaining of the right data at the right time, empowering a better understanding of transferred data, and reducing errors related to the lack of information. (Iroju, Soriyan, Gambo, Olaleke, & Studies, 2013; Luna, Campos, & Otero, 2019)

1.5.1 Significance of Study

This study also gains its significance from the following:

1. Facilitating the exchange of information between Universities participating in joint education programs
2. Facilitating the exchange of information and data between Universities with a unified educational program
3. Facilitating the movement of students from one institution to another
4. Facilitating the exchange of students and knowledge of information from students' grades and others
5. Facilitate the process of following up on decisions in joint programs
6. Using electronic systems across joint programs and thus easing of follow-up and communication between the parties
7. Being able to access continuously updated data and information.

This study is expected to benefit all parties related to higher academic institutions such as the Ministry of Higher Education within its supervisory and follow-up role, students of the programs, in addition to the universities joint and their employees. In consequent, significance of study can be set in variant levels:

1.5.2 The academic level

Academic programs and data exchange in Palestinian universities are relatively recent issues. It is an ambition, bold, and pioneering step in the Palestinian universities because it meets the needs of Palestinian society in terms of providing qualified scientific cadres in various fields of knowledge.

1.5.3 The student level

Saving effort, money and time, the Palestinian students enrolled in joint program, need to move between Universities to obtain data or documents, which can be obtained faster and with less effort using an interoperability system between universities.

1.6 Organization of the Study:

This study consists of six main chapters, (i) an introduction, (ii) theoretical framework & literature review, (iii) methodology, (iv) Requirements and Alternatives of Exchanging Students Data (v) discussion of questions, and (vi) result and conclusion. These chapters can be summarized as follow:

Chapter I: The Introduction contains an overview of the research background, illustrates statement of the problem, determines study's main objectives, explains its significance on different levels, and finally briefs its organization.

Chapter II. Theoretical Framework and Literature review It contains two major titles; the theoretical framework, and the previous studies.

Chapter III. Methodology which defines the methodology of the study, its population, sources of data collection, data collection tools, statistical analysis methods, and the referencing protocol used.

Chapter IV. Requirements and Alternatives of Exchanging Students Data: which discusses the design of alternative for exchanging students’ data between the universities with joint program/s, the advantages and disadvantages of each alternative.

Chapter V. ESR Representation and Adaptation of API Implementation: It discusses the recommended alternative for an ESR system for the Palestinian universities, the architectural design and the development of APIs.

Chapter VI. Conclusion and Recommendation in which the researcher lists the main results/conclusion, recommendations and future potential propositions.

Chapter II. Theoretical Framework & LITERATURE REVIEW

2. Theoretical Framework and Literature review

2. Key Concepts, Theories and Studies

2.1.1. The Theoretical Terms and Concepts:

The structure of higher education institutions is characterized by complexity and constant change due to a set of tangible and intangible factors. While the former include human resources characterized by professional and technological competence, equipment and devices with a high capacity for storage and processing. (Dzimińska, Fijałkowska, & Sułkowski, 2018), the latter include applications that are compatible with all the functions of the institution and its internal and external needs, and private and public networks with a high capacity for communication. In-addition to the information flow which generates enormous data and information that need to be collected, stored, processed, and delivered to their users according to certain characteristics and needs. All of these factors today constitute what is known as modern information systems. (Secundo, Margherita, Elia, & Passiante, 2010)

In fact, growing strategic value of information systems, increasing investments in this field, the increasing risks associated with them, and other factors have today fostered higher education institutions to applying new practices that help them manage to put control on those systems along with their functions, in a way that helps them maximize their value. (Jakimoski, 2016)

Previously, local higher education institutions relied on traditional systems in managing their operations using paper work of record for all the operations carried out by such institution, but the digital revolution and the availability of electronic systems opened the door for these institutions to apply electronic information systems in performing their various work. Here, Palestinian higher education institutions ranged between the reliance on ready-made information systems or building their own systems developed by their own IT technical staff. (Bencheva, Zahariev, & Takruri-Rizk, 2017)

Nowadays, the value of electronic information systems for higher education institutions is receives much of appreciation since various operations are improved and carried out by these institutions. Indeed, this value increases under some special circumstances that require sharing such data, completely or partially with external parties. Still, finding a balanced way between the privacy of this data and its sharing (exchangeability) resembles the biggest challenge for the involved institutions.

The Joint academic programs between higher education institutions are considered one of the most prominent current trends between these institutions, which aim to maximize the potential and exploit it optimally in the light of the joint work environment. This partnership requires data exchange and sharing from both parties, the matter that led to the emergence of the term “interoperability” of data between participating institutions. (Secundo, Margherita, Elia & Passiante, 2010)

The researcher believes that data exchange, or interoperability, are synonymous terms that indicate the possibility of transferring data between participating entities, in a way that ensures the ease of carrying out operations and not repeating them or performing them inconsistently between the institutions participating in this system and that ensures accuracy, ease and speed of access to information. (OASIS, 2022)

Interoperability improves ability for different systems to exchange information by cooperative systems. It plays a vital role in educational information system institutions. Practically, there are two main technical reasons to restrain the interoperability of systems. First, these systems may be developed under various operating systems, programming languages and different database management systems. Second, the obsessions of security greatly impact the execution of interoperability among various educational institutions. (Gansel, Mary, van Belkum, & Diseases, 2019; Matney, 2016)

2.1.2. levels of interoperability

Researchers have classified interoperability into various levels, some researchers have adopted two levels of interoperability (Syntactic interoperability and Semantic interoperability), other have depended on classifying interoperability into three levels including; (Foundational, Structural, and Semantic), while others have gone further to include four levels; like: (No interoperability, Syntactic interoperability, Technical interoperability, and Semantic interoperability). Here are more details:

First group of researchers adopted two levels, (Semantic and Syntactic). Syntactic interoperability refers to the ability of exchanging data/information between systems using common data formats and common communication protocols. XML language and SOAP messages are examples of common data formats and common protocol, respectively.

Semantic interoperability refers to the ability to automatically interpret the information exchanged meaningfully and accurately in order to produce useful results as defined by end users of the communicated systems.

The second group of researcher have classified interoperability in three levels (Reisman, 2017):

1. Level 1: Foundational: exchange data without having the ability to interpret it.
2. Level 2: Structural: can exchange data and interpret it at the data field level.
3. Level 3: Semantic: exchange and use information.

The third group is represented by (Adel et al., 2019); there are four levels of interoperability from the point of data understanding. These levels are:

1. First level: No interoperability: data that is hard to understand by humans or machines. Also, missing the use of it in sharing by e-mail or fax.
2. Second level: Syntactic interoperability: information syntax is clear and well-defined while its meaning is not. Data is represented using high-level transfer syntaxes such as XML or HTML.
3. Third level: Technical interoperability: information can be transferred between machines.
4. Fourth level: Semantic interoperability: information is clear and understood for different organizations that do not speak the same language.

2.1.3. Semantic Interoperability:

Semantic interoperability is the ability of computer systems to exchange data with unambiguous, shared meaning. Semantic interoperability is a requirement to enable machine computable logic, differencing, knowledge discovery, and data federation between information systems. (Matney, 2016)

Semantic interoperability, as defined by the Research Data Alliance (2015) is ‘the ability of services and systems to exchange data in a meaningful/useful way’. It is a more challenging concept because it implies a mutual understanding of the meaning of data and information in the communication process. (Harvey, Kuhn, Pundt, Bishr, & Riedemann, 1999)

Semantic interoperability is therefore concerned not just with the packaging of data (syntax), but the simultaneous transmission of the meaning with the data (semantics). This is accomplished by adding data about the data (metadata), linking each data element to a controlled, shared vocabulary. The meaning of the data is transmitted with the data itself, in one self-describing "information package" that is independent of any information system. It is this shared vocabulary, and its associated links to an ontology, which provides the foundation and capability of machine interpretation, inference, and logic. (Gansel, et al., 2019)

By using semantic, structural and syntactic levels of interoperability, users will be able to describe a document, item or web page; facilitate the searching, locating and retrieving of information; and facilitate the creation of distributed interoperable information systems.

Semantic interoperability or agreement about content description standards, the Dublin Core, the description standard adopted by the Clearing-House Mechanism, is an example of a semantic interoperability standard. Because of its importance to the Clearing-House Mechanism, and because it was adopted as the descriptive standard for the Convention web site and the Blockchain (BCH), (Gansel, et al., 2019).

2.1.4. Structural Interoperability:

Structural interoperability and their models, such as the Resource Description Framework (RDF), offer a means for specifying semantic schemas so that they can be shared. The Pilot Phase of the Bloc-kchain (BCH), RDF is used as the semantic schema. (Jakimoski, 2016)

2.1.5. Syntactic interoperability:

Syntactic interoperability is of significant importance to the BCH because it specifies how to tag and mark data to facilitate the exchange and sharing of the data. The BCH has adopted extensible Markup Language (XML) as the syntactic interoperability standard.

2.2. Literature Review

This section reviews the previous related studies conducted within the broad trending of the present study's field and core subject.

Reference model of e-learning and quality to establish interoperability in higher education systems (Naim & Alahmari, 2020)

This research addresses the role of quality tools in enhancing interoperability and quality within e-learning systems, with a focus on King Khalid University. The study includes additional benchmark models, such as the impact of demographic factors on quality tools. It tackles two main challenges in e-learning for higher education: achieving interoperability and ensuring learning quality. This paper explores the dimensions and scope of e-learning interoperability and its relation to quality development, particularly at King Khalid University, which utilizes Blackboard's Learning Management System (LMS) for its educational delivery. King Khalid University employs three learning modes: fully online, blended, and supportive. The research delves into the dimensions of quality and e-learning standards aimed at improving interoperability and quality development at King Khalid University. By using secondary data from the Deanship of E-Learning at King Khalid University and surveys conducted with 20 online facilitators and accredited administrative staff, the study demonstrated the effectiveness of e-learning interoperability and quality development processes at King Khalid University.

The hidden architecture of higher education: Building a big data infrastructure for the 'smarter university' (Williamson, 2018)

Higher education institutions are increasingly dependent on digital data for organizational management and operations. The collection, processing, and dissemination of this data rely on complex new infrastructures that involve both human and non-human elements. These infrastructures are integrated within broader political, economic, and social contexts. Rather than being mere technical systems, higher education data infrastructures function as practical tools for implementing policy-driven reforms in the sector. This article examines a prominent ongoing data infrastructure project in UK higher education. It explores the sociotechnical networks, including organizations, software, standards, dashboards, and visual analytics tools, that support this infrastructure. The analysis investigates how these technologies align with government-mandated market reforms. Crucially, the paper highlights the dual nature of this process, where higher education is simultaneously reimagined as a ‘smarter university’ through idealistic technological discourse and reshaped into a market-driven entity through political intervention.

Interoperability between Information Systems of Portuguese Higher Education Institutions. (Ribeiro et al., 2016)

The goal of this research is to provide a platform for operating information systems for higher education institutions in Portuguese, through which it demonstrates the benefits of using this platform. This platform operates in a cloud computing environment which aims to bring higher education institutions closer. This project includes four of Portuguese Universities and this project has been developed on the basis of a unified perspective, but not internally, so that each institution is responsible for organizing and delivering its information, and this project supports a strategy to transfer digital content through mobile devices and transfer data and academic processes between institutions electronically, all using the operating platform. The interface aims to develop the electronic management of institutions and expand these services to all higher education institutions and reduce costs in order to remove the physical nature of academic operations.

The IES + Perto project aims to create a shared cloud computing that connects the joint institutions and is built on a unified cloud. Through this platform, access, communication and interaction with the information provided by the information systems of each organization can be done as well as to develop joint services and applications effectively despite the different information systems.

Through open standards and interoperability, work has been done to reduce maintenance costs and licensing needs, facilitate the process of linking systems, and a cooperation agreement is established between institutions in order to ensure the joint management of the cloud and the interoperability platform.

Building a share understanding of the Joint MSc in Electrical Engineering in three Palestinian Universities based on EU practices (Bencheva, Zahariev, & Takruri-Rizk, 2017)

This paper aims to develop a joint master's program between three Palestinian universities and four universities in the European Union in partnership with two Palestinian companies. This paper focuses on reforming the curricula in higher education for electrical engineering through the development of the first joint master's program in electrical engineering in Palestine.

Integration of postgraduate programs in Palestinian Universities (Odeh, 2005)

In this research paper, Palestinian universities compete in offering graduate programs. The problem lies in the fact that Palestinian Universities are transformed in a context from a mere scientific competition to an economic competition. This paper aims to establish an integration of graduate studies programs among Palestinian Universities, which include (Software themes, Geographical distribution, faculty of school, the possibilities available in each University, Consolidation of study plans)

It also aims to make integration and non-repetition in the programs and University specializations in order to benefit more from the specialization.

Research on Centralized Data-Sharing Model Based on Master Data Management (Dandan et al., 2017)

The research aims to analyze the data exchange model that is widely used in the information centers of Chinese Universities, in which a central University data sharing model is proposed that depends on the master data management system to provide unified data standards, data exchange and quality control services, and comprehensive data sharing services for Universities in the big data environment. Then analyses and implement the basic implementation methods of the data sharing model. The model supports large-scale data sharing for the digital campus, through which all data transfer operations can be monitored and managed under a unified management system.

Gaps in Existing Knowledge that there is no system or interoperability platform that supports the process of linking the Ministry of Higher Education with Palestinian Universities. Also this type of system has been applied in the world, such as Portugal, Turkey, and China, but it is not found in Palestine, and a study will be made for its application in Palestine.

Towards a Unified University Information System Bridging the Gap of Data Interoperability (Ise, 2014)

In this paper, an operable framework for information exchange is adopted in a better standardized approach and a framework is proposed based on the Service-oriented architecture (SOA), which helps the disparate information systems used in Universities to interact and exchange information securely between them and NUC and private and public agencies. The study aims to standardize shared education data and adopt an interoperable framework for education. Work on a consensus in order to standardize the exchange of data in the Universities of Nigeria and transform from the exchange of information in a manual and paper-based way to a digital exchange

Challenges of Interoperability and Integration in Education Information Systems (Jakimoski, 2016)

In this paper, interoperability is defined as the ability to communicate with other systems, use the functions of other systems, relate to each other, and eliminate inconsistencies between them. The Schools Interoperability Framework (SIF) has been proposed as a school interoperability framework, which is an industrial initiative to enable interoperability and data sharing between institutions. As well as providing the interoperability framework for information system support management or Education Management Information Framework (EMIF) by the government of China.

The SIF specification consists of two main parts, SOA aimed at the process of information sharing between organizations, as well as the XML specification that aims to model educational data according to educational settings. The SIF is defined by a set of definitions and rules for application to share information across schools. Work was done on designing the framework in order to adopt the concept of SOA with the integration of Education Management Information System (EMIS) into higher education institutions.

The Contributions of E-School, a Student Information Management System, to the Data Processes, Environment, Education, and Economy of Turkey (Durnali, 2013)

This paper talks about the e-school system in Turkey, which has great importance in further improving the efficiency of education. The e-school is an information management system, which is a computerized education in order to better manage student data. It was developed through programs, databases and web-based technologies with the aim of promoting education and its use by anyone in all educational levels, primary and secondary, and this system is under the control of the Ministry of Education that contains a summary of the implementation process and technology used, as well as basic components, design and user profiles for e-school, building an effective educational system, and how to collect, plan and process data for students. All students can use it from elementary and secondary.

Practices for College and University Electronic Records Management (ERM) Programs: Then and Now (Zach & Peri, 2010)

In this article, results emerge from a research project that investigates the patterns and practices among North American colleges and Universities and how records and archives are managed in relation to their methods of capturing, storing and organizing institutional electronic records and better managing them. The project seeks to present a picture of a situation in data and records management in these colleges through conducting a research study and showing the results

Re-orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning (Subosa & West, 2018)

This working Paper provides conceptual frameworks and strategies to help countries re-orient their Education Management Information Systems (EMIS) to support inclusive and equitable quality education and lifelong learning opportunities for all, in line with Sustainable Development. It emphasizes the potential of EMIS to support the implementation at the national, state, local and classroom levels.

- **Academic Gap and Study Distinction:**

A review of the existing literature reveals that previous studies have directly or indirectly addressed the interoperability of information systems, particularly in higher education institutions. These studies have examined various models and systems of interoperability and proposed new models for interoperability. They have provided the researcher with an initial framework to organize their research.

The researcher has actually benefited from these studies in the following ways:

1. Reviewing key models and concepts: The researcher has reviewed prominent models and ideas related to system interoperability in higher education institutions.

2. Cataloging and organizing key fields: The researcher has cataloged and organized the critical fields exchanged between different systems within higher education institutions.
3. Evaluating pros and cons: The researcher has examined the advantages and disadvantages of interoperability solutions proposed in previous studies.

Despite these benefits, there is a research gap remaining between this study and previous researches, as follows:

1- Lack of Focus on Palestinian Institutions: According to the researcher’s best knowledge, none of the previous studies have addressed the interoperability of information systems within Palestinian higher education institutions.

2- Differences in System Nature: The systems handled locally differ from those in foreign contexts. While foreign systems may share certain similarities, Palestinian higher education institutions have diverse systems across public and private universities, as well as other institutes, each employing distinct electronic systems for managing student data that are fundamentally different from those used in other universities and institutes.

CHAPTER III. METHODOLOGY

3. Methodology

3.1 Introduction

Chapter three introduces the procedure of research and the method used throughout the study. Kallet, 2004 explained that methods section should describe what has been done so as to achieve the research objectives, describe how it was done and explain how the results were analyzed. This chapter also sheds light on research strategy and design, population and the chosen sample, questionnaire's design, process of data collection and analysis are taken into consideration

As for methodology, the researcher adopted the following techniques; reviewing related literature to interoperability across information systems of higher education institutions, making a questionnaire for data collection, data analysis, and relevant case studies. The data was analyzed using (SPSS 26). Results of the data analysis are presented. Based on the collected data and the literature review, a number of design alternatives will be discussed to foster information interoperability between information systems of the involved higher education institutions.

3.2. Design of the Study

The term "research design" refers to the plan or organization of scientific investigation, designing of a research study involving the development of a plan or strategy that will guide the collection and analysis of data (Polit & Hungler, 1999). Bums & Grove (1997) defined the term design as: "some consider research design to be the entire strategy for the study, from identifying the problem to finding the plans for data collection".

- The first phase of the study highlights the thesis proposal including identifying and defining the problems and established objectives of the study and development research plan.
- The second phase of the study includes a summary of the comprehensive literature review.
- The third phase of the study includes a field survey which was conducted with the Interoperability between information systems of higher education institutions.
- The fourth phase of the study focuses on the modification of the questionnaire design, through distributing the questionnaire. The questionnaire was later modified in accordance with the results gathered from the study population.
- The fifth phase of the study mainly deals with the distribution of the questionnaire. This questionnaire has been utilized as the key tool for data collection in order to achieve the research objective.
- The sixth phase of the research demonstrates data analysis and discussion. (SPSS) has been used for a thorough data analysis and discussion.
- The seventh phase of the research discusses the design of alternatives for fostering data interoperability.

3.3. Methodology of the Study

To achieve the objectives of the study, the researcher adopted a mixed research method, which involves collecting and integrating quantitative and qualitative data. This approach allows the proof, to disprove, or lend credence to existing theories. It also builds a robust understanding of the topic, taking out the meanings people ascribe to their activities, situations, and circumstances (Leavy, 2017). This method was used to investigate the available system utilized by Palestinian Universities. As well as identifying important roadblocks and motivators for implementing interoperability to our community.

3.4. Population of the Study

The target population for this study is defined to include lecturers of the joint program at Palestinian Universities in both districts of Hebron and Bethlehem. Representing the study population size, the 43-individual university respondents include the deans of graduate studies, employees of registration departments.

3.4.1. Sample of the Population:

Since the sample is relatively small in size, the researcher used the comprehensive survey method including the whole population of the study- deans of graduate studies, employees of registration. Although the researcher has distributed the questionnaire to the whole statistical population of the study, only 25 respondents make up the final sample. The sample includes all members of the statistical community without any exception, final sample size was (25) individual. (AlDamen, 2007).

3.5. Instruments for Data Collection

Two main sources of data collection were used; the first was secondary data which included reviewing previous literature and scientific research related to the subject of the study. In addition to the refereed scientific articles, academic and scientific books, doctoral and master are theses, and websites were used.

The primary data resource, on the other hand, included the questionnaire and personal interviews that the researcher designed for the sake of data collection within the limits and objectives of this study.

3.5.1. Questionnaire

Questionnaire is a quantitative tool that contain a series of questions in many sections that prompt respondents to answer them, so that answers can be interpreted quantitatively (Patra, 2019). Questionnaires represent the main instrument used to conduct the present study, and it contains three main sections as follows:

Section 1: The welcoming Paragraph and an introduction for respondents providing an overview of the study title, objective, population, and ethical commitment.

Section 2: Demographic / Personal information questions about respondents.

Section 3: The main questionnaire section which contains close-ended questions with a 5-point Likert scale about the obstacles and benefits of adopting information linking systems between Universities with joint programs.

The questionnaire was developed by referring to previous related literature on the subject of this study, including studies of (Gansel, et al., 2019; Adel et al., 2019; Ise, 2014). The CIM model which is used to measure system interoperability and improve inter-system integration was also employed. Additionally, some sections proposed by the researcher were included to align with the study population. Subsequently, the preliminary version of the questionnaire was presented to a group of experts for review, and the tool was revised (through additions, deletions, and corrections) based on the consulted expertise feedback.

Finally, the researcher personally distributed the questionnaire to the study population in the universities within the districts of Hebron and Bethlehem. Yet, only 25 respondents replied an were subjected to statistical analysis.

3.5.2. Interview

An interview is a powerful qualitative method for eliciting data that allows researchers to examine people's views in the utmost depth (Alshenqeeti, 2014). The the researcher conducted a set of semi-structured interviews with deans of graduate studies and the employees registration departments within the selected Universities.

A semi-structured interview guide (see Appendix A) was developed before having the interviewees... An interview guide is a method that lists the questions that the researcher will ask. It assists in making the interviewing process more systematic and comprehensive by specifying the matters to be explored (Brayda & Boyce, 2014). The gained insights from the previous literature besides research questions were used as an inspiration for the interview guiding questions. Other related topics were considered, and for each, several closed-ended and open-ended questions were developed.

3.6. Statistical methods

For this study data analysis, the researcher relied on the Statistical Package for the Social Sciences, SPSS, Version (26). Here, the following statistical methods and tests were adopted for conducting the study:

1. Frequency tables to describe the characteristics of the study sample.
2. Arithmetic means and standard deviations for items and axes to answer the study questions.

3.7. Documentation of Bibliography

In documenting the study's sources and references, the researcher adhered to the American Psychological Association (APA) documentation style.

CHAPTER IV. REQUIREMENTS AND ALTERNATIVES OF EXCHANGING STUDENTS DATA

4. Requirements and Alternatives of Exchanging Students Data

4.1. Introduction

As mentioned above in Chapter (1), two or more Palestinian Universities can collaborate to accredit an academic joint program. In this context, the collaborated Universities might agree on how to apply the academic joint program based on a set of predefined terms and criteria called: Academic Joint Program Agreement – AJPA.

Herein, students can be enrolled in a joint academic program according to the following scenario. First, a student can register in one of the Universities that are involved in the AJPA agreement. Second, the other collaborated Universities have to be informed; and all students' data that are enrolled in the joint program in any University must be transferred to the other collaborated Universities. Third, in each semester, a student can register for courses from the joint academic program in any collaborated University including the University he/she originally registered in. Practically, collaborated Universities could agree on how to apply for academic joint programs. As aforementioned, the main aim of this study is to foster potential exchange of student data between the information systems of the joint programs of universities effectively. In the following sections, students' data that has to be exchanged will be classified and several design alternatives will be proposed and discussed.

4.2. Students' Data Analysis

This study primarily adopts two main tools to analyze data of the study sample. These tools included a "content analysis" of partnership agreements between Hebron

University and other universities with joint programs. in addition, to what above referred to as 'primary data' collected via personal interviews and the questionnaire.

4.2.1 Analysis of Joint Program Agreements

After questioner and interview analysis, the researcher analyzed five university joint agreements to establish joint postgraduate programs in doctoral and master’s degrees between Hebron University and local, regional and international educational institutions. The analysis of the content of these agreements was based on an attempt to extract points of commonality and difference between these agreements, as well as focusing on the process of transferring data between partner universities and how do they manage the exchange of student records.

Here are the most significant common points of agreement with regard to universities joint programs:

1- Name of the joint program: all the cooperation agreements that were analyzed indicate that the name of the joint program with regard to the agreement is initially presented at the beginning of these agreements. Also, each program name is agreed upon and unified by all participating universities.
2- Details of the joint program courses: The analyzed agreements highlighted the joint program courses, which included (course name, its credit hours, and course description), while the course serial number was subject to the numbering pattern followed in each university.
3- Implementation mechanism: It was covered in all agreements briefly and without details although it was explicitly referred to in the agreements.
4- Formation of the joint program committee: all joint agreements provide the formation of an academic committee to manage the program, without details on how to perform its work and tasks, and develop detailed executive plans to implement the program.

On the other hand, analysis of the content of the agreements to establish joint programs showed significant differences between them, especially concerning the practical application of the agreements. These agreements do not include detailed procedures for exchanging data and student records between the partner universities. The following are some points of difference between the agreements:

1- Teaching mechanism: The agreements that were analyzed differed in the teaching mechanism agreed upon between the partner Universities, which means that there is specificity for each joint program in the teaching mechanism followed it according to its requirements and agreed upon with the partner Universities.
2- Program instructions: Some agreements referred to the introduction of new joint laws and instructions related to the program, while this was not referred to in other agreements, which means that there is a difference in the mechanisms for implementing and applying joint programs.

4.2.2 Analysis of the Interview and the Questionnaire

The study went beyond a general examination of the content of the agreement; relying on a questionnaire prepared for personal interviews using an open-ended question system. The questionnaire analysis included frequency tables, arithmetic averages, and the degree of respondents' agreement with the questionnaire questions.

Analysis of the questionnaire resulted in the identification of basic student data necessary to create and manage electronic student records. These records facilitate easy and rapid exchange of data between the universities participating in the joint programs. After identifying the data and thoroughly studying it, causing the researcher to classify the data into three categories: (similar, semi-similar, and different data sets).

4.2.3 Classifications of Students Data

Student data typically refers to information related to the students enrolled in a University. In this research, Students' data is defined in chapter (2) as a set of data exchanged between joint programs established between Hebron University and other universities. Recently, the term Electronic Student Record (ESR) has been largely used in the education field as an alternative to traditional hard-copy (paper-based) records in modern educational settings. ESR refers to a digital database that stores and manages information about students in an electronic format (Noureen, 2019). These records are often used by one or more information systems within a University to track and manage student information effectively. It also provides a more efficient way to share and update information among other information systems of Universities participating in a joint program. For better understanding of students' data, the analysis identifies a set of typical data that might be involved in ESR. As aforementioned, this analysis is based on the analysis of the agreements of joint programs and the data collected from structured interviews with representative of employees and students. Accordingly, ESR includes a variety of data. The following list presents typical set of data that might be involved in ESR:

1. **Personal Information:** This includes the student's full name, personal identification number (PIN), date of birth, gender, contact information (address, phone number, email), and sometimes a photograph. In practice, different universities use different student naming conventions. For example, student name may start with either the first name or the family name. Moreover, father's name could be also included / excluded. Additionally, some universities use date of birth, while others might use age concept (calculated age based on Date of Birth).
2. **Program Curriculum:** it includes the program's name, credit hours, course's names, course's number and description. Practically, curriculum data of joint programs is certainly similar; as the involved universities agreed on these data during the preparation of the partnership agreement and submitted a single application for accreditation of the joint program to the Accreditation and Quality Commission of the Palestinian Ministry of Higher Education. However, course numbers might be adapted based on course numbering system that each university has adopted.
3. **Enrollment Data:** Details about the student's enrollment, such as student number, admission date, enrollment status (day learner, afternoon learner), program of study,

and academic level (undergraduate, graduate). Enrollment data almost similar, as students are enrolled in the same joint program. However, some University might have different academic rules related enrollment status. For example, some universities allow students to postpone his registration as much as he needed, while others restrict that. In addition, universities have different numbering systems for issuing student numbers.

4. **Academic History:** This includes information about the courses done, grades received, transcripts, and academic status. It may also include details about the courses in progress and other planned ones. In practice, universities usually use different grading systems for students' course achievements. For instance, some universities use a numeric grading system (i.e., 90, 82, 75), while others opt for letter symbolic grading system (i.e., A, B, C). Moreover, universities use different systems/criteria of grading (i.e., academic qualification or credential) awarded upon successful completion of a program of study. For example, some university awards a student a very good degree if he has an accumulative average range (80 – 85%), while other Universities award students the same degree if he has an accumulative average range (78% - 83%). In addition, different universities might use different Pass/Fail course grades. For example, the pass grade in most universities for master programs is 70%, while the pass grade in some universities for the similar programs is 50%. Finally, universities use different formats of the transcripts based on their local academic system.
5. **Attendance Records:** Information on class attendance, including dates and reasons for absences. It might also include the academic rules that regulate attendance and absence. This involves the number of lectures a student is allowed to miss without excuse; as well as the academic rules that will be applied against a student who exceeds the number of permissible absences. In practice, each university depends on its academic system for handling attendance records.
6. **Disciplinary Records:** Reports of any disciplinary actions taken against the student. In practice, each University depends on its academic system for handling disciplinary records.
7. **Graduation Requirements:** information on degree requirements, progress toward graduation, and graduation dates. In practice, graduation requirements are certainly similar, like curriculum data, as the participating universities agreed on exchanging such data during the preparation of the partnership agreement.

8. **Documents and Attachments:** thus includes scanned copies of documents like transcripts, certificates, and identification.
9. **Financial Records:** These record tuition fees, payment history, scholarships, and financial aid information. Ideally, the financial record has to be similar. However, some differences in the coordination of financial claims between partner universities might be in practice and the presence of grants or **exemptions for** some students in the records of some partner universities might be applied.
10. **Health Records:** Health-related information, including vaccination records, medical conditions, and emergency contact information are all on record.
11. **Extracurricular Activities:** Participation in clubs, sports, and other extracurricular activities.
12. **Contact History:** Records of communication between the student, teachers, administrators, and parents/guardians.
13. **Assessment and Testing Data:** standardized test scores, assessment results, and progress reports.
14. **Special Education Records:** If applicable, records related to special education services, including Individualized Education Programs (IEPs) and accommodations.

Table (4.1) summarizes the set of student data and illustrates the similarities as well as differences for each type between them. These sets of data have to be involved in the ESR to be fully exchanged between universities during the implementation of a joint program:

Table 4.1: Classification of ESR

Field		Differences
Students' Personal data	**Name**	Some Universities use a First name and Family name, while other Universities use a Father Name.
	ID Number	No Difference
	Age	**4. Providing the age** **5. Providing date birth Date-** (age is calculated).
	Contact details	No Difference
	Photograph	No Difference
Program's Curriculum	**Program Name**	No Difference
	Credit Hours	No Difference
	Coursed Names	No Difference
	Courses Numbers	**1- Some universities use numbers** **2- Others use a combination of numbers and letters.**
	Courses Description	No Difference

	Transcript	Universities use different formats of the transcripts based on its local registration system.
Enrollment Data	**Student Number**	Universities show different numbering system for student's No.
	Date of Admission	: No Difference
	Enrollment Status	Some University allow students to postpone his registration, while other University restrict that.
	Program of Study	No Difference
	Academic Level	No Difference
Academic History	**Courses Taken**	No Difference
	Grading System	1- **Numeric grading system** 2- **Letter grading system.**
	Grade Scale/Range	between Excellent to Fail
	Pass Grade	Universities use different “Minimum Passing Grade”.

	Transcript	Universities use different formats of the transcripts based on either's local registration system.
Attendance Records	Class Attendance	No Difference
	Dates of Absence	No Difference
	Absence: reasons/excuse	No Difference
Disciplinary Records	**Disciplinary Records**	No Difference
Graduation Requirements	**Information on Degree Requirements**	No Difference
	Progress Toward Graduation	No Difference
	Graduation Dates	No Difference
Documents and Attachments	Scanned Copies of Documents	No Difference

	Certificates	No Difference
	Identification	No Difference
Financial Records		Differences in the coordination of financial claims between partner Universities, and the presence of grants or exemptions for some students in the records of some partner Universities.
Health Records	**Vaccination Records**	No Difference
	Medical Conditions	No Difference
	Emergency Contacts	No Difference
Extracurricular Activities		Some partner Universities are not interested in this type of information, and thus there are no special fields for this information in the system in general, especially in joint programs between foreign Universities with different cultures.

Contact History	**Records of Communication with Student**	No Difference
	Records of Communication with faculty	No Difference
	Records of Communication with Administrators	No Difference
	Records of Communication with Parents	No Difference
	Records of Communication with Student	No Difference
Assessment and Testing Data		**Standardized Test Scores:** Universities used different score level for test like (TOEFL, ILTS, GMAT … etc.)
	Assessment Results	Some University used a numeric assessment result (GPA, Percentage), while other used

		qualitative style (Written Feedback, Performance Reviews)
	Progress Reports	**Progress Reports:** Universities used different style for progress report.
Special Education Records	Records related to special education services include Individualized Education Programs (IEPs) and accommodations, etc.	

Based on the aforementioned discussion; students’ ESR data can be classified into three categories:

1. Common (similar) data: It is the student's data that does not change when transferred between university systems in joint programs.
2. Semi-similar data: It represents data that is partially changed when transferred between joint software systems to adapt to the different system conditions between partner universities. Examples include the student’s university number, where the change is based on different formatting between the partner universities.
3. Un-common (different) data: These include the student's adaptable data that receive extents of change, deletion, or addition when exchanged or shared between universities in joint programs, such as the place of residence, where the change is based on the requirements of the different systems between the partners.

4.2.4 Analysis of Students’ Data – Conclusion

Accordingly, the researcher can identify several issues that need to be discussed to foster the exchange of students’ data involved in ESR in an efficient manner. First, it is clear that not all students’ data need to be exchanged between the involved universities. Therefore, we need to consider what is the minimal set of students’ ESR data should be exchanged between the participating universities. Second, the above analysis shows that part of students’ data involved in ESR shows a different format and representation.

Moreover, the concepts or terminology that is used to refer to students' data might be different (e.g., academic level vs. academic status). Additionally, the values of some data items might be different and could be interpreted in different ways (e.g., numeric grading system vs. symbolic letter grading). Third, some data items are based on the academic system that is adopted in a given university or implicitly known within the local context of that university. In effect, the interpretation of such data needs more effort and might cause misinterpretation. This will lead to *inefficiency or inaccuracy* problems. Therefore, we have to consider the representation of the minimal set of students' data in a common and meaningful manner at the concepts/vocabulary level as well as at the value level. Also, we need to consider the implicit data in our representation. In addition, we need to consider where and how to store the exchanged data. In the following section, many design alternatives for exchanging students' data will be discussed. Other issues will be addressed in Chapter 5 below.

4.3. Design Alternatives for Exchanging Students Data

Enhancing interoperability between electronic student records in joint programs requires collaboration, technical integration, and a commitment to data quality and security. In addition, universities can streamline administrative processes, improve data accuracy, and provide a seamless experience for students enrolled in joint programs.

There are several alternative designs for exchanging students' data enrolled in joint programs between collaborated universities. Each of these alternatives is based on how to represent and process the ESR of the students enrolled in joint programs. In fact, each alternative has advantages and disadvantages. This section identifies three design alternatives and evaluates them based on the […] design principles. (jaabari, 2011)

Palestinian universities with joint programs have to assess each option towards adopting electronic exchange of student records instead the traditional forms based on the paper exchange of student records.

4.3.1 Standardization of Electronic Student Record

The first alternative is to standardize students’ data involved in ESR between all universities with joint programs at semantic and syntactic levels. The standardization of ESR can be imposed by the Ministry of Higher Education (MOHE) for all joint programs as a set of joint program prerequisites, or the Academic Joint Program Agreement related to each joint program can be extended to involve the standardization process. Practically, all universities have to agree on and adopt the standardization process of ESR to unify all students’ data such as student demographic data, course details, grades, and any other relevant data involved in the ESR (see table 4.1) it also requires the adoption of widely accepted data exchanged formats such as XML or JSON to ensure compatibility. Furthermore, the standardization process might impose a unified academic system or lead to a new unified form of academic regulations and instructions that governs all joint programs.

Example:

For better understanding of this alternative and its consequences, let's assume that Hebron University has a joint program with Al-Quds University. To implement this alternative, both Universities firstly have to agree and adopt a standardized ESR. At operational level, Hebron University or Al-Quds University has to use the unified ESR when new students are enrolled in the joint program. Then, either of the partners has to inform the counterpart about the newly enrolled students, Also, both universities have to exchange students’ ESRs related to old students enrolled in the joint program in order to update their information such as course grades, accumulative average, No. of Credit hours remaining, etc. In other words, the enrolled students can register courses at Hebron University or at Al-Quds University in each semester, and at the end of the semester, both universities have to exchange students' ESR, for updating accordingly.

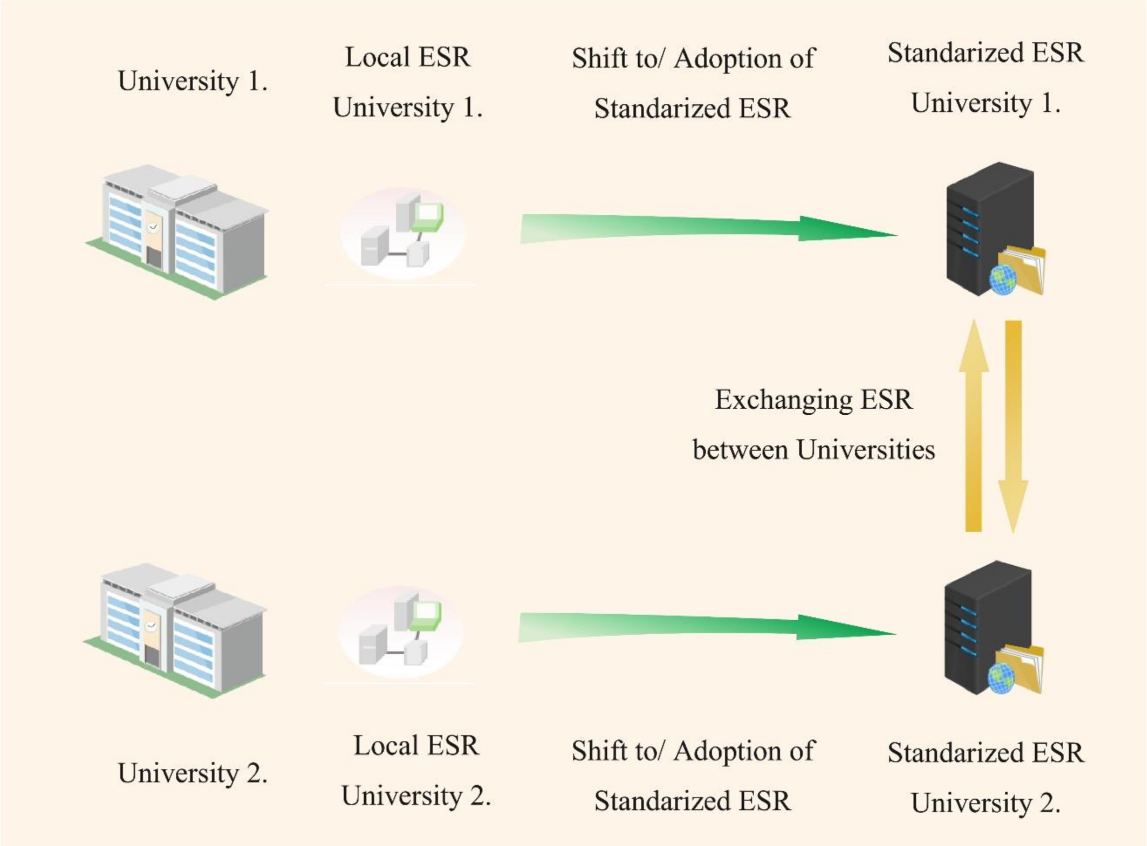

Figure 4.1 Standardization of Electronic Student Records

Discussion

This alternative ensures that data can be easily understood and processed by either of the collaborated universities. As long as collaborated systems adopt and use the unified ESR, data can be exchanged seamlessly, reducing integration challenges. This promotes the interoperability between information systems between the collaborated universities. In addition, standardization of ESR promotes consistency in how student information is represented across all collaborating universities. Consistency, in fact, reduces the chances of errors as well as the likelihood of data misinterpretation. Moreover, standardization of data formats and structures of ESR streamline data processing and exchange. This efficiency benefits various processes, including student enrollment, course registration, and administrative tasks related to joint academic programs. Finally, standardization of ESR will enable collaborated universities to adopt common tools, platforms, and information systems, promoting within a far better cohesive and integrated academic environment.

Nevertheless, the standardization of ESR might face refusal from collaborated universities due to a variety of challenges, not inclusively; cost, flexibility and data overhead. The standardization process might involve costs related to system upgrading, changes to existing processes. Universities will also need to modify their information systems to adhere to the standardized data formats. This may require significant changes to the existing databases, software, and interfaces. In addition, Standardization of ESR can sometimes result in a loss of flexibility in that universities may find it challenging to accommodate to unique data requirements or adapt quickly in response to every change in academic programs. Standardization of data formats and structure might impose additional information that not all universities need. This can lead to data overhead, where unnecessary details are included, impacting storage capacity and processing times.

In summary, while standardization of ESR has several advantages in terms of interoperability, consistency, and efficiency, it still imposes considerable challenges related to resistance, costs, and potential loss of flexibility.

4.3.2 Adaption of Electronic Student Record

The second alternative is to use local students' data involved in the ESR in each university and depends on predefined aApplication Programming Interface (APIs) for adapting students' data upon exchanging them with othor universitieswith joint programs. The adaptation process must extend the Academic Joint Program Agreement (AJPA) related to each joint program ensuring that the exchanged data will be adapted to be compatable and interoperable with the data format and structure of the ESR of other participating university, and vice versa. Practically, all universities have to agree on the adaptation process to consider the variance of all students' data; such as student demographic data, course details, grades, and any other relevant data involved in the ESR (See 4.4.1 above). Also, this alternative requires the adoption widely accepted data exchange formats such as XML or JSON to ensure compatibility.

Example:

Unlike the first option exemplified in (4.4.1) above, the (4.4.2.) alternative demonstrates that either of the universities in agreement will use its own local ESR to perform their daily transactions and processes such as students' enrollment, course registration, accumulative average calculation, etc. When Hebron University intends to exchange students' data that is related to new enrolled students, specific APIs have to be used in order to adapt data to be compatible and interoperable with the data format and structure of the ESR applied in Al-Quds University. Likely, both universities have to adapt students' ESRs related to old students enrolled in the joint program before exchanging their data. In other words, enrolled students can register courses at Hebron University or at Al-Quds University every semester, and at the end of the semester, both universities have to adapt and exchange students' ESR in order to be updated accordingly.

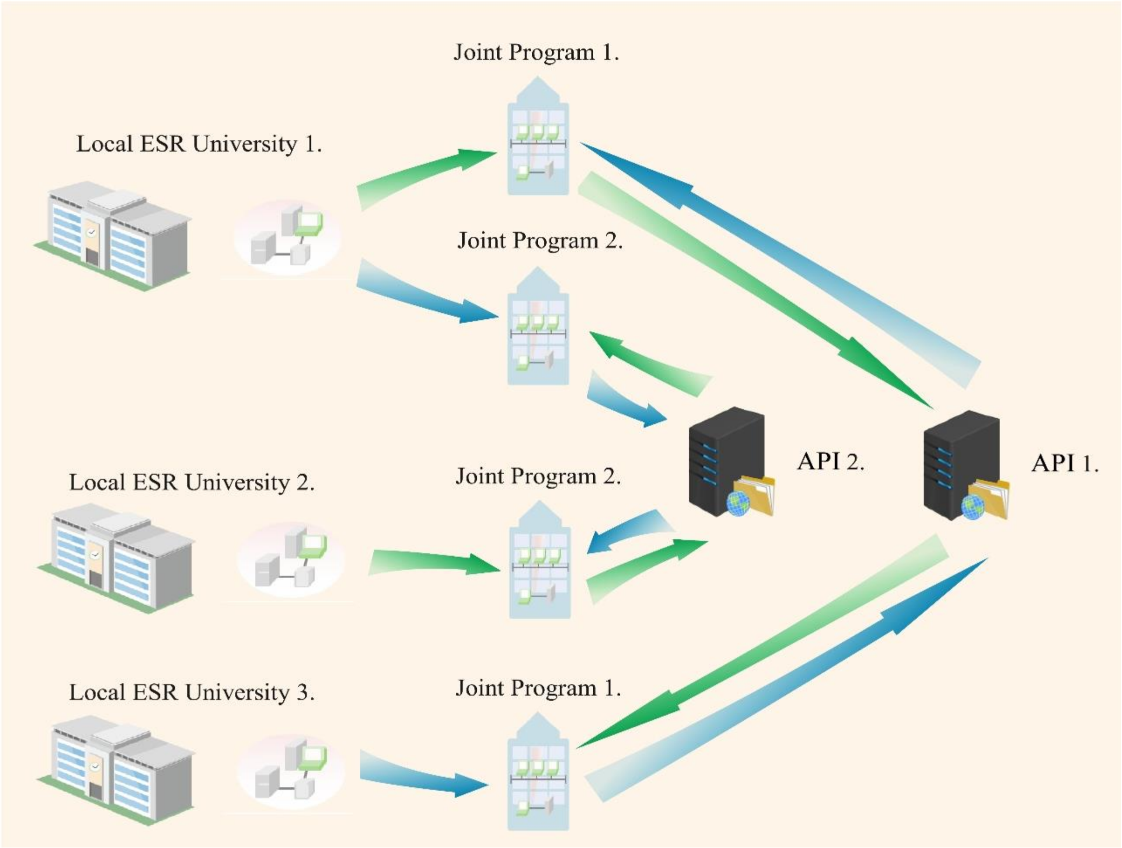

Figure 4.2 Adaption of Electronic Student Records

Discussion

This alternative (see 4.4.2) reduces the challenges related to resistance and flexibility issues. Adopting APIs for data exchange allows universities to make changes incrementally, to largely reduce resistance to transformation and to make the transition smoother. Also, each university can maintain its local autonomy in managing student data using the information systems that best fit its needs. They can develop tailored solutions without the need for extensive modifications of their existing data formats and structures, and without the constraints of complying with a standardized data format. Moreover, universities might have diverse academic programs with specific requirements. Using APIs allow customization to accommodate specific data requirements for different programs. Finally, since this alternative seems cost-effective, universities can selectively integrate APIs based on their needs, which can be more cost-effective than fully updated information systems. This approach allows institutions to focus on specific data exchange requirements.

However, this alternative might face challenges related to interoperability, complexity, and data consistency. The development of custom APIs by each university and for each joint program might lead to a proliferation of diverse interfaces. This might lead to complications in the process of data exchange between universities. In addition, managing multiple APIs and ensuring their work seamlessly together can introduce complexity. This may require universities to invest in sophisticated integration tools and technologies and might need a larger IT staff to manage... Finally, differences in data interpretation and representation across universities can lead to inconsistencies and misinterpretations when exchanging data through APIs.

In summary, using APIs for adapting student data offers flexibility and can be a more gradual approach to data exchange. Though it introduces challenges related to interoperability, complexity, and potential inconsistencies.

4.3.3 Mapping to Standardized Electronic Student Record

This alternative aims to combine the overhead mentioned alternatives (4.4.1 & 4.4.2) so as to reduce their matter of challenge. First, the third design needs to standardize students’ data involved in (ESR) between the joint universities at semantic and syntactic levels. As mentioned above, the standardization of ESR can be imposed by the MOE for all joint programs within the joint program prerequisites, or the AJP agreement of each joint program can be extended to involve the standardization process. Second, each university will use local data formats and the structure of data involved in the ESR. Third, each university depends on a predefined application programming interface (API) for adapting students' data to the standardized ESR upon exchanging them with other universities with joint programs. Here, the exchanged data will be adapted to be compatible and interoperable with the data format and structure of the standardized ESR. On the other side, the same process will be performed by other participating universities.

Example:

To apply the referred to 4.4.3 alternative, both joined universities first have to agree on and adopt a standardized ESR. In addition, each university has to implement its APIs to be used to adapt student data to be compatible and interoperable with the standardized ESR. At operational level, both universities will use their local ESR to perform their daily transactions and processes such as student enrollment, course registration, accumulative average calculation, etc. When Hebron University for instance needs to exchange students’ data with Al-Quds University; the students’ data involved in the local ESR is adapted to the standardized joint ESR and the latter is sent to Al-Quds University. At Al-Quds University side, students’ data involved in the standardized ESR is adapted based on local Al-Quds University ESR. In the same sense, the universities have to exchange students’ ESR enrolled in the joint program each semester in order to be updated accordingly.

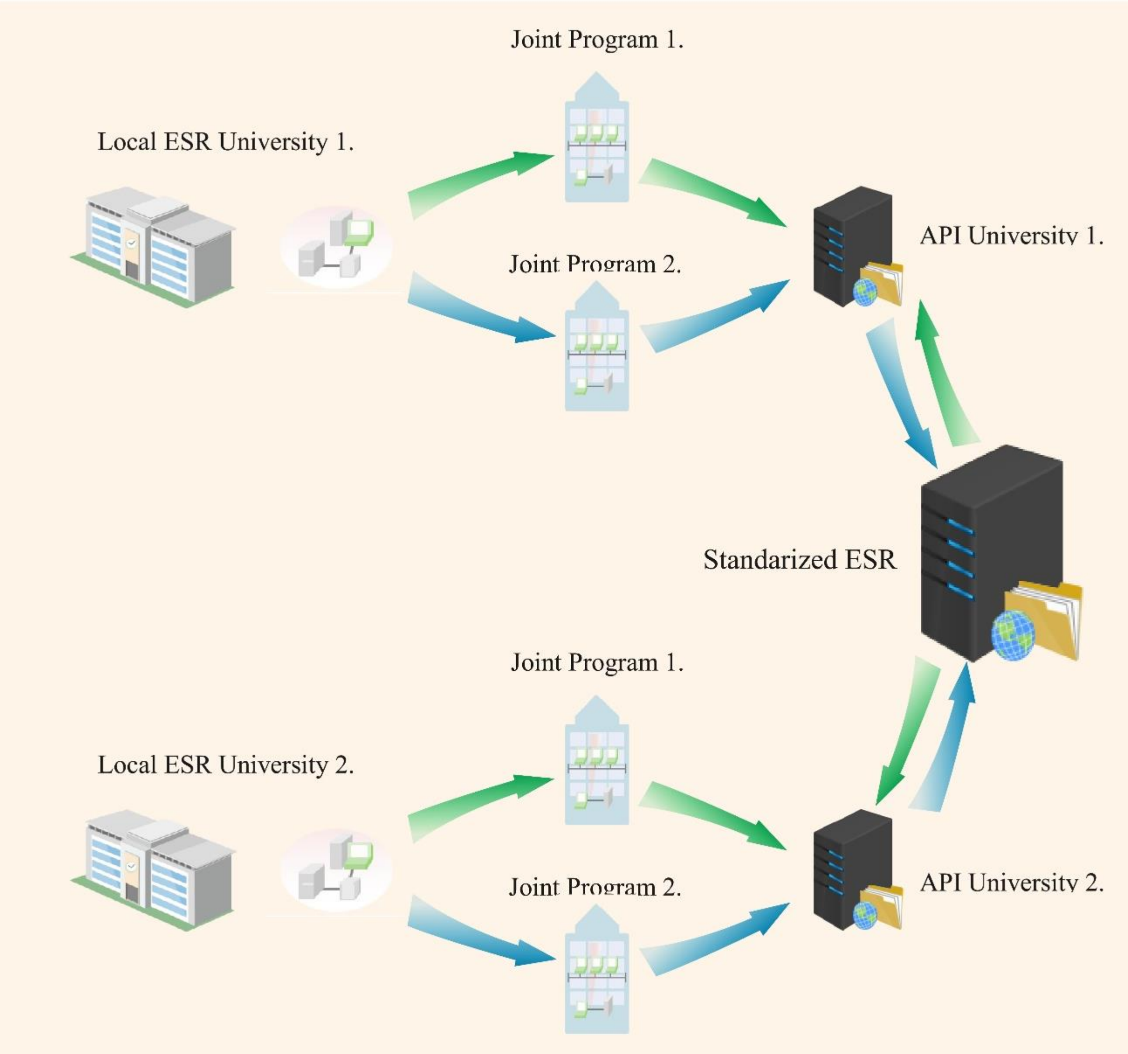

Figure 4.3 Mapping to Standardized Electronic Student Record

Discussion

This alternative will enhance the consistency and interoperability of the students' data exchanged by participating universities. On one side, standardization of ESR at the semantic and syntactic levels ensures a consistent framework for data representation, which will provide a common data interpretation and representation across universities. This will enhance data consistencies and interpretations the process of exchange. On the other side, the adaptation of students' data by one university local data formats and structure to the standardized ESR using APIs has to maintain flexibility whereas universities retain the autonomy to use local data formats and structures, accommodating their unique academic programs and administrative requirements. Moreover, this alternative will reduce the complexities of implementing APIs as well as reducing the cost. Indeed, each university needs to implement a set of APIs that map students' data from local data format and structure to standard data format. This process will be implemented once, and will be reused to exchange data with all participating universities. Furthermore, a number of APIs might be reused to exchange data between other joint programs accredited in the University.

4.3.4 Design Alternatives – Conclusion

Our proposal aims to adopt the third design alternative, since it is the best tradeoff. In effect, combining standardization with local data formats and APIs offers a balanced approach, leveraging the benefits of consistency, flexibility, interoperability, and simplicity.

However, several issues need to be considered to successfully foster the interoperability between university information systems upon exchanging students' data enrolled in the joint programs. First, standardization of students' data involved in the ESR needs a common conceptualization of such data at syntactic and semantic levels. The involved universities need to agree on and adopt the common conceptualization; on which the adaption of students' ESR is mainly based. Second, the adaptation process will generate a new version of each student's ESR (i.e., standardized version of student's ESR). This will impose an architectural issue with due regard to the space for storing the new ESR version. These issues will receive a considerable deal in the coming chapter 5.

CHAPTER V. ESR REPRESENTATION AND ADAPTATION OF API IMPLEMENTATION

5. ESR Representation and Adaptation: API Implementation

5.1. Introduction

Chapter 4 has discussed the design alternatives for exchanging students’ data between universities with joint program, taking each alternative' advantages and disadvantages in consideration. Accordingly, chapter 5 will describe the representation of standard ESR, in details describe the architectural design and finally present the development of APIs.

5.2. Representation of Standard ESR

The adopted design alternative requires a standardized representation of ESR (see 4.3.3); Standardization of ESR at the semantic and syntactic levels ensures a consistent framework for data representation. In addition, it implies that university information systems will be based on common conceptualizations. The term *Common conceptualization* refers to an agreement and commitment by multiple information systems/applications about a domain of discourse, so that they can interoperate in consistent manner. Though, these applications do not necessarily have the same experiences, theories, or prescriptions about that domain. This consensus is fundamental for fostering ESR data exchange and interoperability. From a technical perspective, employing ontologies as a means to establish this common conceptualization is deemed a dependable design strategy. Ontology is a formal representation of knowledge in a specific domain. It defines the concepts, relationships, properties, and constraints within that domain in a structured and organized manner.

Ontologies are commonly used in fields such as information science and philosophy to facilitate knowledge sharing, data interoperability, and reasoning.

Regarding ESR, two levels of common conceptualization can be identified. Each level allows the appropriate API adaption to adapt the exchanged students' data from university local data formats and structure (representation) to the standardized representation:

- Level 1: the real-world concepts that represent students' data that has to be exchanged between participating universities. This also includes the real-world concepts based on the academic system of the participating universities or the implicitly known system in the local context of each either university.
- Level 2: the values of data items related to students' data that has to be exchanged.

Ideally, the above two levels have to be achieved by all participating universities so that they ensure a full interpretability. In that, all forms of change requires agreement and commitment by all participating universities.

5.2.1. Electronic Student Record (ESR): Main Concepts

As mentioned in section 4.2.3, ESR refers to a digital database that electronically stores and manages data about students enrolled in academic joint programs. In that universities represent data in different ways. In this research, the data involved in ESR revolves around three main real world concepts: university, student and academic joint program (AJP). Therefore, the researcher designed a proposed standard ontology about three main concepts: university, AJP, and student (i.e., ontology classes). Two or more universities have participated in the development and implementation of this proposed AJP program. AJP has a set of sub concepts (i.e., subclasses): program's ID, name, curriculum, graduation requirsements, and instructions beside academic regulations. Academic regulations (laws) could be agreed upon when participating universities agreed on implementing a joint program or could be based on local academic system of each participating university. Also, the curriculum of AJP has a number of courses; each of which has a set of attributes: course's No, name, description, credit hours, and possibly a pass grade2 and grade scale/range3. A student has a set of personal information and enrolled in joint academic program (AJP). In addition, each student has an academic record, consisting of courses students register and finish during a study period.

As mentioned above (Section 4.3.4), this proposed interpretation of ESR should consider the minimal data set needed to be exchanged by participating universities. Therefore, the proposed standard ESR consists of (*ESR*) as key concept and of student’s *personal information, enrollment data, and academic record* as three main sub concepts. In addition, some other concepts might be involved and exchanged such as *financial and health* records. However, focus goes to the three main concepts of the ESR. Figure (5.1) bellow illustrates the main concepts and the minimum set of the data involved in *ESR*:

2- The minimum grade required for a student to pass a particular course. Typically, a grade (60) and (70) are adopted for bachelor and master degree courses, respectively.

3 The set of categories used to represent student performance in a course. Typically, categories (excellent, very good, good, fair, and failed) is adopted for grade scale.

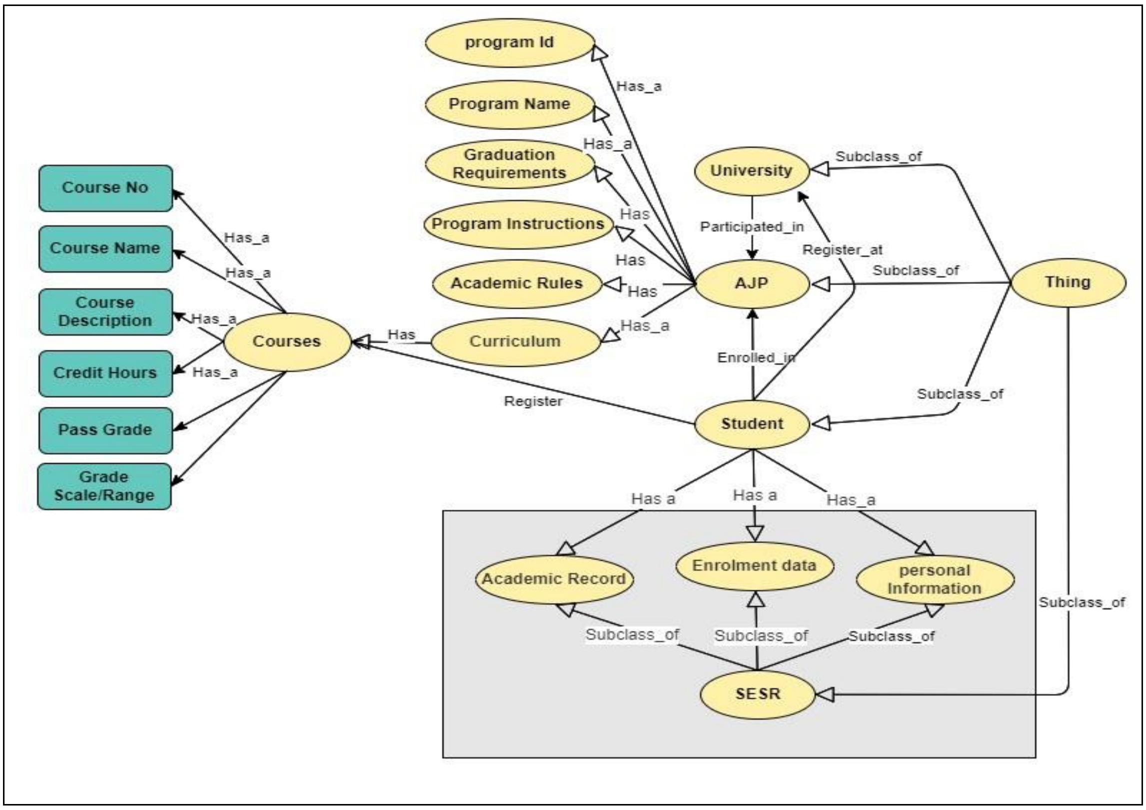

Figure 5.1: ERS Ontology - Main Concepts

5.2.2. ESR Ontology – Personal Information

Personal information consists of the minimal set of student's data that has to be exchanged by participating universities with a number of metadata annotations. The latter will be used to identify the data type, format, and allowable values. In this context, personal information includes the following sub-concepts:

- **Student's Name**: the minimal representation of student name and consists of *First Name* and *Family Name* as *string* sub-concepts. Additionally, the proposed standardized format follows (First Name, Family Name).
- **Personal identification number** (PIN): as mentioned before, the identification number of a student is originally issued by the ministry of interior affairs. In practice, most students enrolled in joint programs have a Palestinian identity card made of exactly a 9-digit number PIN. However, some students might have a Jordanian identity card or passport with an 11-number digit PIN. Therefore, the researcher proposes to represent the PIN concept as long data type and with allowed value enclosed between (9 – 11) digits.

- **<u>Date of Birth</u>**: it is represented as date concept with short format (dd/mm/yyyy).
- **<u>Gender</u>**: it is represented as a string concept with allowed value either *Male or Female-F/M.*
- **<u>Contact Information</u>**: the minimal representation of student's contact information involves *their mobile phone's number* and *email* as two sub-concepts. Mobile Number is represented as long integer with (10) digits. Also, it might be prefixed with *country calling code* (cd) (e.g., +970 for Palestine).

Figure (5.2) illustrates the ontological representation of personal information concepts:

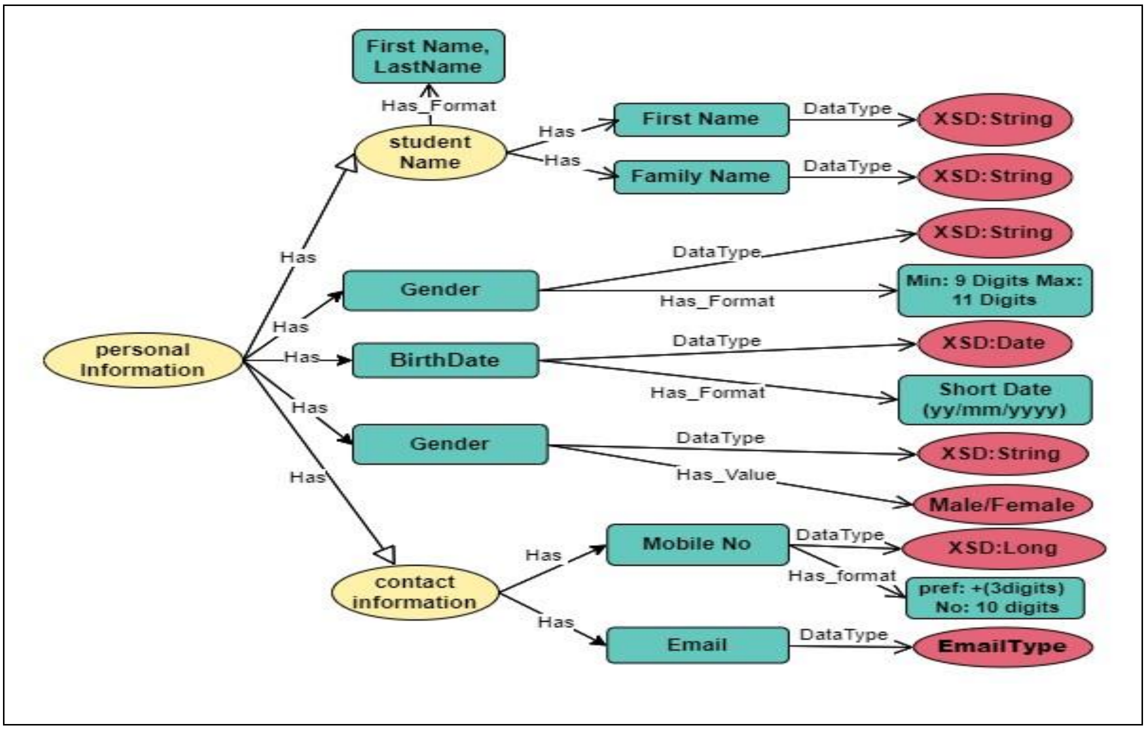

Figure 5.2: Standardized Representation of Personal Information

5.2.3. ESR Ontology – Enrollment Data

Enrollment data is generated when a student is registered at university and enrolled in AJP. Similar to personal information above, we need to consider the minimal set of concepts/data that have to be exchanged by the participating universities as well as metadata related to these concepts. In this context, enrollment data includes the following:

1- **Student Number:** an identification number issued by one participating university when a student register and get enrolled in the AJP. This number has a long data type and refers to an instance of type student (i.e., individual).

2- **Date of Admission**: it refers date of student’s enrollment in the AJP. It is represented as a date property with short date format (dd/mm/yyyy).

3- **Enrollment Status**: it refers to a student's current position within the AJP. It indicates whether a student is actively enrolled (full-time or part-time), Suspended, withdrawn (i.e., no longer enrolled), or graduated. In this sense, the enrollment status is represented as it strings data property with a set of allowed values (active, suspended, withdrawn, and graduated).

4- **Program ID**: it is an instance of AJP’s *program ID* whereby a student is enrolled. It is represented as an integer number, whereas each AJP program is identified by its unique number.

5- **University Name**: refers to an instance of the university (individuals) that a student register in- when a student gets enrolled in the AJP. It is represented as a string data property with allowed values that involves the university's entire abbreviated name (e.g., HU, QU, BZU), including the universities participating in the AJP's development and implementation. Figure (5.3) illustrates the ontological representation of the enrollment data:

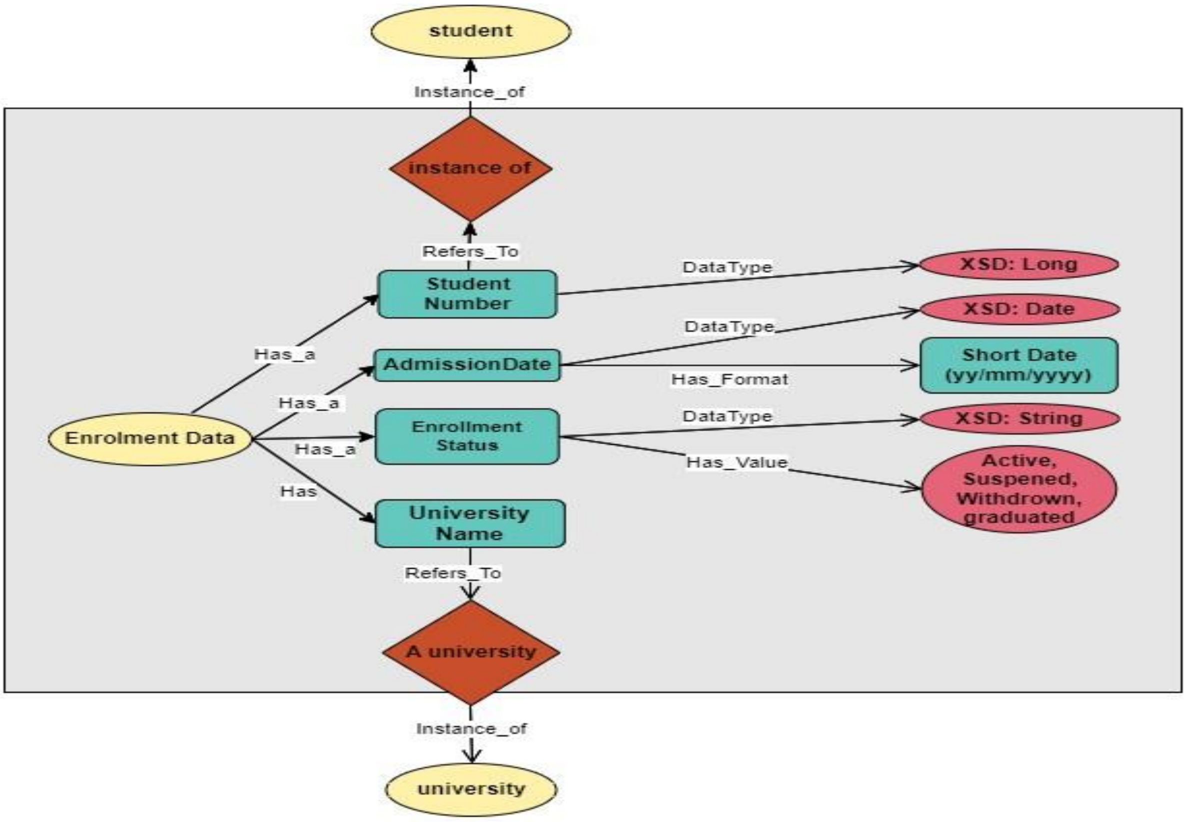

Figure 5.3: Standardized Representation of enrollment Data

5.2.4. ESR Ontology – Academic Record

Academic record is accumulatively updated when a student register courses and complete them at the end of each semester. Considering the minimal set of concepts/data that have to be exchanged by the universities involved; academic record includes the following:

1- <u>Course No</u>: an identification number that is related to a course involved in the AJP curriculum. This number has a string data type and refers to an instance of type course (i.e., individual).

2- <u>Course status</u>: refers to the status of a course that is registered by a student at a given semester. In this sense, it indicates whether a student successfully complete this course with pass grade (i.e., passed), complete this course with failed grade (i.e., failed), drop this course (i.e., dropped), and does not complete this course (i.e., incomplete). In ESR design, the researcher has adopted the above-mentioned values as common values and represents it as string data property.

3- <u>Course Grade</u>: refers to the assessment of a student's performance in a registered course at a given semester. In ESR design, the researcher has adopted the numerical grade value as standardized representation of the course grade data property within range 0 – 100.

4- <u>Accumulative Average</u>: it refers to the average of grades achieved by a student across multiple academic semesters. It provides a measure of the student's overall academic performance up to that point throughout their academic study. In ESR, the researcher has also adopted a numerical value as standardized representation of the accumulated average data property.

5- <u>Academic Semester</u>: it refers to an instance of academic semester in which a student registers and complete courses during his/her academic study. In ESR, it is represented as a string data property with predefined values (First semester, Second Semester, or summer semester).

6- <u>Academic Year</u>: it refers to an instance of academic year in which a student register and complete courses during his/her academic study. In ESR, it is represented as a year range data property (e.g., 2023 - 2024). Figure (5.4) below illustrates the ontological representation of the academic record:

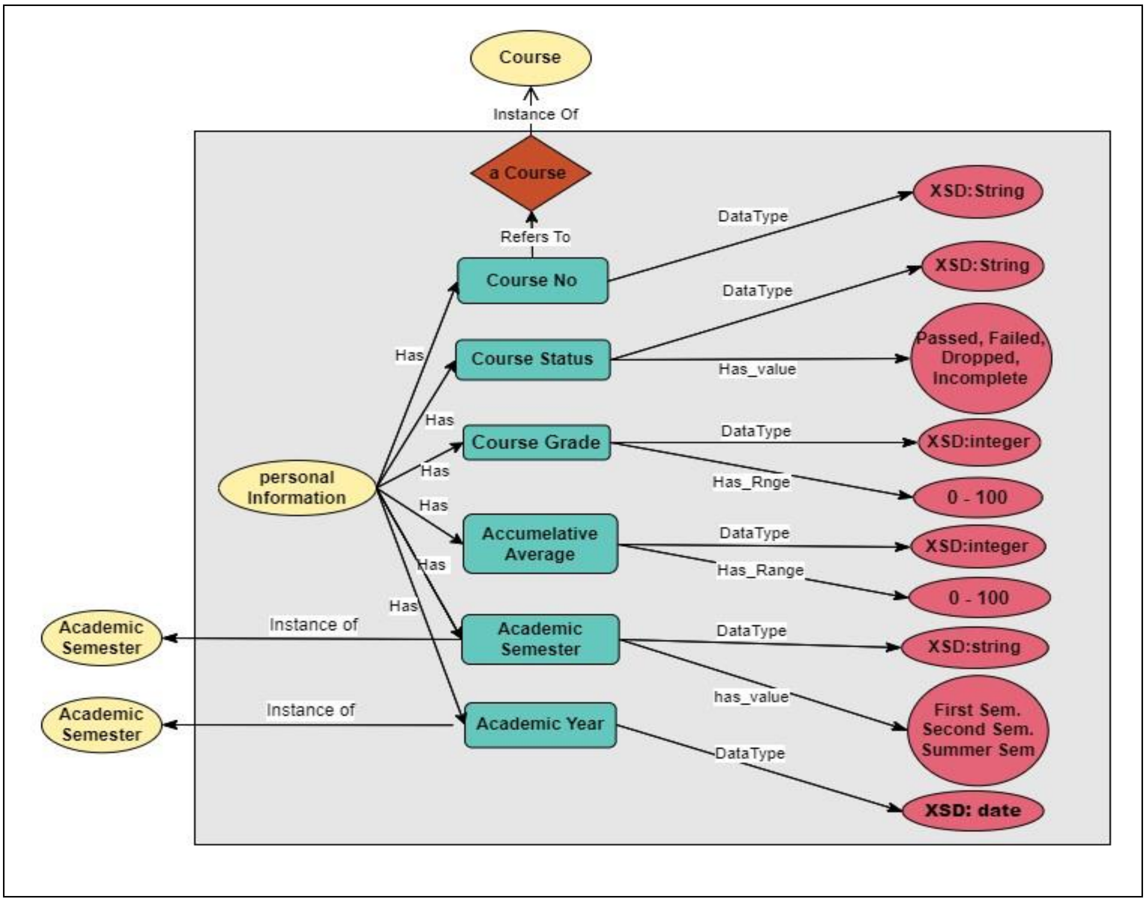

Figure 5.3: Standardized Representation of Student's Academic Record

5.2.5. ESR Ontology implementation

After detailing the design of the ESR and its related concepts, the Protégé[4] 5.5™ ontology modeling editor is applied to implement this proposed system. Technically, each of the aforementioned *concepts* is represented as an *owl: Class*[5], and the *relationships* between these concepts is represented as *owl:ObjectProperty*. With respect to the ESR, each *concept's instance* involved in the ESR is represented as *individual*. In addition, each data item is represented as an *owl:DataProperty* and the data types of each data element is represented as *xsd:datatype*[6] or *RDF:datatype*[7]. Finally, the domain of each concept has to be specified. For instance, the domain of the concept *AJP* involves all joint programs. In this context, we create several instances for some concepts involved in ESR as *individuals*. Figure (5.5) below illustrates an excerpt of the LCO implementation.

---

[4] http://protege.stanford.edu/

[5] OWL is a Web Ontology Language. It is described in more details on: http://www.w3.org/TR/owl-ref/

[6] xsd is an XML Schema Definition Language. It is described in more details on: https://www.w3.org/TR/xmlschema11-1/

[7] RDF is a Resource Description Framework. It is described in details on: https://www.w3.org/RDF/

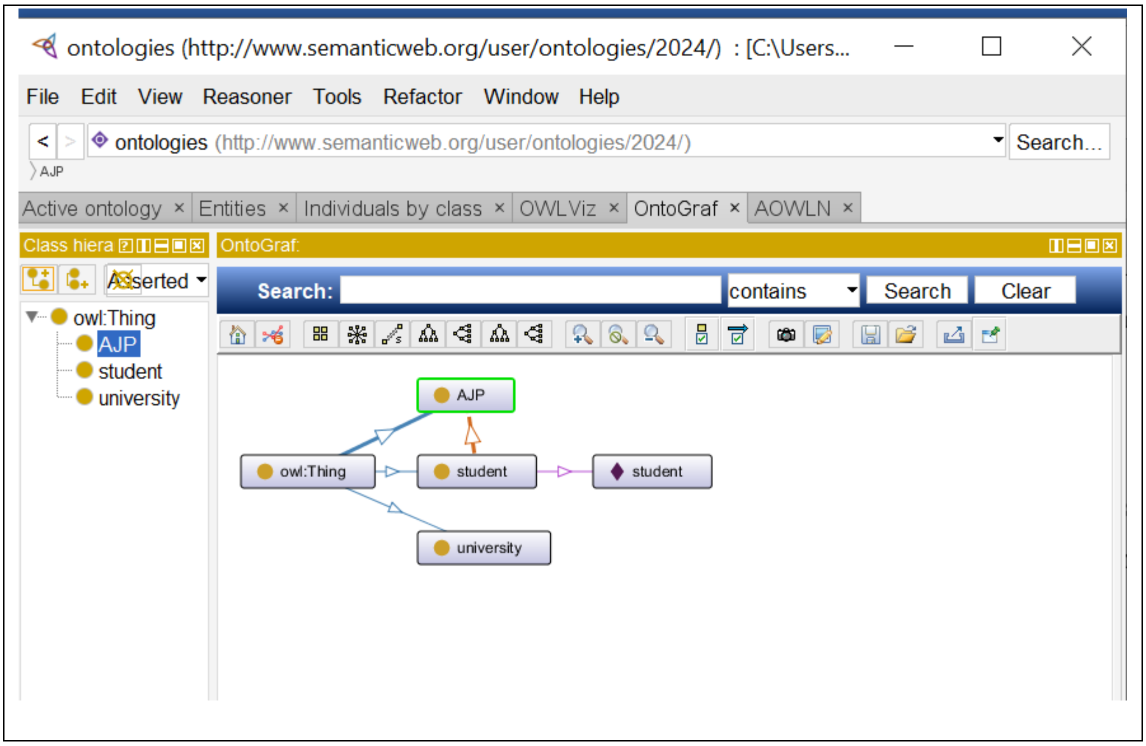

Figure 5.5: ESR Implementation using Protégé Editor

5.3. Architectural Design

This section describes the researcher's vision concerning the architectural design that is intended to support this study proposed approach. The design focuses on the following three aspects. First, the main components that is necessary to accomplish the adaptation process, second, a high-level description concerning the interaction of participating universities' applications with these components for exchanging students' data and third are the development of architectural components from technological perspective.

5.3.1. Architecture Description

Figure 5.6 below depicts our proposed architecture. This architecture encompasses two layers: Standard ESR ontology, Extended University applications with adaption module.

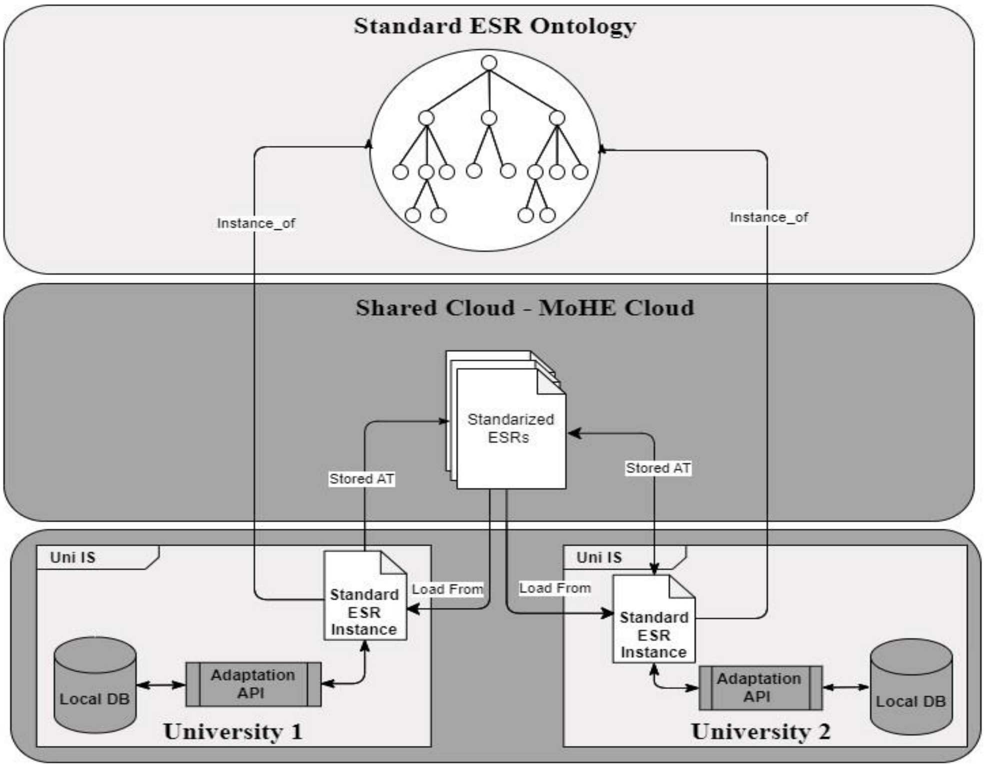

Figure 5.4: Proposed Architecture Design

The *standard ESR ontology* presents a common conceptualization of the students' data that has to be exchanged by participating universities. This will provide the sematic metadata that allows universities' applications to interpret and exchange students' data. In addition, the adaption module extends each university application with a set of adaptation APIs. These APIs will be used to extract students' data from local database of a participating university; adapt these data based on the proposed standardized ESR ontology; and finally to generate an instance of ESR document.

In order to facilitate the exchange of students' ESR by participating universities, our proposed architecture suggests to store the generated ESR instances into a third party data cloud (i.e., data server) such as the MoHE data cloud. On the other side, each participating university can download a student's ESR from that cloud when it needs to access that student's data. Also, it can adapt student's data that is downloaded as well as store a copy from these data in its local database.

5.3.2. Development of the Adaption APIs

Figure 5.4.1 above introduced, the proposed architecture extends each university application with an adaptation module that involves a set of adaptation of APIs. Whereas this section describes our vision on how to develop the adaptation of APIs. In this context, the APIs are mainly used to accomplish the following tasks, shown in Figure (5.5.):

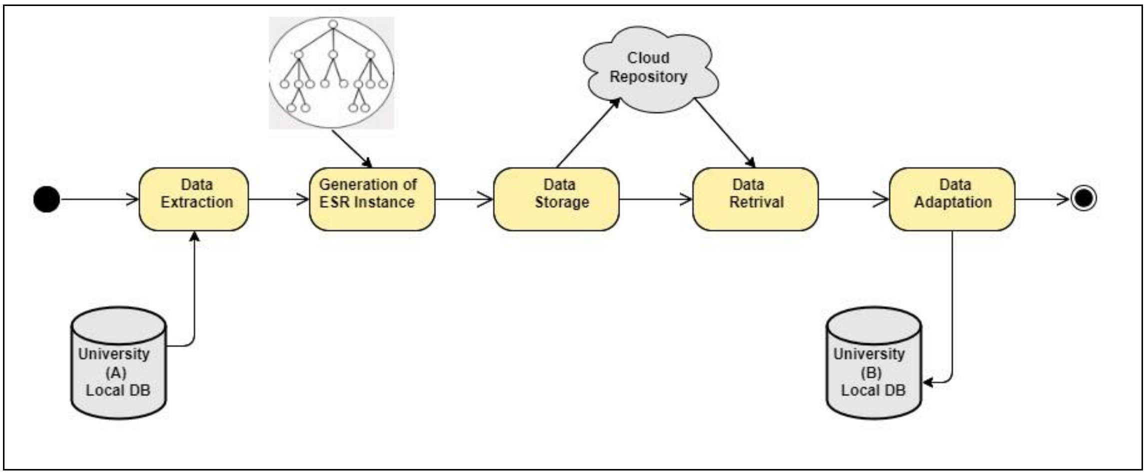

Figure 5.5: Adaption Process - Detailed Tasks

5.3.3. Data Extraction

The API is connected to the university's local database where student records are stored. Then, it retrieves relevant student’s information (i.e., personal information, beside the records of enrollment, and academic). This step ensures that the most current and comprehensive data for each student is available for standardization and exchange.

5.3.4. Generating a Standardized ESR Instance

The API processes the extracted student data and converts it into a standardized format based on the ESR ontology and other common concepts. This involves mapping local data items to the standardized terms and structures agreed upon by all participating universities. Here, the mapping process depends on the local setting of the university; such as the academic systems and the local program instructions. The resulting standardized ESR instance is expected to ensure that the data is consistent and interpretable across different institutions.

5.3.5. Data Storage

Once the student's data is standardized, the API securely uploads these ESR instances to a central cloud storage managed by a third party, such as the Ministry of Higher Education (MoHE) cloud. This cloud storage acts as a centralized repository where all standardized student records are kept, ensuring accessibility and security. The API includes mechanisms to ensure data privacy and integrity during the upload process, using encryption and secure transmission protocols.

5.3.6. Data Retrieval

When a University needs to access standardized student records, the API retrieves the relevant ESR instances from the central cloud storage. This involves querying the cloud database and downloading the required records. The API ensures that the data is securely transferred and remains intact during the retrieval process.

5.3.7. Data Adaptation to Local Format

After retrieving the standardized ESR instances, the API converts this data back into the university's local format. This involves mapping the standardized fields and values to the local data structures and terms used by that university’s systems. The API ensures that the adapted data is accurate and fits seamlessly into the local database, preserving all necessary details and relationships.

5.3.8. Data Integration

The API then stores the adapted student records in the university's local database. It updates the existing records or creates new entries as needed, ensuring that the local database reflects the most up-to-date information. This step makes the process of storage achieved, enabling the university to use the imported student data for administrative, academic, and reporting purposes.

From technological perspective, the tasks of the adaptation APIs can be implemented using a general-purpose programming language such as Java, PHP, or Python, and the ESR ontology instance can be normalized into an XML document.

CHAPTER VI. RESULTS AND RECOMMENDATIONS

6. Results and Recommendations:

6.1. Introduction

Chapter VI. explores the results and recommendations derived from the study. It actually specifies outstanding results concerning the interoperability between information systems within Palestinian universities and underscores the chosen proposition ensuing from the analysis of study tools. Additionally, it includes recommendations formulated to enhance interoperability between Palestinian universities in joint programs.

6.2. Results

The following are the major results that the researcher has come out with:

- Palestinian universities utilize their local systems for registration processes and for the exchange of data and information in the joint programs. This is usually conducted on cooperative agreements signed with partner universities towards organizing the exchange of student records.
- Palestinian universities primarily depend on email as the primary tool for exchanging student records, supplemented by traditional manual exchange of student records, with the absence of a dedicated data exchange system between them.
- The types of data exchanged between Palestinian universities in joint programs are categorized into: similar, semi-similar, and different data.
- Not all students' data need to be exchanged between the participating universities
- The concepts/terms, and values of some data that are used to refer to students' data might be different in different universities.

- “Mapping to Standardized Electronic Student Record” represents the best alternative to implement interoperability between Palestinian universities.
- The common conceptualization of ESR data at syntactic and semantic levels must be included, and the participating universities need to agree and adopt this common conceptualization.

6.3. Recommendations

Consequently, the researcher proposes these recommendations as to:

- Create a unified standardized framework and credit system that allows seamless student transfers between universities. This can be achieved through establishing clear credit transfer protocols, designing a cohesive framework, integrating compatible technology solutions, and fostering collaboration among educational institutions.
- Develop and adopt of an API protocol to enable smooth transfer of academic records and students' data between universities utilizing the available API protocol or developing special an API that best meets the requirements of different universities, ensuring interoperability while maintaining their existing systems...
- Train the faculty involved in joint programs on the application and use of interoperable technologies and collaborative teaching methods.
- Increase investments in IT infrastructure to support interoperable systems لاy focusing on developmental projects for IT infrastructure in Palestinian higher education institutions and seeking the required financial support from various governmental and private sources.

References:

Adel, E., El-Sappagh, S., Barakat, S., & Elmogy, M. (2019). A unified fuzzy ontology for distributed electronic health record semantic interoperability. In *U-Healthcare Monitoring Systems* (pp. 353-395): Elsevier.

AlDamen, M. (2007). *Fundamentals of scientific research* (Vol. 1st edition). Amman, Jordan: Dar Al-Massira House for printing and publishing.

Alshenqeeti, H. (2014). Interviewing as a data collection method: A critical review. *English linguistics research*, 3(1), 39-45.

Arar, R., Abdallah, T. & Shana'ah, H., (2021). Efficiency and independence Choice of university major Field study on Palestinian university students. *Palestinian Vision Institute*. Jerusalem, Palestine.

Arar, R., & Riahi, M. (2021). Choice of University Major, and Future Vision of University Students in Palestine. *Palestine Technical University Research Journal, 9(3)*, 143–122.

Bencheva, N., Zahariev, P., & Takruri-Rizk, H. (2017). *Building a share understanding of the Joint MSc in Electrical Engineering in three Palestinian Universities based on EU practices*. Paper presented at the 2017 27th EAEEIE Annual Conference (EAEEIE).

Brayda, W. C., & Boyce, T. D. (2014). So you really want to interview me?: Navigating “sensitive” qualitative research interviewing. *International Journal of Qualitative Methods, 13*(1), 318-334.

Castronova, A., Goodall, J., & Ercan, M. (2013). Integrated modeling within a hydrologic information system: an OpenMI based approach. *Journal of Environmental Modelling Software, 39*, 263-273.

Dandan, H., Yajuan, Z., Junfeng, L., Chen, L., Mo, X., & Zhihai, S. (2017). *Research on centralized data-sharing model based on master data management*. Paper presented at the MATEC Web of Conferences.

Durnali, M. (2013). *The contributions of e-school, a student information management system, to the data processes, environment, education and economy of Turkey*. Paper presented at the Proceedings of the Asian Conference on Technology in the Classroom.

Dzimińska, M., Fijałkowska, J., & Sułkowski, Ł. (2018). Trust-based quality culture conceptual model for higher education institutions. *Sustainability*, *10*(8), 2599.

Gansel, X., Mary, M., van Belkum, A., & Diseases, I. (2019). Semantic data interoperability, digital medicine, and e-health in infectious disease management: a review. *European Journal of Clinical Microbiology, 38*, 1023-1034.

Harvey, F., Kuhn, W., Pundt, H., Bishr, Y., & Riedemann, C. (1999). Semantic interoperability: A central issue for sharing geographic information. *The annals of regional science*, *33*, 213-232.

Iroju, O., Soriyan, A., Gambo, I., Olaleke, J., & Studies, A. (2013). Interoperability in healthcare: benefits, challenges and resolutions. *International Journal of Innovation, 3*(1), 262-270.

Ise, O. A. (2014). Towards a Unified University information system: bridging the gap of data interoperability. *American Journal of Software Engineering, 2*(2), 26-32.

Jaabari, M., Hainaut, J. & Thiran, P. (2011). *Enhancing Web 2.0 Usability: Handling the Local Contexts of Web Users*. (Doctoral Thesis). University of Namur. Namur, Belgium.

Jakimoski, K. (2016). Challenges of interoperability and integration in education information systems. *International Journal of Database Theory Application, 9*(2), 33-46.

Kallet, R. H. (2004). How to write the methods section of a research paper. *Respiratory care, 49*(10), 1229-1232.

Leavy, P. (2017). *Handbook of arts-based research: Guilford Publications.*

Luna, D., Campos, F., & Otero, C. (2019). Interoperability in Digital Health: Reference Material. *Publications IADB.*

Matney, S. A. (2016). Semantic interoperability: the good, the bad, and the ugly. *Nursing*, *46*(10), 23-24.

MOHE. (2022). *Higher Education Institutions statistical yearbook*.

Ngulube, P., & Chinyemba, A. (2005). Managing records at higher education institutions: a case study of the University of KwaZulu-Natal, Pietermaritzburg Campus. *South African Journal of Information Management, 7*(1).

Noureen, S. (2019). *Student privacy preserving framework based on blockchain technology*. CAPITAL UNIVERSITY,

OASIS. (2022). *Interoperability: Definition and scope*. Open Standards for the Information Society. Retrieved from https://www.oasis-open.org/standards#interoperability

Odeh, K. (2005). I*ntegration of postgraduate programs in Palestinian Universities.* Islamic University Gaza.

Patra, S. (2019). *Questionnaire design. In Methodological issues in management research: Advances, challenges, and the way ahead* (pp. 53-78): Emerald Publishing Limited.

Polit, D., & Hungler, B. (1999). *Nursing Research, Principles and Methods Lippin Cott*. In: Philadelphia.

Qeshta, A. & Najim, M. (2020). A Proposed Strategy to Achieve theCompetitive Advantage in the Palestinian Universities. *Journal of Research & Method in Education. 10*(1), 61,68.

Reisman, M. (2017). EHRs: the challenge of making electronic data usable and interoperable. *Pharmacy Therapeutics, 42*(9), 572.

Ribeiro, L. M., Pereira, R. H., Pacheco, O., Bernardes, M., & Martins, R. T. (2016). *Interoperability between information systems of Portuguese higher education institutions*. Paper presented at the EUNIS 22nd Annual Congress Book of Proceedings.

Shalabi, F. (2017). Internationalization of the Palestinian Higher Education. *Journal of the Association of Arab Universities for Higher Education Research, 37*(3).

Secundo, G., Margherita, A., Elia, G., & Passiante, G. (2010). Intangible assets in higher education and research: mission, performance or both?. *Journal of intellectual capital*, *11*(2), 140-157.

Subosa, M., & West, M. (2018). *Re-orienting Education Management Information Systems (EMIS) towards inclusive and equitable quality education and lifelong learning*.

Zach, L., & Peri, M. (2010). Practices for college and University electronic records management (ERM) programs: then and now. *The American Archivist, 73*(1), 105-128.

Appendices:

Appendix (1) Interview Form

المقابلة:

- ما هي البرامج المشتركة بين جامعة الخليل والجامعات الفلسطينية؟

- هل يتم التعامل مع جميع البرامج المشتركة بنفس النظام/الية أم أن كل برنامج مشترك له نظام خاص ويختلف عن أنظمة البرامج المشتركة الأخرى (بمعنى أن كل نظام له اتفاقية خاصة)؟

- ما هي البيانات التي يتم تبادلها بين الجامعات؟

- ما هي أوجه التشابه وأوجه الاختلاف في البرامج المشتركة؟

	موحد	مختلف
الخطة الدراسية		
نظام العلامات		
خطط المساقات		
المعاملات المالية		
بيانات الطلبة		

- كيف يتم تبادل البيانات المختلفة بين الجامعات، وما هي التعديلات التي تتم على هذه البيانات.

اهم البيانات الرئيسة:

- ○ شروط ومعدلات القبول
- ○ علامة النجاح والرسوب في المساقات
- ○ اجراءات التسجيل والحد الادنى والاعلى لعدد الساعات المسموح بتسجيلها
- ○ علامات الطلاب
- ○ المعاملات المالية
- ○ البيانات ديموغرافية
- ○ بيانات المساقات المطلوبة والمتبقية

- **متطلبات التخرج الاكاديمية وغير الأكاديمية**

كيف تتم عملية التبادل؟ وما هي اهم التعديلات التي تتم على هذه البيانات؟؟

- ما هي الأوقات التي يتم فيها تبادل البيانات؟

يومي	اسبوعي	فصلي	سنوي

- كيف يتم اعتماد الشهادة وتصديقها وإصدارها بين الأطراف في البرامج المشتركة؟

- ما هي طريقة تبادل المعلومات؟

ورقي	الكتروني	ايميل	باستخدام نظام موحد

- كيف تتم حل مشاكل التسجيل التي تواجه الطلبة؟

- هل يشترط للطالب المسجل للبرنامج المشترك الحصول على القبول لهذا البرنامج من قبل كلا الجامعتين أو إحداهما؟

- هل تكون كلا الجامعتين على اطلاع بوضع الطالب الأكاديمي في الدراسات السابقة مثل البكالوريوس ام تكون الشهادة كافية لكلا الجامعتين؟

- هل يوجد مساقات يستطيع الطالب اخذها في كلا الجامعتين، او هل يوجد مساقات يشترط على الطالب أخذها في احدى الجامعتين؟

- هل يحتوي البرنامج المشترك على ورشات تدريبية أو مساقات مشتركة إذا كان الامر كذلك كيف تتم عملية إدارتها؟

- هل توجد عملية منظمة لاستفادة الطالب من احد اساتذة هذا البرنامج من كلا الجامعتين

ما هي آلية التعامل مع المساقات التي لها طابع خاص مثل مساق **رسالة الماجستير**، **مساق مشروع التخرج**، مساق التدريب الميداني، ...؟

Appendix (2) Questionnaire Form

الاستبيان

السادة الأعزاء:

يجري الباحث دراسة بعنوان: نحو تعزيز التبادل بين نظم المعلومات في مؤسسات التعليم العالي في فلسطين. كمحاولة للوفاء بمتطلبات درجة الماجستير. ويعمل على جمع البيانات المتعلقة بتبادل بيانات الطلاب عبر برامج الماجستير المشتركة في جامعة الخليل. نتمنى أن تجيبوا على البنود المحددة بموضوعية مع العلم أن جميع الإجابات سرية وتستعمل لأغراض البحث العلمي فقط.

الباحث: إسراء شاور

المشرف: د. مهند الجعبري

الجزء الأول: المعلومات الديموغرافية

العمر:

- **30>**
- **39-30**
- **49-40**
- **50 <**

مكان العمل:

- **جامعة الخليل**
- **جامعة القدس**
- **جامعة الاستقلال**
- **الجامعة العربية الأمريكية**
- **أخرى**

سنوات الخبرة (بعد التدريب)

- **4 - 1**
- **8 - 5**
- **12-9**
- **أكبر من 12**

الوظيفة الحالية (يسمح بالاختيار المتعدد)

- **عميد كلية الدراسات العليا**
- **رئيس برنامج الماجستير**
- **أستاذ أكاديمي (تدريس مقررات برنامج مشترك)**
- **سكرتير**
- **موظف قسم التسجيل**

الجزء الثاني: تبادل بيانات الطلاب في البرامج المشتركة

هل يمكنك الحصول إلكترونيًا على بيانات / معلومات الطلاب التي يحتاجونها من جامعات أخرى باستخدام نظام المعلومات الخاص بجامعتك؟

- **نعم**
- **لا**

هل يمكنك الحصول إلكترونيًا على بيانات / معلومات الطلاب التي يحتاجون إليها من جامعة أخرى باستخدام أنظمة المعلومات الخاصة بالجامعات الأخرى؟ *

- **نعم**
- **لا**

عادةً ما يتم إرسال بيانات / معلومات الطلاب المتعلقة بالطلاب المسجلين في إحدى الجامعات الشريكة واستلامها باستخدام: *حدد خيارًا واحدًا

- **ورق**
- **فاكس**
- **البريد الإلكتروني**
- **النظام المحوسب/الالكتروني**

الإطار الزمني المعتاد لتلقي المعلومات؟ *حدد خيارًا واحدًا

- **خلال 30 دقيقة**
- **خلال 24 ساعة**
- **من 2 إلى 3 أيام**
- **أكثر من 3 أيام**

الجزء 2: حواجز التشغيل البيني

برأيك، ما هي العوائق التي تمنعك من الحصول إلكترونيًا على البيانات / المعلومات التي تحتاجها من الجامعات الشريكة الأخرى؟ * (حدد خيارًا واحدًا لكل صف)

	موافق بشدة	**موافق**	**محايد**	**غير موافق**	**غير موافق بشدة**
لا توجد نسخة إلكترونية من النظام الأكاديمي في الجامعات الشريكة					
لا توجد بنية تحتية إلكترونية تدعم تبادل البيانات / المعلومات					
تفضل الجامعة الاعتماد على مصادر معلوماتها الداخلية					
زيادة تكاليف المعلومات					
تبادل البيانات / المعلومات مكلف					
قد يتسبب تبادل البيانات / المعلومات في تسرب المعلومات الخاصة بالطالب					
لدى الجامعة سياسات صارمة فيما يتعلق بتبادل / مشاركة المعلومات					

الجزء 3: القوى الدافعة لقابلية التشغيل البيني

إلى أي مدى توافق على الحاجة إلى حل قابلية التشغيل البيني لتبادل البيانات عبر البرامج الأكاديمية الرئيسية المشتركة؟

	1	2	3	4	5	
غير موافق بشدة						موافق بشدة

برأيك، ما الفوائد التي ستجني من التبادل الإلكتروني لمعلومات الطلاب بين الجامعات الشريكة * (حدد خيارًا واحدًا لكل صف)

	موافق بشدة	**موافق**	**محايد**	**غير موافق**	**غير موافق بشدة**
الحصول على بيانات دقيقة (منع الأخطاء البشرية)					
تحسين اتخاذ القرار					
توفير الوقت					
يساعد الطلاب المسجلين في إحدى الجامعات الشريكة على الاستفادة من الأستاذ (الأساتذة) الذين يعملون في جامعة شريكة أخرى					
تساعد جامعات الشركاء في التعامل مع الدورات ذات الطبيعة الخاصة، مثل دورة أطروحة الماجستير، ودورة مشروع التخرج، ودورة التدريب الميداني.					
مساعدة الجامعات الشريكة في عقد ورش عمل تدريبية ودورات مشتركة					
يساعد الطلاب على التسجيل في الدورات التي يمكن الالتحاق بها في جامعتين أو أكثر من الجامعات الشريكة					

هل هناك مساقات يجب على الطالب دراستها في إحدى الجامعتين؟					
يساعد الجامعات الشريكة على أن تكون على دراية بالوضع الأكاديمي الحالي للطلاب					
تساعد الجامعات الشريكة في التعرف على الوضع الأكاديمي السابق للطلاب مثل درجة البكالوريوس، وما إذا كانت هذه الشهادة كافية لكلا الجامعتين؟					
يساعد الجامعات الشريكة في التحقق من متطلبات قبول الطلاب المسجلين في برنامج مشترك					
يساعد الجامعات الشريكة على فهم المتطلبات الخاصة و / أو الاختلافات الخاصة في النظام الأكاديمي الموجود في الجامعات الشريكة					

Appendix (3) Frequency Tables for Questionnaire

العمر

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	أقل من 30 سنة	6	24.0	24.0	24.0
	30-39سنة	4	16.0	16.0	40.0
	40-49سنة	5	20.0	20.0	60.0
	أكبر من 50 سنة	10	40.0	40.0	100.0
	Total	25	100.0	100.0	

مكان العمل

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	جامعة الخليل	16	64.0	64.0	64.0
	جامعة بوليتكنك فلسطين	9	36.0	36.0	100.0
	Total	25	100.0	100.0	

سنوات الخبرة

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	أقل من 9 سنوات	7	28.0	28.0	28.0
	9-12سنة	3	12.0	12.0	40.0
	أكثر من 12 سنة	15	60.0	60.0	100.0
	Total	25	100.0	100.0	

الوظيفة الحالية

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	منسق -رئيس برنامج الماجستير	2	8.0	8.0	8.0
	مدرس -أستاذ أكاديمي	10	40.0	40.0	48.0
	قسم التسجيل	4	16.0	16.0	64.0
	إداري	2	8.0	8.0	72.0
	طالب	7	28.0	28.0	100.0
	Total	25	100.0	100.0	

هل يمكنك الحصول إلكترونيًا على البيانات / المعلومات التي يحتاجون إليها من جامعة أخرى باستخدام أنظمة المعلومات الخاصة بالجامعات الأخرى؟*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	13	52.0	52.0	52.0
	2	12	48.0	48.0	100.0
	Total	25	100.0	100.0	

عادةً ما يتم إرسال البيانات / المعلومات المتعلقة بالطلاب المسجلين في إحدى الجامعات الشريكة واستلامها باستخدام* :

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	النظام المحوسب	1	4.0	4.0	4.0
	البريد الإلكتروني	14	56.0	56.0	60.0
	ورقي	10	40.0	40.0	100.0
	Total	25	100.0	100.0	

الإطار الزمني المعتاد لتلقي المعلومات؟*

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	خلال 24 ساعة	6	24.0	24.0	24.0
	من 2 إلى 3 أيام	8	32.0	32.0	56.0
	أكثر من 3 أيام	11	44.0	44.0	100.0
	Total	25	100.0	100.0	

إلى أي مدى توافق على الحاجة إلى حل قابلية التشغيل البيني لتبادل البيانات عبر البرامج الأكاديمية الرئيسية المشتركة؟

	1	2	3	4	5	
غير موافق بشدة						موافق بشدة

لا توجد نسخة إلكترونية من النظام الأكاديمي في الجامعات الشريكة"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	2	8.0	8.0	8.0
	2	3	12.0	12.0	20.0
	3	4	16.0	16.0	36.0
	4	11	44.0	44.0	80.0

	5	5	20.0	20.0	100.0
	Total	25	100.0	100.0	

لا توجد بنية تحتية إلكترونية تدعم تبادل البيانات / المعلومات"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	3	12.0	12.0	12.0
	2	7	28.0	28.0	40.0
	3	3	12.0	12.0	52.0
	4	8	32.0	32.0	84.0
	5	4	16.0	16.0	100.0
	Total	25	100.0	100.0	

تفضل الجامعة الاعتماد على مصادر معلوماتها الداخلية"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.0	4.0	4.0
	2	2	8.0	8.0	12.0
	3	3	12.0	12.0	24.0
	4	13	52.0	52.0	76.0
	5	6	24.0	24.0	100.0
	Total	25	100.0	100.0	

زيادة التكاليف"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	16.0	16.0	16.0
	2	3	12.0	12.0	28.0
	3	8	32.0	32.0	60.0
	4	8	32.0	32.0	92.0
	5	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

تبادل البيانات / المعلومات مكلف"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	5	20.0	20.0	20.0
	2	9	36.0	36.0	56.0

	3	5	20.0	20.0	76.0
	4	3	12.0	12.0	88.0
	5	3	12.0	12.0	100.0
	Total	25	100.0	100.0	

قد يتسبب تبادل البيانات / المعلومات في تسرب المعلومات الخاصة بالطالب"

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	4	16.0	16.0	16.0
	2	9	36.0	36.0	52.0
	3	4	16.0	16.0	68.0
	4	8	32.0	32.0	100.0
	Total	25	100.0	100.0	

لدى الجامعة سياسات صارمة فيما يتعلق بتبادل / مشاركة المعلومات

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	12.0	12.0	12.0
	3	13	52.0	52.0	64.0
	4	7	28.0	28.0	92.0
	5	2	8.0	8.0	100.0
	Total	25	100.0	100.0	

الحصول على بيانات دقيقة (منع الأخطاء البشرية)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.0	4.0	4.0
	2	1	4.0	4.0	8.0
	3	2	8.0	8.0	16.0
	4	12	48.0	48.0	64.0
	5	9	36.0	36.0	100.0
	Total	25	100.0	100.0	

تحسين اتخاذ القرار

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.0	4.0	4.0
	2	1	4.0	4.0	8.0

	4	10	40.0	40.0	48.0
	5	13	52.0	52.0	100.0
	Total	25	100.0	100.0	

توفير الوقت

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	2	8.0	8.0	8.0
	4	10	40.0	40.0	48.0
	5	13	52.0	52.0	100.0
	Total	25	100.0	100.0	

يساعد الطلاب المسجلين في إحدى الجامعات الشريكة على الاستفادة من الأستاذ) الأساتذة (الذين يعملون في جامعة شريكة أخرى

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	4	16.0	16.0	16.0
	4	13	52.0	52.0	68.0
	5	8	32.0	32.0	100.0
	Total	25	100.0	100.0	

تساعد جامعات الشركاء في التعامل مع المساقات ذات الطبيعة الخاصة، مثل مساق أطروحة الماجستير، ودورة مشروع التخرج، ودورة التدريب الميداني.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	7	28.0	28.0	28.0
	4	14	56.0	56.0	84.0
	5	4	16.0	16.0	100.0
	Total	25	100.0	100.0	

مساعدة الجامعات الشريكة في عقد ورش عمل تدريبية ودورات مشتركة

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1	1	4.0	4.0	4.0
	2	5	20.0	20.0	24.0
	3	7	28.0	28.0	52.0
	4	11	44.0	44.0	96.0
	5	1	4.0	4.0	100.0
	Total	25	100.0	100.0	

يساعد الطلاب على التسجيل في الدورات التي يمكن الالتحاق بها في جامعتين أو أكثر من الجامعات الشريكة

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	7	28.0	28.0	28.0
	4	13	52.0	52.0	80.0
	5	5	20.0	20.0	100.0
	Total	25	100.0	100.0	

هل هناك مساقات يجب على الطالب دراستها في إحدى الجامعتين؟

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	4.0	4.0	4.0
	3	3	12.0	12.0	16.0
	4	12	48.0	48.0	64.0
	5	9	36.0	36.0	100.0
	Total	25	100.0	100.0	

يساعد الجامعات الشريكة على أن تكون على دراية بالوضع الأكاديمي الحالي للطلاب

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	3	12.0	12.0	12.0
	3	2	8.0	8.0	20.0
	4	11	44.0	44.0	64.0
	5	9	36.0	36.0	100.0
	Total	25	100.0	100.0	

تساعد الجامعات الشريكة في التعرف على الوضع الأكاديمي السابق للطلاب مثل درجة البكالوريوس، وما إذا كانت هذه الشهادة كافية لكلا الجامعتين؟

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2	1	4.0	4.0	4.0
	3	5	20.0	20.0	24.0
	4	12	48.0	48.0	72.0
	5	7	28.0	28.0	100.0
	Total	25	100.0	100.0	

يساعد الجامعات الشريكة في التحقق من متطلبات قبول الطلاب المسجلين في برنامج مشترك

		Frequency	Percent	Valid Percent	Cumulative Percent

Valid	3	2	8.0	8.0	8.0
	4	11	44.0	44.0	52.0
	5	12	48.0	48.0	100.0
	Total	25	100.0	100.0	

يساعد الجامعات الشريكة على فهم المتطلبات الخاصة و / أو الاختلافات الخاصة في النظام الأكاديمي الموجود في الجامعات الشريكة

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3	2	8.0	8.0	8.0
	4	15	60.0	60.0	68.0
	5	8	32.0	32.0	100.0
	Total	25	100.0	100.0	