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UNIVERSITY OF SOUTHAMPTON

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A Trust Framework for Information Sharing

by

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Thesis for the degree of Doctor of Philosophy

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ABSTRACT

FACULTY OF ENGINEERING AND PHYSICAL SCIENCE
SCHOOL OF ELECTRONICS AND COMPUTER SCIENCE

Doctor of Philosophy

A TRUST FRAMEWORK FOR INFORMATION SHARING

by Rayan Mohamed S Ghamri

The Kingdom of Saudi Arabia (KSA) is planning Vision 2030 to improve the outcomes of its education and training system and subsequently to develop a local and global labour market. The country needs to establish KSA's current educational and employment status, as this will assist in finding areas that need development to support government planning and human resource capital, mainly since education is provided and funded by the government. Since the government funds education, most young people study whatever they like or what is readily available. That means it creates a dearth of a particular graduate's specialisation and an overflow of another, which leads to training and educating more graduates majoring in subjects than the employment market needs or not training enough graduates in specific areas the employment market needs. Without information sharing between employment and education, it lowers having accurate information to make economic growth decisions. This novel framework assists in finding the numbers of skilled candidates, vacancy opportunities and learners in one place, thus ensuring sustainability, efficiency and effectiveness.

In light of the above, there is a need for a research project to explore how best to allocate and share trusted and accurate information on educational certificates and employment achievements while preserving the privacy and security of stakeholders' digital assets. This research examines current practices in information-sharing of educational certificates and employment history verification in the integrated environment intending to reduce wasted resources. Part of the e-government system, the scheme considers aspects relating to both KSA's unique context and information-sharing technologies, making it highly relevant and context-specific. A prerequisite is a framework of factors to enable information-sharing among educational providers, employers and the government.

This research introduces a novel framework comprising four principal dimensions: Facilitating Conditions, IT Services, Secure Access, and Trust and Accuracy (FIST). These four elements collectively form the basis of the innovative framework, named the 'FIST Framework,' an acronym derived from the initial letter of each dimension. The FIST Framework aims to help software engineers structure an integration system at an early stage of the software development life cycle. Four dimensions characterise the architecture: **F**acilitating Conditions; **I**T Services; **S**ecure Access; and **T**rust and Accuracy. Each has six requirements (factors) defined in natural language for software engineers when implementing the FIST Framework. The purpose is to preserve the trust and accuracy of integrated data (Shared or Exchanged) that contain both organisations' and individuals' personal and private data.

The primary objective of this research is to build a robust framework, known as the FIST framework, developed to improve the outcomes of education and training systems to strengthen economic growth in the labour sector through information sharing. This framework development happened through comprehensive expert reviews and analysis. The core purpose of the FIST framework is to tackle two hidden but critical problems in data integration: Trust and Accuracy. Experts often express concern regarding the trustworthiness of data integration, primarily due to the potential unavailability of data. Additionally, there needs to be more accuracy, particularly in identifying the data sources. This lack of trust and observed inaccuracy pose significant challenges for data integration. This research used the Delphi method to confirm and expose various factors and their associated requirements. It involved a systematic approach for gathering requirements, primarily focusing on human interactions, then a modelling approach for designing interaction models.

Formal Modelling is essential in validating the critical tasks of systems based on the FIST framework. Utilising Rodin for rigorous analysis, this approach strengthens the system by ensuring robustness and detecting inconsistencies in data integration, sharing, and exchange. This process is necessary for the FIST framework's integrity, which involves simulating various scenarios to test the data integration system's effectiveness against theoretical and real-world requirements. The outcome is a reliable, trusted system for essential tasks in education and employment. Formal Modelling demonstrates the FIST framework's theoretical soundness and practical effectiveness, especially in maintaining trust and accuracy in data integration. Applying Formal Modelling rectifies potential weaknesses, enhancing the FIST framework's recognition and stakeholder confidence.

To my beloved parents

My deepest and sincerest gratitude is reserved for you, my beloved mother and father. Your unconditional love and unwavering support have been the pillars of my strength. Your belief in me pushed me forward even during the most challenging times. Thank you, Mom and Dad.

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To my darling daughters

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I hope these acknowledgements justify my deep gratitude towards each of you. Thank you for being a part of my journey.

Declaration of Authorship

I, Rayan Mohamed S Ghamri, declare that this thesis and the work presented in it is my own and has been generated by me as the result of my own original research.

Title of thesis: A Trust Framework for Information Sharing

I confirm that:

1. This work was done wholly or mainly while in candidature for a research degree at this University;
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3. Where I have consulted the published work of others, this is always clearly attributed;
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6. Where the thesis is based on work done by myself jointly with others, I have made clear exactly what was done by others and what I have contributed myself;
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List of Abbreviations

CEOALM	Centre for Alignment of Educational Outcomes with the Labour Market
CV	Curriculum Vitae (Resume)
FIST	F acilitating... I T... S ecurity... T rust...
FITS	F acilitating... I T... T rust... S ecurity...
GOSI	General Organisation for Social Insurance
HRM	Human Resources Management
HRSD	Ministry of Human Resources and Social Development
ICT	Information and Communication Technology
IT	Information Technology
KSA	Kingdom of Saudi Arabia
MCS	Ministry of Civil Service
MEP	Ministry of Economy and Planning
MLSD	Ministry of Labor and Social Development
MOE	Ministry of Education
MOI	Ministry of Interior
NSHR	National Society for Human Rights in Saudi Arabia
PPA	Public Pension Agency
SCFHS	Saudi Commission for Health Specialties
SR	Saudi Riyal

Thesis-Specific Terminology

FITS	This abbreviation, primarily introduced in Chapter 4 and occasionally referenced elsewhere, signifies the initial version of the framework.
FIST	This abbreviation, primarily utilised from Chapter 5 onward, denotes the ultimate iteration of the framework.
System Integration	This is the process of linking together different systems, meaning various systems or components work together in a coordinated manner. This process facilitates data allocation and data assignment.
Data Integration	This is the process of combining data from different systems, meaning data from various systems is combined. This process facilitates data exchange or data sharing.
Colour Coding	Throughout the thesis, several figures are colour-coded. These colours correspond to different categories within the FIST framework, providing a visual aid for understanding the structure and components of the framework.
Trust	In the context of this research, the term 'trust' predominantly refers to the availability of information for exchange. This definition aligns with the perspective of the experts involved in the study, although it may suggest other meanings due to the interviews conducted in a different language.
Accuracy	The term 'accuracy,' as perceived by the experts, primarily denotes information sourced from an authorised entity responsible for data creation. Even if the entity is not the originator of the information, an attestation process is required to ensure the data's accuracy, thereby confirming its authenticity and reliability.

Chapter 1

Introduction

The Saudi government is planning to reduce counting on oil and advancing a promising development plan: Saudi Vision 2030. This research contributes to the Vision by investigating gaps, issues and challenges within educational certificates and employment records. This research was inspired by the Saudi Vision 2030 and how can it contribute to the development vision.

As Saudi Arabia government strides towards diversification from oil dependency and envisions a promising development plan, Saudi Vision 2030, this research aligns with these objectives by investigating prevalent gaps, issues, and challenges within educational certificates and employment records. Motivated by the transformative goals of Saudi Vision 2030, this research aims to contribute significantly towards fulfilling this development vision.

1.1 Research Overview

The Ministry of Education in Saudi Arabia caters to a burgeoning population of learners seeking quality education. The Ministry oversees many educational institutions, from private schools, universities, and colleges to vocational, technical and training institutes, providing learning opportunities for local and overseas students. As the principal awarding body for all scholarships to these institutions, the Ministry grapples with the challenge of understanding and aligning the varied learning outcomes of many qualifications with the needs of the labour market.

Young Saudi citizens and recent graduates often find navigating the labour market an uphill battle. Job hunting involves a labyrinth of procedures, from attending job fairs and sending resumes to recruitment departments to providing official documents and certificates to validate their credentials. Many graduates need help to showcase their

qualifications and experiences effectively, and employers find themselves investing substantial resources to fill vacant positions with suitable candidates.

The potential of new technologies to transform this landscape is significant. A trust-based platform integrating various systems to facilitate information-sharing can significantly streamline processes, ensuring efficient allocation and processing of critical information such as educational achievements and work experiences. Current practices, which involve the manual provision of information from multiple departments, can be overhauled to deliver more effective and streamlined services.

This trust-based platform would serve as a credible entity, validating the ownership and provenance of information and fostering trust in its accuracy and authenticity. The platform can assure more remarkable accuracy and reliability by designating the responsibility of providing specific pieces of information to respective information owners.

Additionally, the trust-based platform can enhance the security of citizens' digital information, offering privacy safeguards by permitting access to private information only upon authorisation. By maintaining comprehensive records of individuals' employment history, certified training, and achievements, the platform could assist the Ministry of Labour and Social Development (MLSD) in talent identification, reducing outsourcing and facilitating local talent development. Furthermore, by granting individuals the power to control their data, the platform can ensure privacy while fostering an environment conducive to skill showcasing and job match-making.

Furthermore, expert reviews were utilised in this research to identify and develop the factors contributing to the framework; this was followed by applying the Delphi method to validate and confirm these elements, creating a robust foundation for our platform.

Once validated, the factors were subjected to a systematic approach to evaluate their interactions and their efficacy in the overall framework. Critical elements like trust and accuracy, particularly regarding availability and authorisation, were brought to light during this exploration.

Subsequently, formal modelling was employed to examine the framework's completeness, sufficiency, and accuracy. This rigorous analytical process led to the critical revelation that the modelling of trust within the system was accurate and effectively integrated into the framework. The thoroughness of the formal modelling process served to underscore the robustness and validity of the framework, paving the way for its effective implementation.

1.2 Research Motivation

This research is motivated by the evolving demands of the labour market, the conspicuous absence of a dedicated information-sharing system among educational and employment organisations, and the inefficiencies of current document confirmation practices. It aims to address these influential factors and propose a more efficient and integrated approach to managing and confirming qualifications in the educational and employment sectors.

The **Motivations** for this research are:

1. **Dynamic Labor Market Needs:** The Saudi labour market demands are constantly inconstant, requiring a suitable and responsive approach.
2. **Absence of a Unified System:** There currently needs to be a dedicated system that facilitates information-sharing between various educational and employment organisations, which includes communication:
 - Among educational institutes.
 - Among employment organisations.
 - Between educational institutes and employment organisations.
3. **Resource Inefficiencies:** The existing practices for information confirmation, which heavily rely on manual document checks, lead to significant resource wastage, including time and human resources. These practices demand an urgent re-evaluation and refinement.

1.3 Research Problem and Research Statement

This research primarily focuses on clarifying two problems. The first involves identifying and addressing the principal issues from a social perspective within the specific context of Saudi Arabia. The second pertains to a comprehensive literature review to understand the technological aspects of information-sharing issues and the challenges associated with confirming the provided information. These two distinct yet interconnected paths form the basis of this research, shedding light on the cultural and technological factors of the problem.

Problem Statement:

There is a persistent imbalance between educational outcomes and labour market demands. Specific fields of study are witnessing an over-saturation of graduates, while other fields experience a significant dearth. This unsustainable imbalance leads to misalignment, creating a notable gap between educational institutions' products and the labour market's evolving needs.

The rapidly changing Saudi Arabian labour market, a significant gap exists between educational outcomes and market needs. This research explores the potential of information technology advancements to narrow this discrepancy and create a more aligned future.

The Research Statement:

Narrowing the disparity (inconsistency) between Saudi Arabian educational outputs and labour market requirements through information technology advancements in collaboration with the Ministry of Economy and Planning.

1.4 Conjecture

The conjecture is that a new system can alleviate some of the issues and solve the privacy and security challenges inherent in such a information-sharing system for education and employment. Through the use of new technologies that can confirm profiles, it is possible to create and allocate accurate citizen profiles and thus improve people's education and employment outcomes through information analysis. In other words, it is possible to study current and future potential to request and locate profiles by conducting profile-spotting by perusing confirmed profiles. Therefore, there is a need to develop a framework. The questions to consider are:

- How can technology provide an immutable and trustworthy system platform?
- What are the factors for government ministries in the development of a platform for information-sharing?
- How should e-government approach the new system's development to bring added value?

1.5 Aims and Research Questions

KSA is planning Vision 2030 to improve the outcomes of the education and training system and subsequently to develop a local and global labour market. The country needs to know citizens' current educational and employment achievements, as this will assist in determining which areas should be funded to support government planning.

The present research aims to provide a system for enabling the sharing of educational and employment information while preserving the accuracy and trust the shared information, also preserving security and privacy of KSA citizens. This is possible through the development of a framework to enable informant exchanges while providing a template for modelling trust in information exchange,

First Research Question

The First Research Question is:

What is a suitable framework for ensuring the accuracy of information shared between Saudi Arabian educational and employment agencies?

This question is divided into three research objectives:

1. To identify the main dimensions that lead to the development of a back-end system.
2. To identify the main dimensions of the issue while providing appropriate factors.
3. To evaluate the FIST framework with experts.

Second Research Question

What is the Trust Issues within Information-Sharing Framework?

1. To identify the main issue with Trust.
2. To identify the main cause of the trust issue.
3. To evaluate the trust framework with experts.

Third Research Question

The Third Research Question is:

What are the Trust requirements for information-sharing systems?

This Third question led to following objectives:

1. To establish requirements for accuracy and trust in information exchange **System** Design.
2. To establish requirements for accuracy and trust in information exchange **Model** Design.
3. To identify **threats** and **controls** for accuracy and trust in information exchange model. - through provenance model.

Fourth Research Question

The Fourth Research Question is:

What is an appropriate template for modelling trust in Information-Sharing?

1. To identify the model the accuracy issue.
2. To identify the model trust issue.
3. To evaluate the model and tested by Rodin.

1.6 Research Objectives

This research is guided by four primary objectives, with a clear focus on culminating in creating a verified and validated framework and developing a model to test critical tasks based on expert evaluations.

- The first objective is to identify the key social challenges specific to the Saudi Arabian context, particularly regarding societal impacts on information sharing.
- The second objective involves conducting a comprehensive literature review to understand and analyse the existing information-sharing challenges, emphasising trust.
- The third objective is to explore the technological aspects of information sharing, aiming to uncover factors that facilitate or hinder this process in the context of government agencies in Saudi Arabia.
- The fourth and final objective is designing and developing a robust framework for structured information exchange. This framework will be rigorously verified and validated by experts in the field, ensuring its relevance and applicability.

Subsequently, a model will be constructed to test critical tasks identified through the framework. This model will consider human and machine interactions, aiming to refine and validate a methodological approach for modelling trust in information exchange. The ultimate goal is to provide a comprehensive, expert-backed solution for influential and trustworthy information sharing within related agencies in Saudi Arabia.

1.7 Publication

The following conference paper based on this work has been accepted for publication:

1. Ghamri, R., Fadhel, N., & Wills, G. (2020). Investigating Trusted Records for Employment and Education. Proceedings of the 5th International Conference on Internet of Things, Big Data and Security, 412–419.
<https://doi.org/10.5220/0009489504120419>

1.8 Thesis Overview

- Chapter 2 provides background information on the Saudi Arabian context. This chapter situates the research gap and research problem. Also, it identified unique factors. While it is the literature review chapter, which focuses on trust and the technology aspect of the identified factors. Also, it focuses on the information-sharing aspect and creates new factors that address the research problem and gap.

-
- Chapter 3 describes the research methodologies used in this research.
 - Chapter 4 proposes an investigative framework named FITS based on distributed ledger technology to assure records in education and employment history.
 - Chapter 5 reveals the 15 expert analyses and findings and builds the appropriate FIST framework with its established factors and dimensions, which answers the First Research Question.
 - Chapter 6 adds clarity and an extra layer of understanding the FIST framework. It is based on expert analyses using Delphi methodology, which answers the Second Research Question.
 - Chapter 7 Moves from framework to modelling, the first part based on human interactions and the second on machine interactions, which answers the Third Research Question.
 - Chapter 8 Modelling trust and accuracy using Event-B, which answers the Fourth Research Question.

Chapter 2

Literature Review

2.1 Saudi Arabia Background

This section discovers unique aspects of Saudi Arabia's approach to integrating education with the labour market, a practice mirrored by neighbouring countries in the region. Central to this discussion is Saudi Arabia's strategic use of educational investments to strengthen its workforce, supported by the goals of Vision 2030. This vision is a roadmap for economic diversification and a catalyst for technological advancement, particularly in e-government services. This section will explore how the Kingdom's ministries are vital in implementing these strategies, focusing on their roles in harnessing technology to empower government services. Additionally, the section will highlight current practices within Saudi Arabia that could demonstrate the successful working together of education, technology, and labour market needs, showcasing the country's innovative approach to national development and digital governance.

2.1.1 Saudi Arabia 2030 Vision

Below is a summary of the official document on KSA's Vision 2030 (Vision 2030 Official Website, 2017).

The Saudi Arabian government initiated Vision 2030 on 25 April 2016, aiming to decrease its reliance on oil and to foster a more diverse economy. This strategy involves the development of various sectors, including health, education, infrastructure construction, recreation, and tourism (Nurunnabi, 2017). Vision 2030 is structured around three key themes: a vibrant society, a thriving economy, and an ambitious nation. This research primarily focuses on the second theme – a thriving economy. This theme is fundamental as it provides opportunities across multiple domains, which are summarised as follows:

1. **Learning for Working:** The government values education and training and will be investing in these areas to prepare its citizens for future job opportunities,

mainly through investment in early childhood education. The government wants to ensure that the outcomes of education are in line with the needs of the job market. Moreover, it will expand vocational training to advance economic development.

2. **Providing Equal Opportunities:** The Saudi economy will provide equal opportunities for everyone so that they can contribute to the best of their ability. The government stresses the importance of lifelong training by encouraging a culture of high performance, with citizens' skills being properly deployed. The ultimate goal is to cut the rate of unemployment from 11.6% to 7%.
3. **An Education that Contributes to Economic Growth:** The Saudi government aims to close the gap between the attributes of graduates of higher education and the requirements of the employment market. Moreover, it plans to build a student-tracking database system from early childhood through to K-12 and beyond higher education to improve education planning, monitoring, evaluation and outcomes.
4. **King Salman Program for Human Capital Development:** The Saudi government wants to ensure that all public sector employees have the right skills. It requires its employees to raise their productivity and aims to apply proper performance management standards, providing continuous training for professional development and sharing knowledge.
5. **Effective e-government** Saudi Arabia will expand its online services to health-care and education. In addition, there will be support for online job applications to government agencies, such as through cloud applications, data-sharing platforms and Human Resources Management (HRM) systems.

2.1.2 Saudi Arabia Related Ministries

This sub-section focuses on the ministries directly affected by and related to this research. These governmental bodies play crucial roles in shaping the outcomes of this research. One ministry plans national development, another for educational output, and the last has market demands. Their combined actions are central to understanding and addressing information-sharing issues in Saudi Arabia.

2.1.2.1 Future Planning in Saudi Arabia (Ministry of Economy and Planning)

The Ministry of Economy and Planning (MEP) is a fundamental player in the economic landscape of the Kingdom of Saudi Arabia (KSA). Guided by a vision to become a key enabler of sustainable growth and diversification of KSA's economy, the Ministry is deeply committed to the realisation of Saudi Vision 2030. Its mission revolves around developing knowledge and evidence-based economic policies and development plans, working in partnership with various governmental entities. Strategically focused, the Ministry

aims to drive progress in the face of rapid national and international economic changes (Ministry of Economy and Planning, 2023).

2.1.2.2 Education in Saudi Arabia (Ministry of Education)

In Saudi Arabia, the MOE supervises and implements the procedures and rules on education. The summary below is from public government websites, the Saudi Arabian Cultural Mission, WES (World Education Services) and the MOE (Ministry of Education, Saudi Arabia, 2021; Saudi Arabian Cultural Mission, 2001; Sedgwick, 2001; Sidiqa AllahMorad, Sahel Zreik, 2020).

Education for every citizen is one of the priorities in developing the modern State of Saudi Arabia. It goes back to 1925, when the first education administration was established, serving as a foundation stone. 1953, there was a significant step in education; on December 24, the MOE was founded. The late King Fahad was the first minister of education, committed to educational development and growth. He expanded the number of schools throughout the Kingdom. In 1958, a general guide was released on how the educational system should be made consistent. Members of the Arab League decided the system. This system comprises six years of elementary education, three of intermediate education and three of secondary education, after which students are assigned to various higher education programmes. Each school year consists of two semesters, each 15 weeks long, with a two-week examination period. Students have long summer holidays because of the hot weather and the religious breaks. Each school day comprises six to seven classes, each 45 minutes long.

A National Development Plan was essential to facilitate the successful transformation and development of KSA. The key objectives of this plan are centred around two central values:

1. Development of human resources through education and training.
2. Configuration of a complete economic infrastructure.

Higher education in Saudi Arabia has experienced remarkable growth over the past five decades. There are 29 government universities, 14 private universities and 29 private colleges, and some offer distance learning online. Each university has colleges and departments that offer candidates diplomas, Bachelor's, Master's and PhD degrees. According to MOE's published budget and "*Al-Jazirah*" newspaper, the Saudi government spends more than 22% (Alangari, 2019) of its income on education, amounting to SR 135,531 million in 2019 alone (Ministry of Education, Saudi Arabia, 2019).

Reflecting on the current educational landscape, according to Statista Inc. (2018), there are 6.1 million students enrolled in the Saudi Arabia school system, 3.2 million of whom are at primary school. This signifies a substantial need for an electronic form of record-keeping and the issuance of electronic certificates.

2.1.2.3 Employment in Saudi Arabia (Ministry of Human Resources and Social Development)

Employment in Saudi Arabia falls into two main sectors, public and private. Each has its own structure, employment procedures and pension practices and a distinct system. Since March 2020, both sectors are under the same ministry and it is now called; Ministry of Human Resource and Social Development (HRSD) (Ministry of Human Resource and Social Development, 2020).

2.1.3 Public Sector

In Saudi Arabia, the public sector ensures the efficient and fair functioning of government services and employment. The Ministry of Civil Service (MCS), previously known as the Ministry of Civil Service, was established to create merit-oriented processes, policies, and procedures. These are underpinned by values of accountability, fairness, and equal recruitment opportunities for workers nationwide, aiming to enhance the services offered to citizens. With a commitment to digital transformation, the MCS offers 49 services, of which 22 have been transformed into electronic systems better to serve the public sector (Ministry of Civil Service, 2019). Among these, six services are particularly relevant to this research, highlighting the Ministry's dedication to leveraging technology in governance and public administration:

TAWTHEEQ: As a job transactions documentation service, TAWTHEEQ actively streamlines follow-up and documentation processes between government agencies and the MCS. It seamlessly incorporates electronic transactions into related systems. This service is crucial in actively registering and electronically monitoring job activities and employee accidents within the government sector (Ministry of Civil Service, 2019).

TADWEER: A job rotation programme designed as a practical solution for workers moving between government agencies for legal or organisational reasons (Ministry of Civil Service, 2019).

My Employment Data: A digital platform that empowers government employees and human resource specialists with the latest technological advancements from the Ministry. It facilitates the correction and updating of employment information and has partnered with the Ministry of Health to provide employees with information on their sick leave. This platform also offers access to background work history and service documents to assist in tracking hiring decisions, scholarships, and administrative transactions (Ministry of Civil Service, 2019).

KAFA'AT: This service enables Saudi employers, including government agencies, organisations, and companies, to access CVs from the MCS Database, connecting

job-seekers with opportunities in both the public and private sectors (Ministry of Civil Service, 2019).

JADARAH. An electronic recruitment facility that allows Saudi job-seekers to upload personal data, skills, experience, and employment records. It matches job vacancies advertised by government agencies to applicants' credentials and specialities, facilitating a digital selection process (Ministry of Civil Service, 2019).

SAAID. A support system for job-seekers and organisations looking to fill waged positions. It allows registering personal details, health status, and employment information, contributing to a comprehensive database to bolster employment support within the MCS (Ministry of Civil Service, 2019).

These services collectively represent Saudi Arabia's forward-thinking approach to public sector management, aligning with the broader objectives by harnessing technology to improve governance and public service delivery.

2.1.4 Private Sector

The Ministry of Human Resources and Social Development (HRDS), formerly the Ministry of Labour and Social Development (MLSD), plays a crucial role in Saudi Arabia's private sector. Established around 1960, it underwent organisational changes, splitting up around 2004 and later merging into its current form in 2014. Since its inception, the Ministry has been instrumental in fostering the development of local communities, overseeing community committees, and managing provincial councils (Ministry of Labor and Social Development, 2019). Three primary objectives guide the HRDS they are:

- To formulate a general policy for social and labour affairs for the Saudi systems.
- To plan and implement projects.
- To take part in KSA's social development to raise awareness, improve living standards and maintain spiritual and moral values in order to build an integrated society.

There are a few further systems, with some limitations, which can be considered as record-tracing and verifying systems. They focus mainly on the engineering and health sectors. Those that are relevant to this research are:

Saudi Council of Engineers. The SCE aims to promote the engineering profession in Saudi Arabia, in both the public and private sectors, to develop standards and regulations for engineers. The first suggestion of engineering profession development was in 1978. In 2002, the SCE Act was passed by Royal Decree of HRH of King Fahd bin Abdulaziz, who appointed the council (Saudi Council of Engineers, 2019). The following are its main responsibilities relating to this research:

The following are the main responsibilities of the council which are related to this research:

- Engineering profession development.
- Regulation of licences.
- Managing examinations and assessments for the award of a professional degree.
- Organising engineering profession training courses, conferences and seminars.

EJTTIAZ In November 2018 the Chairman of the Board of Directors of the SCE launched this online service for the use of any engineer who is not a graduate of a Saudi university yet who wishes to work in the engineering field. Candidates are required to register with the SCE before signing a work contract and applying for a work visa. Successful engineering candidates are approved to work in either the government sector or private sector. This service has a mandatory condition whereby candidates have five years of experience, in addition to verifying their data, to prevent non-certificated engineers from working in KSA. The system requires personal information, academic qualifications, experience and supporting certificates. The SCE chairman determined that this service is important to the KSA economy by raising standards and giving priority to Saudi engineers for job openings, thus reducing the cost of hiring overseas engineers (Alyaum Newspaper, 2018; Saudi Council of Engineers, 2018).

The objectives of the system that relate to this research are to:

- Organise the engineering sector by removing unskilled employees.
- Prevent fraud by documenting relevant credentials.
- Give priority to hiring Saudi engineers.
- Save employers' costs.
- Raise the quality of the engineering sector by providing only qualified engineers.
- Eliminate violations and engineering errors.

Although this system has started to prove its reliance and produce good outcomes, it does not include Saudi engineers working in Saudi Arabia or those who plan to work outside KSA.

Saudi Commission for Health Specialties The Saudi Commission for Health Specialties (SCHS) is a scientific corporate entity for health specialists in Saudi Arabia. It was established in 1993. So far, it has 18 branches in KSA regions and has two crucial functions, namely certifying residency programmes and licensing healthcare practitioners (Saudi Commission For Health Specialties, 2012). For this research, an important objective of the SCHS is granting professional certificates, diplomas, fellowships and memberships and evaluating practitioners' performance.

HADAF The Human Resources Development Fund (Hadaf) is crucial in aligning the Kingdom's workforce with its evolving labour market. Various sources reveal that Hadaf's primary objective is to bridge the gap between graduates and employment opportunities, particularly in the private sector. It achieves this through a myriad of employment support programs, training, and empowerment initiatives to enhance the competitiveness and employability of Saudi graduates. In the context of Saudi Arabia's Vision 2030, which emphasises economic diversification and the development of non-oil sectors, Hadaf's contribution is significant. The fund has made notable strides in reducing unemployment rates to record lows by facilitating job placements and offering extensive training and counselling services. In 2023 alone, Hadaf spent a substantial amount on supporting programs (94 Million Dollars), benefiting many Saudi men and women. This effort extends to various sectors. Hadaf's e-service platform is another critical aspect, streamlining the link between training centres, private sector establishments, and job-seeking individuals. This digital approach not only simplifies the employment and training process but also ensures a more efficient allocation of resources and opportunities (ARAB NEWS, 2021, 2023a, 2023b; My Gov SA, 2023).

2.1.5 E-Government

E-government promises to integrate technology into society for administrative procedures, thus achieving a more effective form of government. Information and Communication Technology (ICT) has the tools to enhance the transformation of information and services, thereby supporting citizens, customers and professionals (Al-Nuaim, 2012). It includes government communications in electronic format from multiple levels of government, citizens and businesses to deliver products, to interact and to receive services 24 hours a day, seven days a week. Through the use of the internet and new media, e-government is capable of transforming internal and external relations through technology (Riad, El-bakry, & El-adl, 2010). E-government is based on two important aspects: government use of ICT to deliver services and information and, second, being citizen centred (A. Abanumy & Mayhew, 2007). E-government is about building a partnership that involves both governments and citizens, not one-way interaction (Silcock, 2001).

2.1.5.1 E-Government Related Systems

The following are the e-government services that are directly relevant to this research. This discussion will surround the various digital initiatives and platforms that play a necessary role in this study, highlighting their significance and impact within the scope of the analysis:

1. **Absher:** Absher is an online service and smartphone application that grants its users access to a range of government services. It provides 160 governmental services to more than 12 million active users (Absher.sa, 2019).
2. **Elm:** Elm is a Saudi company that is involved in several KSA sectors (Elm, 2019). It provides a number of services and develops solutions such as 'Absher'. Elm is a joint venture owned by the Public Investment Fund, and it specialises in developing customer-centred solutions on platforms that can be available everywhere, including digital services, training, advisory and IT solutions, as well as providing support to organisations (Arab News, 2019).
3. **Yesser:** The Ministry of Communication and Information Technology, established in 2003, was tasked with developing a strategy for delivering government services and transactions electronically (Yesser - E-Government Program, 2019), a move essential for setting standards and regulations and implementing guidelines for government projects. This initiative led to the e-government program 'Yesser' in 2005, named after the Arabic word meaning to facilitate or make easy (A. Abanumy & Mayhew, 2007). Yesser's mission is to regulate, facilitate, and accelerate the development of e-government services (A. N. Abanumy & Alshitri, 2014). It focuses on developing and managing e-government products and initiatives in Saudi Arabia, adhering to high technical and security standards and serving as the connective hub for government agencies in their e-transition (Yesser - E-Government Program, 2019). Key goals of the Yesser program include raising productivity and efficiency in the public sector, providing better and more user-friendly services to individuals and businesses, increasing investment returns, and ensuring rapid and accurate delivery of requested information. These objectives are integral to the transformation into an information society, a goal that requires collaboration and intensive efforts to realise the set objectives. The project provides an environment for collaboration that allows government organisations to implement e-government and increases the effectiveness and efficiency of the public sector. The first action plan was in 2011; it highlights the fact that e-government initiatives faced issues such as a lack of cooperation, queries over the ownership of data and weaknesses in the ICT infrastructure (Alassim, Alfayad, & Abbott-Halpin, 2017). While acting as the government's controller, 'Yesser' supports e-government activities, legislation, procedures and other related issues (Alfarraj, Alhussain, & Abugabah, 2013).
4. **Nafath:** Nafath is a platform for management of the national digital identity. It is provided by The National Information Centre in Saudi Arabia. It administrate digital identities for both citizens and residents that closely reflect their actual identities (National Information Centre, 2023).
5. **National Single Sign-On:** The Saudi Ministry of Interior (MOI) has initiated a national project to manage and issue digital identities for its citizens and residents. In response to the growth of e-services, various government and private organisations have incorporated e-IDs for user verification. These e-IDs form a

digital identity for users during e-transactions. The National Single Sign-On initiative aims to deliver an all-inclusive solution for governing and managing these digital identities, which, in turn, offers uniform access nationwide. Its objectives are to develop a national system for managing digital identities, issue 'E-Identity' to individuals or organisations, and introduce a secure registration and verification process to ensure the ID's validity and secure usage (GOV.SA, 2023).

2.1.5.2 E-Government Implementations Challenges

Studies on Saudi Arabia's e-government implementations in the public sector have identified issues that may hamper the process. Most focus on the ICT infrastructure, security and privacy. Saudi Arabia has a conservative culture and society (Alassim et al., 2017). The present study explores the organisational factors that influence KSA's e-government implementation, namely:

1. **Misunderstanding the New Policy and Regulations:** Misunderstandings and varied understandings of new e-government policies would result in different actions for procedures.
2. **Lack of Visioning and Planning:** This would result in no clear vision or plan for the e-government project.
3. **Top Management Commitment:** Commitment from the operational level.
4. **Low Level of Cooperation with Yesser:** This is the e-government transformation plan.
5. **Updating the Infrastructure:** The study found weaknesses in the ICT infrastructure.
6. **Resistance to Change:** Employees fear change.
7. **Lack of Continuous Training:** There is a shortage of qualified, trained technical professionals.

A single study has examined the factors that influence e-government development context that could lead to delays in Saudi Arabia. This emphasises two important factors, namely cooperation and collaboration (Alfarraj & Alhussain, 2013), comprising the following aspects:

1. *“Cooperation and collaboration between government sectors”*
2. *“Lack of cooperation between government sectors”*
3. *“Lack of cooperation with Yesser program”*
4. *“Plans, strategies and changing procedures for cooperation”*
5. *“Understanding the cooperation concept for eGovernment implementation”*
6. *“Cooperation of top management”*
7. *“Cooperation of financial departments at government sectors”*
8. *“Cooperation with researchers”*

Another study shows the importance of e-government in successful implementation, through international development experience, to demonstrate the benefits of improving KSA's e-government performance (F.El-Sofany, Al-Tourki, Al-Howimel, & Al-Sadoon, 2012).

2.1.6 Records Keeping Practices

This subsection is dedicated to discussing record-keeping practices in both educational and employment contexts. This examine how records are maintained, managed, and utilised, highlighting the similarities and differences in approaches within these two critical areas.

2.1.6.1 Educational Records

In Saudi Arabia's educational sector, managing and sharing educational records are essential for the system's effective functioning. There are three primary systems for information-sharing in Saudi Arabian education. Each system is designed to cater to different segments within the educational landscape: one focuses on the school system from early childhood through to K-12, another addresses the needs of overseas students, and the third system involves the assessment and validation of academic qualifications from foreign institutions. Each system is crucial in facilitating educational processes and enhancing data accuracy.

Together, these systems contribute to the infrastructure of Saudi Arabia's education sector, aligning with the nation's educational excellence and workforce development goals. These systems are:

Noor Public and government sectors in Saudi Arabia have been actively investing people and money in new technologies and software to support the government's strategic objectives for Saudi Vision 2030. KSA's education sector is adopting new technologies and developing systems such as the Noor Educational Management System. This system aims to improve educational outcomes by increasing the productivity of the educational process by recording supervisors and teachers on a centralised database. This database guarantees the accuracy of the information and resources exchanged. According to EduWave EMIS (2018) "*Noor serves more than 10 million users, including 6 million students and half a million teachers working in over 40,000 public and private schools*".

What Noor does is vital to the management level of education institutes. It provides online access to reports, performance and historical records, aiding in future planning and decision-support systems. Moreover, it offers many e-services to

administrators, teachers and guardians. Its most important feature is providing records of education, in other words, information on student grades, daily attendance, late attendance and other notes. Indeed, Noor grants administrators and guardians access to the records so that they can follow up with their youngsters to review their study schedule, assignments, tests and academic accomplishments, read notes and learn about school bus services. Guardians can use Noor to communicate directly with teachers. In addition, the system provides solutions to the issues faced when moving from one school to another (AL-Ghamdi, 2015; EduWave EMIS, 2018).

Safeer Efforts to promote tracking and monitoring the knowledge society's future national workforce resulted in early 2008 introducing the Safeer programme (Safeer Program - MOE, 2019). It has a website where Saudi students can apply for 86 academic, administrative, and financial services. It connects the MOE to the Saudi Arabian Cultural Bureaus (SACB) in various countries (AL-Zuabi & AL-Shaikhli, 2012). Safeer enables Saudi students overseas to submit requests to modify personal data, follow up on services and apply for scholarships (Najem, Alnoeim, & Najem, 2016). Safeer supports all users, whether administrators or SACB staff in 32 countries or the 85,085 students (AL-Zuabi & AL-Shaikhli, 2012; The Scholarship Department - MOE, 2019).

As the number of students studying abroad has grown, a comprehensive information system has been developed with massive amounts of data, transforming them into digital transactions, facilitating the operation and workflow for all beneficiaries and promoting accuracy and high-quality information on students abroad. Safeer has seven goals related to this project, aiming to improve the data security of systems containing data of students from abroad and their dependents. There are three services (total of 10) related to this research:

- Safeer Academics (SAAF): considered a key information storage centre for Saudi students from abroad.
- Safe Graduates: seeks to provide employer and statistical organisations with data on foreign graduates.
- Secure Documents: the programme's main document management system to fulfil the electronic government's goals. It reduces paper use and optimises data storage and record archiving across all departmental sectors (Safeer Program - MOE, 2019).

University Certificates Equalisation The University Certificates Equalisation Committee is a body within the Ministry of Education. Its primary responsibility is to assess academic certifications earned post-school from overseas institutions for Saudi citizens (and others). 'Certificate equivalency' refers to an academic procedure that appraises a 'graduate qualification' of its courses, comparing it with a similar educational ladder and its conditions. Sometimes, the committee refers to

internal university programs and qualifications to compare them and consider their equivalence with similar certificates (Education Affairs Agency, 2023).

2.1.6.2 Employment Records

To gather information and carry out background checks, employers (usually the HRM department) validate information from the MCS. This can provide information through mandatory pension systems such as the Public Pension Agency (PPA) or the General Organisation for Social Insurance (GOSI).

Public Pension Agency. Public Pension Agency. The Retirement Pension Department was founded in 1958, and it was renamed the PPA in 2002. It handles retirement plans in KSA's public sector for both civilian and military personnel. It provides public sector workers with a secure pension plan when they reach retirement at the age of 60. It also covers the deceased's family members and disabled employees who were injured at work. The agency's objectives are to enhance the governance model and drive human capital development (Public Pension Agency, 2012). Its historical record can be used as an official document to prove the length of experience. The reports show the duration of the employment and the salary. An additional official document, known as the Service Certificate (see Appendix A.2, is issued through the employer as proof of the employee's experience.

General Organisation for Social Insurance. GOSI covers workers in the private sector and those in the public sector who are under contract. It has aspects similar to those of the PAA, although it is mainly for the private sector. The social insurance scheme is provided by the society to citizens through social cooperation. Its official document shows the employer's name and address, the dates when the employee was employed the firm and his/her salary (General Organisation for Social Insurance, 2018); however, there is no mention of experience apart from the duration of employment.

2.1.7 Revealing the Challenges

In this section, the focus narrows down to identifying the critical challenges associated with information sharing within the Saudi Arabian context. This exploration is crucial, as it sheds light on the complexities specific to the region. The issues were uncovered through a multifaceted approach, drawing insights from various sources. Academic research provided a perspective on the intricacies of information-sharing practices and their implications in Saudi Arabia. Additional insight was further enriched by the perspectives of various news outlets, offering a more dynamic and current view of the information-sharing landscape. These media sources highlighted real-world instances and

case studies, illustrating the practical challenges and consequences faced without efficient information-sharing mechanisms.

Meaningful factors contributing to these challenges are the need for a unified system seamlessly integrating different information-sharing elements. Currently, the nature of existing systems leads to a fragmented approach that prevents an effective dissemination of utilisation of information. A cohesive framework is needed to ensure information-sharing. Therefore, this section digs into the core of these issues, piecing together insights from academic research, media reports, and the observed systemic gaps to present a comprehensive picture of the current state of information sharing in Saudi Arabia.

2.1.7.1 Comparative Analysis: Press & News Outlets

This section provides a relative analysis of how various news outlets have reported on relevant issues and associated events or conferences related to educational graduates and the labour market. Numerous reports and news articles have addressed the challenges and issues within the Ministry of Education (MOE) and the Ministry of Human Resource and Social Development (HRDS) and their impact on the labour and economic sectors. Additionally, well-established traditional newspapers have published the following selected new articles. These articles are available in the appendix for reference (Please See Appendix A.1).

The news articles reveal an urgent problem in Saudi Arabia's education system: a misalignment between academic specialisations and the labour market demands. Graduates are often unemployed or underemployed due to oversaturated, undesired study fields. Conversely, fields are in high demand but with a shortage of graduates. This mismatch raises questions about the effectiveness of current educational institutions and practices. Consequently, there is a call for strategic academic planning and careful analysis of the labour market to guide admissions and program offerings. In response to these issues, the University Council plans to modify academic programs to meet the demands of the labour market better, closing unnecessary specialisations and aligning education with regional development needs. This effort is crucial in preparing the workforce for Saudi Arabia's Vision 2030 economic transformation and preventing wasteful spending on retraining and job searching for misaligned graduates. The articles underscore the importance of building a more robust connection between universities and the labour market to preserve young human resources and facilitate economic growth. This analysis offers insight by addressing challenges and identifying potential research gaps.

2.1.7.2 Cross-Sector Issue: Absence of Information Sharing

The primary issue this research addresses concerns the use of unreliable information sources that require improved accuracy. The objective is to validate claims made by

individuals and organisations. E-government services should be responsible for sourcing information from relevant organisations or institutes. The ministries involved should direct information sharing with external organisations and institutes. Figure 2.1 provides a visual representation of the current practices in information sharing within the domains of employment and education.

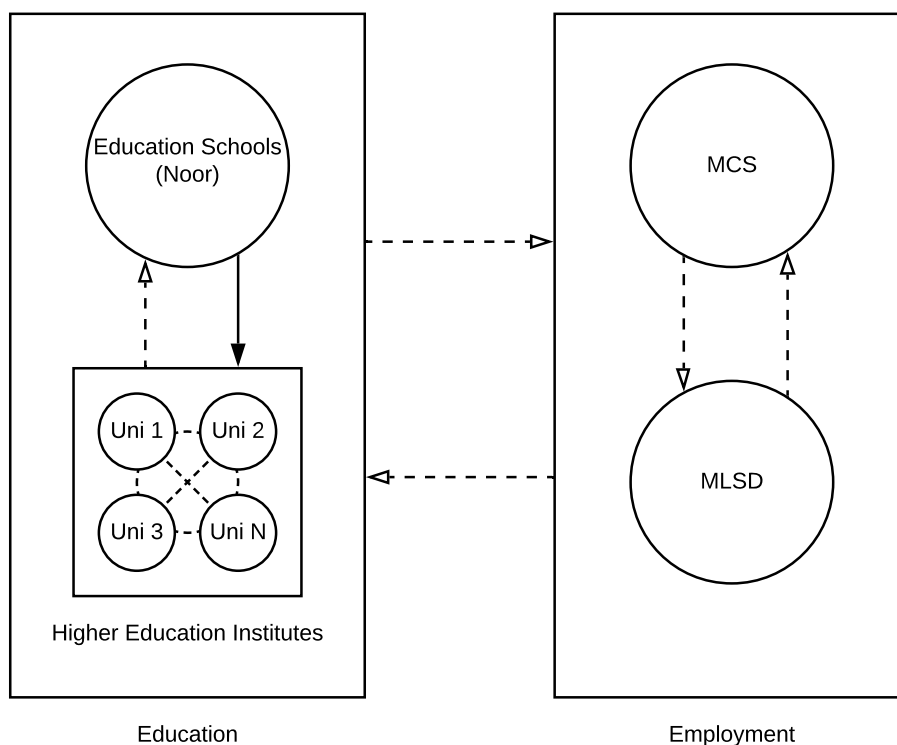


FIGURE 2.1: Current System

Employment: The public sector works as an independent entity and does not share any information with the private sector or vice versa.

Education: Educational institutes up to K12 use a web service called Noor (see Section 2.1.6.1). This system provides accurate information only on students in schools; however, colleges, universities, diplomas and training courses are not a part of the system. High school records get integrated across the Noor system. Then the school records are provided or shared during vacancy applications to public universities.

Education and Employment: There is no information-sharing between educational institutes and employment organisations, yet this could benefit hiring, saving time, reaching prospective employees, and changing employment.

2.1.7.3 Employment Issues

According to one Saudi researcher Assad (2002) who conducted a sociological analysis of the administrative system in Saudi Arabia, there is one major problem: organisations suffer from administrative problems at both the structural and behavioural levels (Assad, 2002; Harbi, Thursfield, & Bright, 2017). For the purpose of this research, the factors at the structural level are:

1. Job assignments that differ from workers' educational background and job training.
2. Unreliable evaluations of employees' performance.
3. A lack of management skills.

2.1.8 Research Gap and Research Problem

A *research gap* is a topic or area of interest that has yet to be explored or addressed by previous studies, historically and presently. In contrast, a *research problem* is a clearly defined and explicit expression of an issue or challenge that requires more profound understanding and deliberate investigation (Dissanayake, 2013).

2.1.8.1 Research Problem

For the reasons outlined in this chapter (up to this point), there is a pressing need for an accurate information-sharing system that comprehensively tracks a citizen's history from early education to graduation and beyond. This system should encompass complete educational and employment records detailing all training, skills, and development acquired throughout an individual's life. The system must match the skills and experiences employers seek with available talent, thus reducing unemployment rates. However, current practices, including initiatives like TAWTHEEQ and Hadaf, while contributory, need to fully address the core issue of a mismatch between the abundance of graduates in specific fields and the actual needs of the labour market. These practices, although beneficial, need to be more explicit in bridging this gap. Consequently, educational outputs and labour market demand remain the same. Addressing the underlying factors that have led to this disparity is crucial in developing a comprehensive solution that effectively bridges this gap, ensuring that educational pathways are more closely aligned with current and future market needs.

Research Problem Statement:

There is a persistent imbalance between educational outcomes and labour market demands. Specific fields of study are witnessing an over-saturation of graduates, while other fields experience a significant dearth. This unsustainable

imbalance leads to misalignment, creating a notable gap between educational institutions' products and the labour market's evolving needs.

2.1.8.2 Research Gap Saudi Arabia

Based on an analysis of news outlets and ministries' involvement and viewing the research problem, statement, and motivations previously outlined in response to an extensive review of existing literature in the context of the Saudi Arabian labour market, the research gap has become clear:

Despite some initial exploration in the academic domain, there needs to be more comprehensive, in-depth studies dedicated to the strategic application of information technology advancements to bridge the persistent imbalance between Saudi Arabian educational outputs and evolving labour market demands. This gap is even more pronounced when considering the dynamic nature of labour market needs, the absence of a coherent, unified system capable of effectively matching educational outputs to these needs, and the current resource inefficiencies in Saudi Arabia's education and labour sectors. Specifically, there is a clear void in the literature addressing the development of innovative, sustainable strategies that utilise information technology for the real-time adaptation of educational programs to the fluctuating labour market requirements. Additionally, the potential of information technology to enhance resource efficiency, optimise the alignment process between education and labour markets, and contribute to a more sustainable and balanced development of the Saudi Arabian economy needs more research; this underscores the critical need for further scholarly investigation, as comprehensive analysis may offer transformative solutions, fostering a closer alignment of Saudi Arabian education and labour market requirements. This thesis aims to fill this gap in the literature.

Considering the dynamic labour market needs and the ever-evolving nature of educational outcomes in Saudi Arabia, more comprehensive studies are needed to utilise information technology advancements to bridge the gap between these two domains. The lack of a unified system and persisting resource inefficiencies further exacerbate this gap. Therefore, this research seeks to fill this critical gap in the existing literature by implementing an innovative framework based on information sharing to structure the bridge across this gap. The strategic application of the framework, rooted in both social and information technology, aims to align Saudi Arabian educational outputs with labour market requirements more effectively, paving the way for a more sustainable and balanced development of the nation's economy.

The research gap identified here lies in

The limited exploration of using information technology precisely to align educational outputs with its labour market demands information sharing. This

thesis addresses the need for a unified system and strategies for real-time education adaptation to evolving market needs, aiming to develop a framework that effectively bridges this gap.

2.1.9 Key Factors Influencing the Saudi Arabian Context

This chapter identified factors by searching through key components and discovering critical factors from the extensive literature review by exploring existing scholarly works and news. The valuable insights shape this research's direction and inform the problem's understanding. The factors discovered serve as significant indicators, informing the research topic's Saudi Arabian context, challenges, and potential solutions. This chapter discusses each factor in detail, elaborating on its origin in the literature and its relevance to this study. Literature review and factor discovery establish a solid foundation for our research, leading us closer to the answers we seek.

Table 2.1 summarises social factors from four studies. Factors were based in the context of the Saudi Arabia.

TABLE 2.1: Factors for Saudi Arabia Context

Group & Reference	Factor
Organisational (Alassim et al. (2017) & Alfarraj et al. (2013))	Continuous training and awareness
	Cooperation and collaboration
	Lack of visioning and planning
	Misunderstanding the new policy and regulations
	Outdated infrastructure
	Resistance to change
	Top management commitment
Technical Environment (Alfarraj et al. (2013)& Alassim et al. (2017))	E-readiness (emails)
	Financial support
	Implementation
	Qualification in IT
	Trust in e-services
Human Resource Assad (2000, 2002)	Cost
	Efficiency
	Hiring Procedures
	Job assignments
	Lack of Skills

Conclusion for Saudi Arabian Context This section, grounded in analysing news sources and ministry activities, builds upon the defined research problem and gap to pinpoint a specific yet unexplored issue within the Saudi Arabian context. We will detail the methodology used to identify this research gap and problem. The following section will present a strategy for employing technology to address this issue, utilising technological innovations to develop a tailored framework for Saudi Arabia.

This chapter provides an overview of the Saudi Arabian background and briefly shows how the country operates regarding education and employment. Also, it revealed some e-government issues and why implementing such a system would be challenging in the Saudi context. It reported on how the country is launching its development vision and how this relates to this research. Finally, it discussed what is considered a form of information-sharing among employment organisations.

The next chapter (Chapter 2.2) presents the technological aspects of information-sharing and how they could benefit e-government, education, HRM and digital records. This KSA literature review identified factors in creating a social structure for information-sharing. So, technological factors are required to address the Saudi Arabian context factors.

Furthermore, this chapter assesses the unique socio-cultural factors in Saudi society that could influence the successful implementation of a new back-end system. It explores the distinctive challenges and unique elements inherent to the Saudi context, shedding light on the sectors most relevant to information sharing among educational institutions and employment organisations. The aim is to offer an encompassing overview of the current situation, pinpointing areas that require special attention.

Relating to the Appendix As presented in this chapter, building on the examined matters in the context of Saudi Arabia. **Appendix A** contextualises the discussion to further within the specific country's unique case study in exploring research problem relationships and its dynamics. Correspondingly, it is vital to shedding light on news outlets' role and their relevance to the research problem. Furthermore, it outlines some of the official practices utilised within the country for checking the credibility of qualifications. The process typically involves time-consuming cross-referencing methods and confirmation of qualification details from reliable sources, proving employment history as being claimed by a candidate, so this can ensure the data's credibility, which is crucial in a range of fields, from HR to security. The intricate intersection of these aspects paints a vivid picture of the scenario, highlighting the importance of rigorous information credibility.

2.2 Trust and Technological Aspects for Information-Sharing

Building on the previous sections, the current section will evaluate the research background of the information-sharing infrastructure within the domains of government, education, human resources, and certificates. This examination will consistently focus on the factors uniquely related to the Saudi societal context (as enumerated in Table 2.1), recognising their potential impact on the successful implementation of a new back-end system.

2.2.1 Trusted Computing, Systems and Platforms

Trusted computing, an emerging technology in information system security, has made significant strides in the global information security landscape. Mirroring the concept of trust and security in human society, it extends these principles into the digital realm. Trusted computing encompasses trusted hardware, trustworthy software, trusted networks, and trusted applications. Its key objective is to ensure data integrity, secure storage, and remote attestation for a trusted platform. The fundamental technological approach of trusted computing is to establish a root of trust in the computer system, secured through physical, technical, and managerial security measures which form a chain of trust extending from the root through the hardware platform and operating system and up to applications (Shen et al., 2010).

Trusted systems are those that have reliable and predictable operations to depend on them. If they fail, undesirable consequences may follow. In this context, trust is somewhat separate from security: while utilising trusted components to construct secure systems, trust does not imply security but rather denotes consistent behaviour. The primary objective of the trusted platform approach is to safeguard against all software-based threats, which means it is impossible to construct a secure system based on components that lack trustworthiness (Martin, 2008).

2.2.2 Security Principles

Security and trust in record-sharing are essential, and it is necessary to have a framework to assure the authenticity of information. Trust can have many meanings and definitions, but this research will focus on trust in computer science.

Fadhel et al. (2014), in their article on 3D technologies, talk about security provenance. They refer to general computer security principles: information security; information authenticity; and information exchange. The three can be practised to ensure a secure environment in which information exchange will take place.

2.2.2.1 Information security

To achieve information security successfully, Confidentiality, Integrity and Availability are the three elements of a further generic security model, known as the CIA model. This security model is necessary to protect both physical and digital attributes (McCONNELL, 1994).

- Confidentiality: a property that only allows approved entities, parties or processes to receive information.

- Integrity: defined as the process whereby data is maintained over the course of its life cycle to achieve a high degree of accuracy and consistency.
- Availability: a property given on request by a trusted person, group or system whereby authorised access is granted.

2.2.2.2 Information authenticity

Since their implementation in electronic exchange, the standards of digital signing have not altered. A digital signature is a way of showing the validity of electronic mail by demonstrating that the message has not changed and to identify the sender (Davies, 1983). It has the same quality as a hand signature but is made with a digital device, which makes visible the signature of the writer and of the recipient of the message for annotating a record. Cryptographers use three basic principles for electronically signing digital documents: authentication; integrity; and non-repudiation:

- Authentication: a property that verifies an identity claim. Authenticity implies authenticity and trustworthiness. It is necessary to ensure that the records, transactions, communications or documents are genuine. The validation of both parties involved is necessary, and their claim is critical to authenticity (Carugi, 2016). The term is used in conjunction with integrity, defined by the British Standard as a property whereby data are not altered or destroyed in an unauthorised procedure.
- Integrity: (the earlier definition of integrity can be applied).
- Non-repudiation: the state whereby an entity involved in communicating with other entities cannot deny its involvement in the communication between parties.

2.2.2.3 Information exchange

The principle of data exchange is maintained to ensure exchange of information between parties (receive and transmit). It is based on three elements, known as the AAA model:

- Authentication: (earlier definition of authentication can be applied).
- Authorisation: a property whereby resources based on permissions are granted access.
- Accounting: a property whereby actions and interactions may be identified and tracked in a unique way.

2.2.3 Database Management System

Within a centralised database, all components exist on a singular computer or designated site. These elements include the data, the Database Management System (DBMS), and any additional storage media necessary for a smooth operation. Intelligent workstations

and remote access terminals, employing directed communication links, facilitate access to the data housed in this centralised location. A central feature that all Database Management Systems (DBMSs) share is the distribution of data and software across various locations. These locations are interconnected through a network, facilitating communication and enabling the transfer and activation of processes from one site to another (Tupper, 2011)

According to van Steen and Tanenbaum (2016) A distributed system can be depicted as an ensemble of independent computational components, which seamlessly integrate to present themselves as a unified, coherent entity to its users. So, it refers to the concept where data is stored across a variety of locations.

According to X. Wang, Asif, and Vaidya (2023) data distribution system is a term refers more to the process or method of distribute, sharing or delivering data to end-users, systems,

2.2.4 Distributed Information Areas

Blockchain usage is no longer limited to the financial field and can now have many applications. This logic has emerged because all systems need technology to ensure safety and to provide integrity (Andrian, Kurniawan, & Suhardi, 2019; Grover & Prasad, 2021; Liu, Lu, Zhu, Paik, & Staples, 2023).

This section will assess the research background of Distributed Ledgers Areas in government, education, human resource and authenticated certificates.

2.2.4.1 Human Resource Management

The authenticity of human resource information is an important factor in the cost and efficiency of HRM. The risk is produced by information asymmetry; in other words, information failure. X. Wang et al. (2017) suggest that the solution be built by combining encryption technologies with internet-distributed technology to establish an HRM model to increase the authenticity of human resource information. This is to counter discrimination and provide authentic and effective decision-support information to an organisation's HRM. According to X. Wang et al. (2017), earlier studies have proposed blockchain technology to record human resource information in an accounting book. Various articles have underlined the importance of combining IT with the HRM concept. These demonstrate the importance of authenticity in human resource information, illustrated by a survey showing that over 70% of job applicants hide details or present fraudulent or inaccurate information during the recruitment process, explicitly mentioning how this can

be achieved by a fake resumé, fake diploma, fake certificate of qualifications and exaggerations of capabilities. Although this study states that personal data will be involved and shared, it makes no mention of privacy or how to solve this issue.

A system that is based on information technology in the domain of HRM will ensure a non-biased, efficient, transparent and secure environment. Hassan Onik, Miraz, and Kim (2018) proposed a recruitment management system and a HRM system algorithm, both using record-keeping technologies based on blockchain. The authors proved the proposed system's advantages by comparing it to an existing system through a case study. The suggested system can verify profiles from various sources, such as the last workplace; it can also detect irrelevant data and fake certificates. It proposes two algorithms. The first is on the hiring system and validates and ranks applicants' profiles, while the other uses a hash-based data structure to store information on the system.

2.2.4.2 Digital Records

Gräther et al. (2018) focused on technology usage that can record professional development on the certificates more accurately. Clearly, certificates play an key role in education and professional development, as learning records have become essential to people's professional careers. Consequently, due to their importance, such records should be stored in long-lasting, tamper-proof ledgers. A technology-based system focused on record-keeping in a permanent way with authenticated fingerprints of certificates and other educational records should be presented to support learning history. Indeed, this would be an educational platform system that would serve as a solution for issuing, validating and sharing certificates. Certificates have many statements; the present study focuses on qualifications and academic titles that can be confirmed by a traceable issuer to validate whether or not the qualifications are true. Finally, the research shows both the importance of protecting certificates against forgery and the ease of verification, even if the certificate issuer manages to vanish through the use of blockchain technology.

The conventional paper certificate is difficult to fake due to built-in security features. These usually give the holder full control over them, and Grech and Camilleri (2017) have explored the notion that certificates could be stored and shared with whoever authorised them. However, paper certificates also have disadvantages. Problems include:

1. They represent a single point of failure: e.g. a certificate may be valid but cannot be verified.
2. Register-keeping involves a manual process that requires human resources.
3. Producing a paper certificate costs around 20 euros, while a highly secure electronic certificate costs 150 euros.
4. Once a paper certificate has been issued, there is no way to revoke it.
5. There is a need for the involvement of third parties manually and individually to verify resumé claims, which is a time-consuming process.

In his study, Lemieux (2016), explored the values of blockchain technology as a solution to create and protect trustworthy digital records. The analysis of the results of this study implies that blockchain can be used to amend security issues related to integrity, while guaranteeing the reliability of the information because it validates transitions.

SAP introduced a system called TrueRec, which is a secure and trusted digital wallet for storing professional and academic credentials. Credentials can range from personal ID, such as passports, to certificates from education institutes and employer-issued certificates. Since credentials can easily be faked, tampered or stolen, the system aims to make the necessary verification procedure more accurate and less stressful (Benjamin, 2017).

2.2.4.3 E-Government

Ølnes (2016) explores a possible use for blockchain technology to support a smarter government. Blockchain can be applied in e-government because it exploits a distributed, secure, inexpensive database technology. Blockchain has shown its capabilities through decentralised digital currency, Bitcoin, and these can be applied to many long-term government documents in the public sector. There is a general issue in the public sector regarding the necessity of verifying and authenticating documents. This needs to be smarter. Proving the authenticity of documents is a general issue in the sector and finding smarter solutions that scale globally and are cost efficient can cut public-sector costs and increase the quality of these services. Regardless, the article by Ølnes has shown that the topic of Bitcoin technology is absent from e-government literature. The design variables should be determined cautiously, in line with the requirements of the government organisation for the e-government system (Ølnes, 2016).

Using blockchain technology to record transactions on distributed ledgers offers new opportunities for governments to improve transparency. Its adoption for e-government offers new opportunities for the public sector to improve transactions, prevent fraud and establish trust in the public sector. The use of IT in the public sector is often referred to as e-government, and the concept has been expanded to cover relationships between governments and citizens, hence the adoption of new technologies would improve public services (Rizal Batubara, Jolien Ubacht, & Marijn Janssen, 2018).

Government services in Dubai, UAE, are storing data, while travelling, in a decentralised structure. The Dubai government is aiming to become paperless by introducing blockchain to take over all government transactions by 2021 (Alketbi, Nasir, & Talib, 2018).

Currently, most real business applications that use blockchain are limited to financial services. However, many research and development projects in organisations are trying to explore the areas of blockchain which can be implemented. Alketbi et al. (2018)

conducted a systematic survey to discover in which areas the blockchain applications can be developed for the public and private sector.

If blockchain is properly managed, decentralised government services are feasible because this technology can increase the functionality of public administration; by contrast, decentralisation of governance through an open, distributed blockchain involves serious risks and drawbacks. Blockchain has beneficial applications but must be studied carefully to be applied to manage social interactions on a large scale (Atzori, 2017).

2.2.4.4 Education

The strength of blockchain technology can be applied in education organisations, which will benefit from a decentralised method (Kuppusamy, 2019). The Kuppusamy study illustrates a decentralised public ledger system based on educational smart contracts to share information on an untrusted network. The proposed architecture can benefit prospective employers, who can directly validate the information.

There is ongoing research by Fujitsu and Sony Global Education Initiate Blockchain Field Trials for Course Records and Transcript Management. Sony Global Education Inc. are currently testing a new service for managing transcripts and scores using a digital platform. This digital platform is blockchain. They are focusing on how blockchain would maintain and manage student records and transcripts while maintaining high security data in education. They have managed to build a highly reliable individual performance database in education services. They handle valuable student data, such as student credits. The usage of blockchain assures the authenticity of transcripts and that they will remain secure (Sony Global Education Inc., 2019).

A system called EduCTX uses blockchain technology in higher education. This platform creates a globally trusted, decentralised credit and grading system. The system offers a global unified viewpoint for users such as students and higher education institutes. It transforms the current physical or digital record into a new form, based on blockchain technology, which is efficient and simple (Turkanović, Hölbl, Košič, Heričko, & Kamišalić, 2018).

2.2.5 Summary of Factors

Based on this chapter, a single table summarises the factors found in the literature review. Table 2.2 summarises the technological for Table 2.1 factors which are based on 14 studies.

TABLE 2.2: Factors for Distributed Ledgers

Group	Factor	Reference
Technological	Anonymity	Atzori (2017); Rizal Batubara et al. (2018); X. Wang et al. (2017)
	Authenticity	Alketbi et al. (2018); Lemieux (2016)
	Consensus mechanism	Alketbi et al. (2018); Andrian et al. (2019); Rizal Batubara et al. (2018); L. Wang, Liu, and Han (2018)
	Cryptography & Digital signatures	Alketbi et al. (2018); Ølnes (2016)
	Data availability	Alketbi et al. (2018); L. Wang et al. (2018)
	Decentralisation	Andrian et al. (2019); Atzori (2017); Rizal Batubara et al. (2018); L. Wang et al. (2018); X. Wang et al. (2017)
	Design variables	Ølnes, Ubacht, and Janssen (2017)
	Flexibility	Ølnes (2016)
	Immutability	Ølnes et al. (2017); Rizal Batubara et al. (2018)
	Integrity	Lemieux (2016)
	Privacy	Alketbi et al. (2018); Atzori (2017); L. Wang et al. (2018)
	Reliability	Alketbi et al. (2018); Lemieux (2016); X. Wang et al. (2017)
	Scalability	Angraal, Krumholz, and Schulz (2017); Biswas and Muthukkumarasamy (2017); L. Wang et al. (2018)
	Security	Ahram, Sargolzaei, Sargolzaei, Daniels, and Amaba (2017); Angraal et al. (2017); Atzori (2017); L. Wang et al. (2018); X. Wang et al. (2017)
	Storage	L. Wang et al. (2018)
	Smart contract	Andrian et al. (2019)
Trust	Atzori (2017); Lemieux (2016); Ølnes (2016); L. Wang et al. (2018)	
Usability	Ølnes (2016); Ølnes and Jansen (2017)	
Organisational	Acceptance	Ølnes (2016); Ølnes and Jansen (2017)
	Adoption	H. Wang, Chen, and Xu (2016); Woodside, Augustine, and Giberson (2017)
	Auditing	Ølnes et al. (2017); Rizal Batubara et al. (2018)
	Cost	Angraal et al. (2017); L. Wang et al. (2018)
	E-readiness	Ølnes and Jansen (2017)
	New governance model	Ølnes (2016); Ølnes and Jansen (2017); Ølnes et al. (2017)
	Organisational Transformation	Ahram et al. (2017); Ølnes et al. (2017)
	Support infrastructure	Ølnes (2016)
	Support low	Ahram et al. (2017)
Trust	Ølnes et al. (2017); X. Wang et al. (2017)	

2.3 Chapter Conclusions

This chapter navigated through the extensive literature encompassing the technological facets of information-sharing. The discussion brought into focus the potential benefits that these benefits can contribute to e-government, education, and HRM, not to mention their ability to strengthen the functionality of digital records. The chapter also enlightened critical aspects of trust, the roles of different platforms, and the necessity of adhering to strict security principles for secure access. The influence of implementing distributed ledger areas got explored, establishing its contribution towards constructing a resilient and efficient framework for information-sharing, specifically in education and employment. Furthermore, this chapter assesses the unique socio-cultural factors in Saudi society that could influence the successful implementation of a new back-end system. It explores the distinctive challenges and unique elements inherent to the Saudi context, shedding light on the sectors most relevant to information sharing among educational institutions and employment organisations. The aim is to offer an encompassing overview of the current situation, pinpointing areas that require special attention.

Chapter 3

Research Methodology

Establishing a significant research plan is naturally linked to selecting an appropriate research methodology. A deep understanding of the research problem forms the foundation of a robust research plan. This chapter outlines the research methodologies required to design, develop, and analyse an information-sharing framework. As characterised, the gaps and issues in current research underscore the need for this framework. Figure (3.1) represents a summarised overview of the research methodology employed.

The previous chapter explored the literature review, identifying factors that may affect the implementation of new systems for information sharing. Also, it delved into the technological intricacies of information-sharing while considering relevant social factors. The topics in the literature review have successfully identified factors relevant to this research. This framework necessitates an infrastructure comprising both hardware and software factors.

The framework's requirements, developed based on insights from the literature review and research problem and gap analysis, are tailored to address these identified factors, both technical and social. The framework actively structures itself to:

Based on the literature review chapter, research questions, research problem and gap analysis, The following is the most applicable to its system requirements. The framework must be capable of:

1. Provide the main dimensions covering each aspect to address the research problem and gap.
2. Customise relevant factors to each of these dimensions.
3. Form factors for higher management assuming responsibility for the system's usefulness.
4. Furnish factors for developers responsible for creating the necessary infrastructure.
5. Equip factors encapsulate information while assuring its security before distribution.

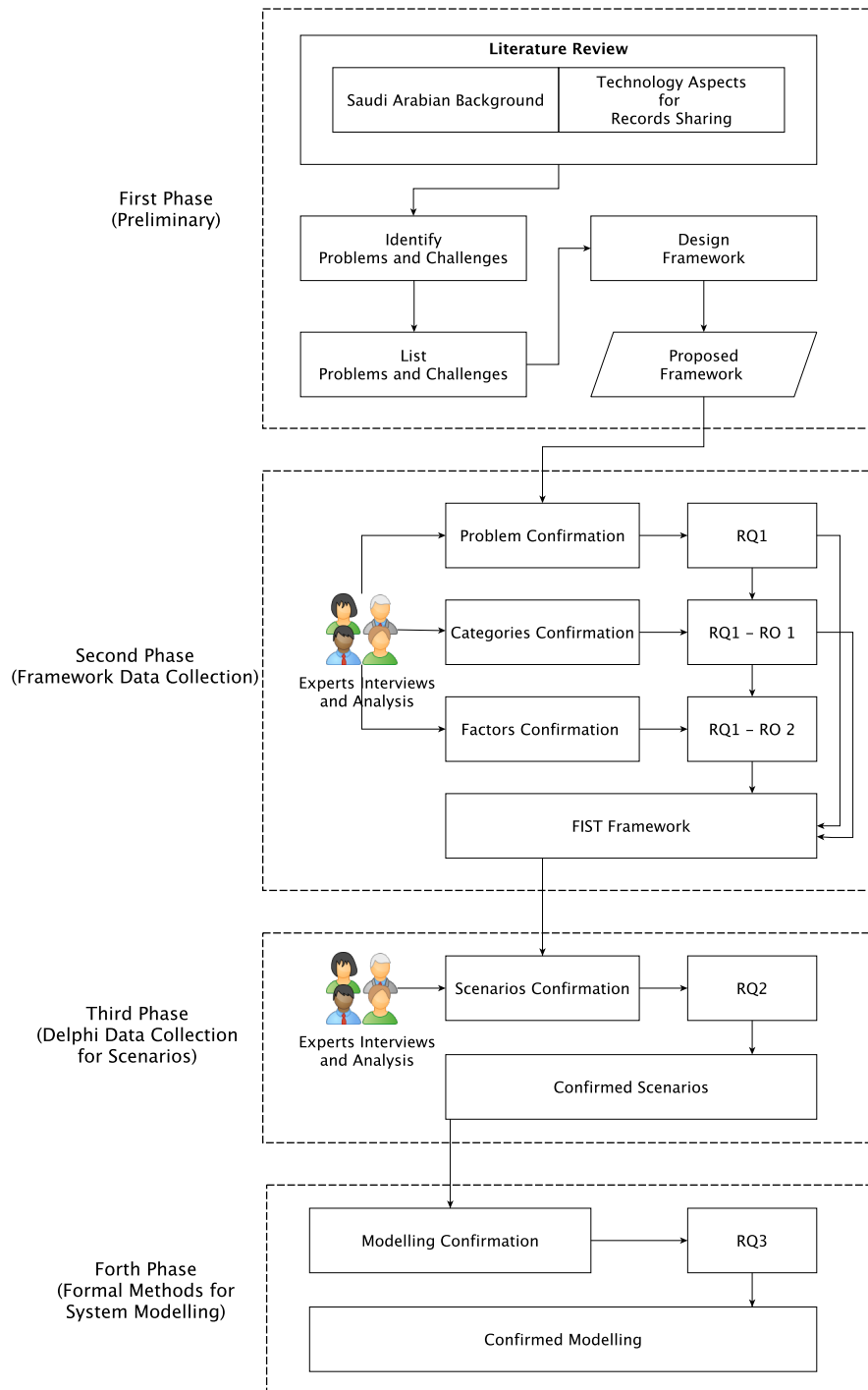


FIGURE 3.1: Overview of the Research Methodology

6. Provision factors to validate the accuracy of the enclosed information.

3.1 Overview of Common Research Methods

Research methods define the techniques used to collect and analyse data. In the research domain of information systems, there are three main research methods: qualitative,

quantitative and mixed methods (Recker, 2012). A qualitative and quantitative ‘mixed methodology’ are proven to achieve the research objectives (Johnson & Onwuegbuzie, 2004). More specifically, this study employs the triangulation research technique to achieve its goals (Carugi, 2016). Triangulation helps to visualise the research topics while validating and confirming the results. This research combines three methods for each research question (see Figure 3.2).

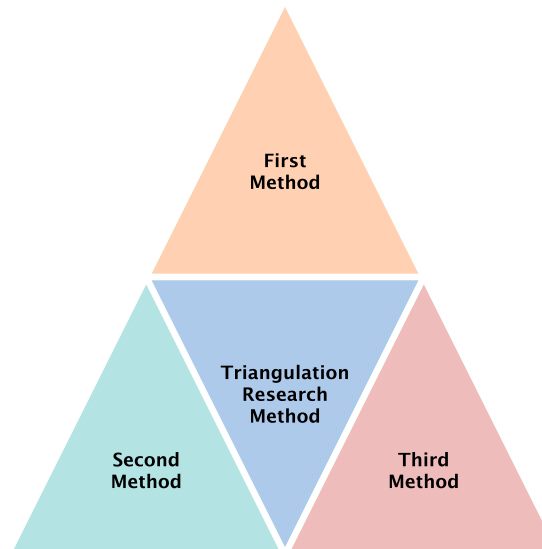


FIGURE 3.2: The Triangle Technique Method

3.1.1 Qualitative Research Method

Qualitative analysis is an approach to gathering, evaluating and building from various models of observational resources, such as text and images, obtained from interviews with open-ended discussions. The findings of qualitative methods are collected in such a way and result in outcomes that cannot be represented in numeric form (Creswell & Creswell, 2018; Recker, 2012).

Qualitative analysis involves the study and evaluation of data that is not able to be seen in numeric form, hence requires the qualitative approach. Such approaches are usually taken to establish a deep understanding of a problem to reveal new scientific perspectives (Recker, 2012). When studies involve human interactions, the most frequently used research method is qualitative, as this allows interactions with humans and data collection (Carter, 2014).

3.1.2 Mixed Methods (Multi-methods)

A third study approach that is an alternative to relying on qualitative or quantitative research has emerged as mixed-methods research (Johnson & Onwuegbuzie, 2004; Johnson,

Onwuegbuzie, & Turner, 2007). Over the past 20 years, research using mixed-method approaches has expanded, and combining experiments or blending qualitative and quantitative data is nothing unique. This approach has been deployed in search areas such as social sciences, education, behavioural sciences, health and sports sciences (Creswell & Creswell, 2018).

Mixed methods is a concept commonly used in a study to define the mixture of qualitative or quantitative research approaches.

The concept of multi-method research may suggest that several styles of the same methodology can be deployed in a single study, incorporating various styles in the same project. This means that a study is not necessarily restricted to quantitative or qualitative methods; furthermore, it could include the same qualitative operation with expert interviews. Also, it could be a quantitative survey with another type of quantitative experimental research (Anguera, Blanco-Villaseñor, Losada, Sánchez-Algarra, & Onwuegbuzie, 2018).

This research, particularly involving two distinct qualitative approaches, is rooted in the need for a comprehensive and subtle understanding of the research problem. Traditional methods involve a blend of qualitative and quantitative techniques. However, in this context, the mixed methods approach incorporates two different qualitative methodologies, diverging from the traditional blend with quantitative methods. This approach ensures a more layered and thorough investigation, capturing the complexities of the subject matter that might be missed by relying on a single method or a strict qualitative. Using two different qualitative methods under the umbrella of mixed methods is a strategic choice to enrich the research with diverse perspectives and deeper insights, thereby enhancing the overall quality and depth of the findings. This research uses Mixed methods, for example; there is two qualitative approach methods used (see Figure 3.2).

3.2 Specific Research Methods

This section shows the more specific research methods that were used to develop qualitative research methodology.

3.2.1 Delphi Method

In recent decades, the Delphi approach has been used frequently and is now recognised as a powerful tool in academic research to achieve agreement on particular topics where scientific data are insufficient or controversial (Barrios, Guilera, Nuño, & Gómez-Benito, 2020).

Rounds of data collection are used in the Delphi method to gather and structure the information and experiences of a group of experts on a subject on which they are considered to have experience. The first round is typically qualitative in nature to enable the recognition of a wide variety of opinions. One of the core concepts underpinning the Delphi process is to allow as many rounds as are required to achieve agreement or before the law of diminishing returns takes effect. Providing input and an ability explicitly to revisit prior answers requires that there be at least two rounds of the methodology (Keeney, Hasson, & McKenna, 2006).

Researchers need to give out two to three letters of reminder to non-responders: questionnaire testing is known for its poor response rates. Delphi methodology asks far more of respondents than a standard survey, involving for instance four questionnaire rounds, and the likelihood for low responses grows exponentially. The most important element of Delphi is the selection of experts or participants, especially for validation. Many such studies recruit persons who (based on criteria) are considered to have experience in the topic under review, as the whole qualitative analysis could be undermined by the wrong panel selection (Russo, Ciancarini, Falasconi, & Tomasi, 2017). Before the analysis begins, a researcher must settle on requirements such as ethnicity, technical background, schooling, jobs or classification (Keeney et al., 2006).

3.2.2 Formal Methods

Formal modelling and verification contribute to a better comprehension of the specification and design and greater accuracy than informal or semi-formal approaches. The choice of formal methods is made to overcome the problem of lack of precision. As well as supporting accurate descriptions, testing approaches help in the detection and removal of contradictions in formal modelling languages and support the discovery and elimination of inconsistencies. It is primarily about strengthening the methods used to engineer software-based applications throughout the device creation stage, specification and configuration. Systems errors are detected and rectified as quickly as possible at an early stage. It has been known from the earliest days of software engineering that the later the error is found in development, the greater the cost of correcting any specification or design flaw (Akeel, Fathabadi, Paci, Gravell, & Wills, 2016; Boiten & Abrial, 2012; Butler, 2013).

Event-B is an example of a formal method developed from the B-Method (Akeel et al., 2016; Boiten & Abrial, 2012; Butler, 2013). The modelling technique is intended for the study of computer systems at an early stage. It offers a rich modelling language that enables accurate representations of expected machine behaviour (models) to be written in an abstract manner, based on set theory. It offers a mathematical definition of consistency, along with methods to spot anomalies or check consistency within a model. Through abstracting and modelling system behaviour at the specification stage, earlier

in the implementation cycle than system testing, it is possible to detect and address requirement ambiguities and inconsistencies (Butler, 2017).

A major objective of software engineering is to encourage developers to build systems that operate in a reliable manner, despite their complexity, and to work reliably. The use of formal methods, which are mathematically based languages, procedures and instruments for defining and checking certain processes, is one way to accomplish this purpose. This would not ensure the consistency of a truth claim; nonetheless, through exposing contradictions, ambiguities and incompleteness that would otherwise go undetected, they may dramatically improve our perception of a method (Clarke & Wing, 1996).

3.2.3 Tell me more, Explain, Describe, and Walk me through (TEDW - Model)

Developing the skill to ask insightful questions is fundamental to enabling a comprehensive understanding and facilitating sound decision-making. Achieving effective communication when the intent shifts from simply replying to genuinely comprehending the perspectives shared in the conversation. Active listening plays a crucial role in this dynamic, encouraging a genuine interest in the speaker's message, thereby improving understanding. The TEDW model emerges as a practical framework to support active listening and enhance communication. This model encourages a communicative style rich in storytelling through open-ended questions. With active listening, open questions can significantly contribute to understanding another's position, ideas, or arguments. The TEDW model, an acronym for "Tell me more," "Explain," "Describe," and "Walk me through," serves as a guide for framing open-ended questions. These prompts encourage speakers to share more detailed information, explain, and guide listeners through processes or steps. They fill the information gaps with the speaker's intent rather than the listener's assumptions. This model can be utilised effectively in various professional contexts, such as working with stakeholders, conducting hiring interviews, and researching with customers (Curtis Stanier, 2020).

3.2.4 Goal Question Metric

The Goal-Question-Metric (GQM) is an approach used in software development. Developed by Basili, Caldiera, and Rombach (1994) this method operates as a top-down, hierarchical model for setting and achieving objectives. The highest level of this hierarchy is the "Goal", which contains the broad ambitions or desired outcomes for a system. Next, these goals get dissected into "Questions" that aim to characterise the goal's aspects that need addressing. These questions make the goals more definite, leading to a more straightforward path. Finally, the last tier involves defining "Metrics." These metrics serve as the specific measurements to answer the questions and, by extension,

achieve the goals. The standout of the GQM approach is that it establishes a clear and structured pathway from a broad goal to the specific steps needed to achieve it. It fosters an understanding of the goal while facilitating systematic progress tracking.

The Goal-Question-Metric (GQM) methodology, as an essential part of the assessment and metrics identification processes, ensures comprehensive understanding and efficient utilisation of collected data, thereby mitigating the collection of irrelevant measurements. It empowers project teams to craft measurements that align with predetermined objectives, fostering an environment for constructive feedback (Van Latum et al., 1998).

In line with the principles of the GQM approach, an organisation must clearly articulate its objectives for effective and efficient project measurement. These objectives, mapped operationally with the corresponding data, warrant a supporting framework to interpret this data in the context of previously outlined objectives (Basili, 1992).

At the metric or quantitative level, the GQM approach focuses on associating data with each question to yield quantifiable answers. The data can be **objective**, relying solely on the measured item and devoid of any particular viewpoint, such as staff hours devoted to a task, program size, or document version count. On the other hand, the data can be **subjective**, influenced by the measured object and the perspective from which they prospect as a viewpoint (Basili et al., 1994).

Overall, the GQM methodology provides a structured, hierarchical framework to guide goal setting, question formulation, and the selection of suitable metrics, thereby offering a systematic way to align project measurement with organisational objectives. It emphasises the need for objective and subjective data, underlining the importance of multiple perspectives in measuring progress towards goals.

3.2.5 University System Modelling (USM)

This research benefits from the Universal System Modelling approach of Ludwig von Bertalanffy's General System Theory because it provides a robust foundation for understanding complex systems while emphasising the crucial aspects of input and output. Bertalanffy's theory underscores the significance of comprehending how systems interact with their environment, exchanging inputs and producing outputs. By incorporating these principles into a modelling framework requirements, this aim is to create a universal system analysis tool that not only identifies the dimensions and factors within a system but also pays particular attention to the inputs and outputs, ultimately enhancing our ability to understand, predict, and manage complex systems effectively (Bertalanffy, 1968; Guberman, 2004; Šijan, Karabašević, & Rajčević, 2019).

This approach holds distinct value, particularly in engaging non-technical stakeholders who often articulate their input requirements and specific expectations. It facilitates

more effective communication and alignment between technical and non-technical parties. Consequently, the paramount significance of inputs and outputs becomes increasingly salient in such interactions.

3.2.6 Software Engineering

Software engineering does not provide this sort of instruction, as is well known. Researchers in software engineering write explicitly about their testing paradigms and provide criteria for evaluating the validity of their performance. Elements of the response have led to efforts to describe software engineering studies, but they still do not paint a complete image (Shaw, 2002). Shaw identified types of research questions, validation techniques and research results aspects, as described in Table 3.1.

TABLE 3.1: What Makes Good Research in Software Engineering? (Shaw, 2002)

Type of Research	Type of result
Research	Methods or means of development
Questions	Method for analysis
	Design, evaluation, or analysis of a particular instance
	Generalisation or characterisation
	Feasibility
Validation	Procedure or technique
Techniques	Qualitative or descriptive model
	Empirical model
	Analytic model
	Notation or tool
	Specific solution
	Answer or judgement
	Report
Research results	Analysis of the results such as formal analysis, empirical model, and controlled experiment.
	Experience of use of results by other people to find them correct, useful, or effective
	Showing an example of how the results work.
	Evaluation of the results against a given criterion.
	Persuasion of the results by describing related techniques, systems, models and a working system for feasibility research questions.
	Blatant assertion where no serious attempt is made to evaluate the result.

3.3 Chapter Conclusions

This chapter thoroughly explores the methodologies that will guide the research. It underscores the importance of a well-structured approach to research, encompassing a range of methods to address the research questions and objectives comprehensively. The chosen methodologies aim to ensure a deep and thorough analysis of the information-sharing framework, considering technical and social factors.

The next chapter represents a critical juncture where we begin to apply the methodologies outlined in this chapter. In this upcoming phase, we will focus on building the first version of the framework. This initial construction will be based on desk studies, leveraging the insights and strategies developed in the current chapter. This step is not only a practical application of our research methods but also a pivotal moment in bringing the theoretical aspects of our study into a tangible, operational framework.

Chapter 4

Building a Framework for Information-Sharing (FITS)

This chapter describes the process and building the formation of the FITS framework. Embarking on creating a comprehensive framework for information-sharing in the context of the Gulf countries, this chapter builds upon the foundational research methodology detailed in the previous chapter. It aims to construct a cohesive structure, the FSIT framework, meticulously integrating insights from an extensive literature review. This endeavour is key in addressing the unique challenges and intricacies of information-sharing within this region, particularly in education and employment.

This chapter combines factors identified from the two fundamental tables, encapsulating technological, organisational, and societal elements that influence information-sharing systems. This combination is an aggregation and a thoughtful framework construction that prioritises trustworthiness and accuracy in an integrated, secure environment. The framework proposed herein, therefore, stands as a testament to a balanced approach that combines innovative strategies and rigorous analysis. Its development sets the stage for subsequent chapters, where the framework's robustness and applicability will be further investigated and validated through expert analysis.

The references cited within this chapter, while approximately two years old at the time of writing, were deliberately chosen for their relevance and foundational value in constructing the initial framework. Given the specific focus of this chapter on establishing a preliminary structure, the temporal proximity of these sources to the current state of research was deemed sufficient for our foundational purposes. Therefore, there was no perceived necessity to include more recent references, as the primary aim was to lay down a theoretical and contextual groundwork for making an expert interview questionnaire rather than providing an up-to-date review of the latest developments in the field.

4.1 Framework Foundation

In this section of the research, particularly within this chapter, the foundational aspects of the framework are established. Formulating the initial research question was based on three critical components: the technological aspect that facilitates information sharing, the organisational element as they are the custodians and disseminators of information, and the human resource perspective, which focuses on balancing educational outcomes with labour market needs (See Figure 4.1). This comprehensive approach ensures that the question encompasses the key areas essential for a holistic understanding of the framework. This foundational phase is a central research question crafted to direct the exploratory preliminary studies:

What is a suitable framework to share information among Saudi Arabian educational and employment agencies?

At this initial stage, the framework is conceptualised with two primary objectives, reflecting the study's exploratory nature. These foundational objectives are:

1. Identify factors relevant to the Saudi context and identify technologies that align with these unique context factors.
2. To develop open-ended questions for expert discussions to confirm the research problem and explore the potential of technological solutions to address the identified gap effectively.

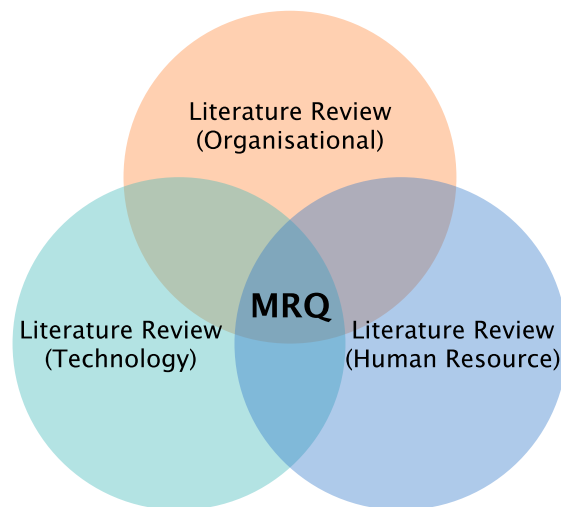


FIGURE 4.1: The Main Research Question

4.2 Framework Development

This research will investigate a framework built on factors related to new technologies in record-sharing and e-government in the Saudi context. The challenge is to improve

communications and information-sharing between MOE and employment in Saudi Arabia. This study builds a framework for the Saudi infrastructure. In the literature review, there is mention of similar themes that can be developed to devise a framework.

The proposed framework in this chapter is designed to assist in the examination of Facilitating Conditions, Implementing Conditions, Trusted Chain Authentication and Security Principles (FITS). These affect the investigation of factors of record-sharing. The framework is divided into two parts. The first part is information-gathering from academic articles and a literature review to construct the factors for this proposed framework. The second part involves planning future expert reviews to validate and confirm the related factors. The framework will be validated and confirmed using the triangulation technique, including a literature review, expert reviews and formal methods. Chapter 3 gives a description of the research methodology. The planned framework development is shown in the following figure (see Figure 4.2).

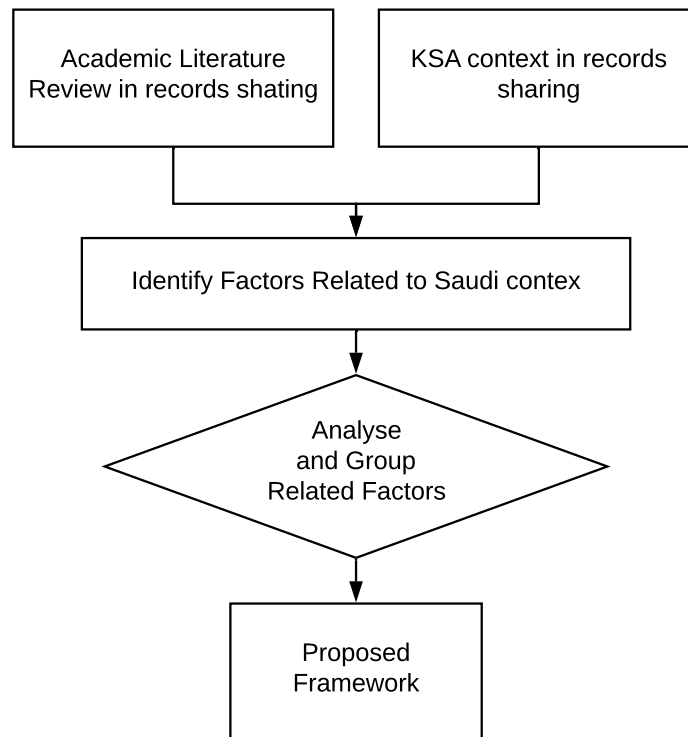


FIGURE 4.2: Framework Development

4.3 Framework Progress and Grouping Methodology

All factors able on Table 4.1 will be discussed with experts in their field, and to confirm the proposed framework shown on Figure 4.4. There will be an open discussion to refine the proposed framework.

The current chapter describes the factors that were previously identified. The framework has four stages:

Stage 1: to review the Saudi background and the development vision, making it possible to extract factors related to the Saudi context (see Table 2.1).

Stage 2: to review articles on securing record-sharing in a decentralised structure that can support different ministries to share information between one another to extract factors related to distributed ledgers (see Table 2.2).

Stage 3: to combine similar factors and exclude those that are redundant or irrelevant to the Saudi context, based on Saudi studies and the literature review.

Stage 4: To suggest an architecture for the trusted platform for record-sharing and divide the factors into related groups (see Figure 4.3)

Process of Improvement: There will be a discussion with experts to consider all the factors to update the proposed framework. However, some components were not mentioned because they are not about record-sharing or they are more about implementing and not investigating. Moreover, some were dropped because this research is about record-sharing within Saudi government (e-government) and between government ministries, characterised by the same Saudi government regulations and privacy practices.

4.4 The Architecture of Framework

For record-sharing, a trusted platform is a back-end platform. This can ensure the security, privacy, integrity and accuracy of the information shared between agencies and ministries. The platform does not stores and only shares the records.

Since government ministries are the owners of the data, they can implement a trusted platform within a private sharing environment. Ministries are the main participants, and they own all the required information, thus they will have full access to the trusted platform. The platform allows sharing of information by relevant organisations to employment and education. There will also be users of the trusted platform, so there will be protocols and algorithms to review and insert new data. Users may be citizens, employers, training institutes, academic institutes and human resource departments. The protocol will provide the various types of users with appropriate permissions, ranging from administrator privileges to view-only usage. Figure 4.3 show an illustration on how the framework be centred between educational and employment sectors, it features the private and public sector on the employment section (n the right side). Also, the figure illustrate how would academic and institutes and training institute would (on the left side) fit in this framework.

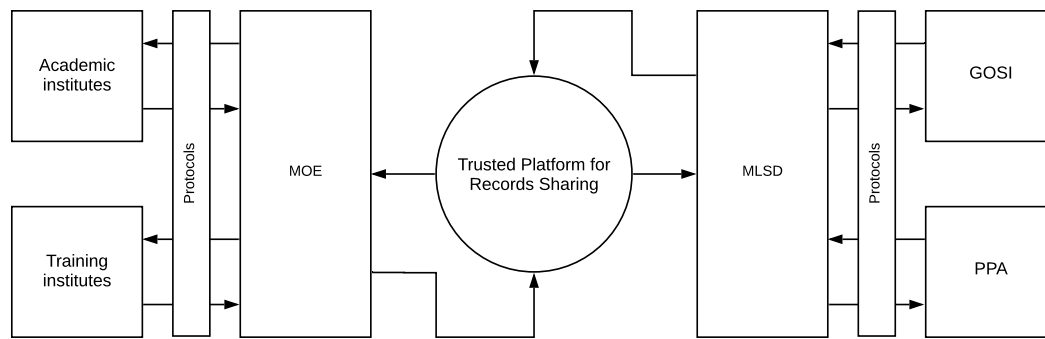


FIGURE 4.3: Enhanced System Architecture Featuring Trusted Platform for Records-Sharing

4.5 Framework

Implementing the suggested platform would share information only between those agencies involved with education and employment records. MOE and employment bodies (Public & Private) can choose what kinds of information are to be shared.

Factor 1: Facilitating Conditions

This can be explained as the components that must be presented to enable the use of the trusted platform. These components can be the organisational and technical infrastructure that needs to be available for successful implementation.

Factor 2: Implementing Conditions

This has components relating to the system administrators and IT department for deployment.

Factor 3: Trusted Chain Authentication

Records must be exchanged in an inherited trust, secure system, in a chain of authorised agreements, starting with the issuer of the record. The authentication has algorithms to confirm the validity and authenticity.

Factor 4: Security Principles

There are three main principles of security practice: Information Security, Information Authenticity and Information Exchange. All three have to be practised and implemented to assure a secure environment of stored or shared information.

Each of the above factors has components that assure trusted record-sharing. The definitions for the components are based on the articles in Tables 2.1 and 2.2, adding some

TABLE 4.1: Framework: Factors and Components

Categories	Factors
Facilitating Conditions	Financial Barriers
	Top Management Commitment
	Cooperation and Collaboration
	Outdated Infrastructure
	Learning to Build Skills
	Job assignments
	Hiring Procedures
Implementing Conditions	Security
	Reliability
	Scalability
	Usability
	Flexibility
	Storage
	Efficiency
Trusted Chain Authentication	Authenticity
	Trust
	Privacy
	Smart Contract
	Consensus Mechanism
	Decentralisation
	Immutability
Security Principles	Authenticity
	Confidentiality
	Data Availability
	Cryptography and Digital Signatures
	Integrity

information related to Saudi ministries. The framework and components of each factor are explained below:

4.5.1 Facilitating Conditions

This factor encompasses the components to be addressed to enable the use of the trusted platform, explained as follows:

1. **Financial Barriers:** At organisational level, top management must be willing to spend money to build a trusted platform for record-sharing. Providing benefits would favour the implementation of such a platform. It is a significant barrier, for

it has three aspects: limited budgets for ICT; the expense of running ICT; and the high costs charged by service telecommunication providers (Alassim et al., 2017; Alfarraj et al., 2013; Angraal et al., 2017; Assad, 2000, 2002; L. Wang et al., 2018).

2. **Top Management Commitment:** This plays an important part by taking responsibility for accelerating or suspending an implementation (Ahram et al., 2017; Alassim et al., 2017; Alfarraj et al., 2013; Ølnes et al., 2017).
3. **Cooperation and Collaboration:** This is a major issue in the public sector. To implement the suggested platform successfully, there needs to be cooperation and collaboration among many departments: cooperation and collaboration between ministries and government sectors; the cooperation of the finance department for funding; the cooperation of researchers to find issues related to implementation; and the cooperation of top management (Alassim et al., 2017; Alfarraj & Alhussain, 2013; Alfarraj et al., 2013).
4. **Outdated Infrastructure:** There are limitations stemming from outdated infrastructure, known as legacy systems, for instance outdated computer systems. This is a partly hardware and partly software. Updating such infrastructure enables government agencies to save time and effort and thus accelerate daily tasks through the use of technology (Alassim et al., 2017; Alfarraj et al., 2013; Ølnes, 2016).
5. **Learning to Build Skills:** One aspect is employees' ability to learn to build new skills. Another is employers' willingness to fund their employees' learning and development (Alassim et al., 2017; Alfarraj et al., 2013; Ølnes & Jansen, 2017).
6. **Job assignments:** Employee assessment should be practised to assign employees who have a the background and training in line with a certain job assignment (Alfarraj et al., 2013; Assad, 2000, 2002).
7. **Hiring Procedures:** Decision-making should be practised in hiring procedures. A process should be adopted of accepting only candidates who both fill the job description and are appropriately qualified (Alfarraj et al., 2013; Assad, 2000, 2002).

4.5.2 Implementing Conditions

These are components relating to system administrators and IT departments. They take the form of questions to trigger experts' feedback:

1. **Security:** Is the platform secure? Is there any added value? How can we confirm that the system is more secure than in current practice?(Ahram et al., 2017; Angraal et al., 2017; Atzori, 2017; L. Wang et al., 2018; X. Wang et al., 2017).
2. **Reliability:** Information is reliable because records are created only by authorised personnel, usually at the organisation that issued the information. This means opening up the process of verifying records to everyone with appropriate authority; in other words, there is no independent and isolated verification of a

record. Moreover, records must be relatively safe and capable of preventing modification by human subjectivity and artificial records. Reliability will answer these questions: Can the user depend on the system to achieve its tasks? Can it function under given conditions while maintaining accurate records? (Alketbi et al., 2018; Lemieux, 2016; X. Wang et al., 2017).

3. **Scalability:** Can the platform function rapidly enough not to have scalability issues that slow the system? (Angraal et al., 2017; Biswas & Muthukkumarasamy, 2017; L. Wang et al., 2018).
4. **Usability:** Is the platform user-friendly? Can it be used with different software and hardware? Can it achieve its objectives? (Ølnes, 2016; Ølnes & Jansen, 2017).
5. **Flexibility:** Is the platform flexible enough to be implemented with the current infrastructure without many software and hardware changes? Is it flexible enough to work with different operating systems and users? Ahram et al. (2017); Alfarraj et al. (2013); Ølnes (2016); Ølnes and Jansen (2017); Ølnes et al. (2017); H. Wang et al. (2016); Woodside et al. (2017).
6. **Storage:** Where will the shared records be stored? Where will the related physical hardware be stored? L. Wang et al. (2018).
7. **Efficiency:** Is efficiency an important feature? Is it important to reduce the cost and time of verification? Ølnes (2016); Ølnes and Jansen (2017); Ølnes et al. (2017); H. Wang et al. (2016).

4.5.3 Trusted Chain Authentication

It is imperative for a system that holds information to provide secure records that are trustworthy. This type of citizen record is often required for long periods that may extend beyond the life span of a database system or a server. Records should be exchanged in a trusted, secure system. Using technologies to enables an ongoing chain of authorised agreements, starting from the issuer of the record. It contains algorithms to confirm the validity and authenticity of the information. It represents a trustworthy system through the following components:

1. **Trust:** Having trust in an organisation to handle personal information. Also, an organisation has to have trust in the new system to store and practise record-sharing (Alfarraj et al., 2013; Atzori, 2017; Lemieux, 2016; Ølnes, 2016; Ølnes et al., 2017; L. Wang et al., 2018; X. Wang et al., 2017).
2. **Privacy:** Blockchain has features of decentralisation and encryption, while being resistant to change or modification. It strengthens privacy by allowing citizens control over their information that is accessible to the public (for employment or sharing records) or has private access (for government records) (Alketbi et al., 2018; Atzori, 2017; Rizal Batubara et al., 2018; L. Wang et al., 2018; X. Wang et al., 2017).

3. **Smart Contract:** This is a code to perform an algorithm attached as a condition of an operation. The code is stored on the blockchain and becomes active when it is about to execute an operation. It can be used in education and employment both to validate a record and to authorise its update (Andrian et al., 2019).
4. **Consensus Mechanism:** An ongoing algorithm to verify information, starting with the organisation that issues the record. It ensures that the records are valid and confirmed. These kinds of records provide data consistency, fraud protection, information ownership and immutability. To achieve this, records should be securely sealed and recorded in the system; any proof of tampered data should lead to it being discarded or rejected (Alketbi et al., 2018; Andrian et al., 2019; Rizal Batubara et al., 2018; L. Wang et al., 2018).
5. **Decentralisation:** A decentralised structure will allow for historical/related record-sharing in a secure environment in several organisations. There is no central ownership of the records, although information is validated by an authority. Once a record has been verified, it is stored (Andrian et al., 2019; Atzori, 2017; Rizal Batubara et al., 2018; L. Wang et al., 2018; X. Wang et al., 2017).
6. **Immutability:** Once information is recorded, it will remain the same and should not change, and it should be traceable. Information can be changed, updated and modified but never deleted by ministries. Even if a system mentions that a record is invalid, has expired or is hidden, the record is always stored (Ølnes et al., 2017; Rizal Batubara et al., 2018).
7. **Authenticity:** Blockchain is used to record the ownership of a record. This guarantees its authenticity. It depends on the first identity and integrity at the point of the record's creation. Authenticity under trust is based more on the creation of the record (Alketbi et al., 2018; Andrian et al., 2019; Rizal Batubara et al., 2018; L. Wang et al., 2018).

4.5.4 Security Principles

There are three main components of security principle practice: information security, information authenticity and information exchange. These need to be practised and implemented to assure a secure environment for sharing records of citizens.

Information security requires the CIA model: confidentiality, integrity and availability. Information authenticity requires authentication, integrity and non-repudiation. Information exchange requires authentication, authorisation and accounting.

Some components were mentioned under other factors, and some could be inherited and achieved by alternative factors. The following components are those that have not yet been addressed by any previous factor in the suggested framework:

1. **Confidentiality:** A property that only allows approved entities, parties or processes to receive information (Fadhel et al., 2014).

2. **Data Availability:** The authenticated records should be available at all times, whenever needed. A system that stores records or transactions separately would mean an increase in the number of potential single points of failure (Alketbi et al., 2018; Fadhel et al., 2014; L. Wang et al., 2018).
3. **Cryptography and Digital Signatures:** Used to demonstrate the authenticity of the information, using public–private key pairs. In a digital signature, the recipient encrypts the hash of the message using their private key, which can be sent to the receiver along with the message. The recipient also produces the original message’s hash value, and authenticity can be checked against the hash value that is generated by decrypting the hash values sent by the sender using their public key(Alketbi et al., 2018; Fadhel et al., 2014; Ølnes, 2016).
4. **Integrity:** Authenticated records are stored in sequential order in the form of a trust chain. This chain includes all the previous hashed stored transactions that led to the verified record. This helps to verify and track long-term digital transactions(Fadhel et al., 2014; Lemieux, 2016).
5. **Authenticity:** As a security principle, this is a different from trust authentication. In this context, it means validating both parties – the sender and the receiver of the information. Also, it verifies claims to identity to ensure that communication and information are genuine(Alketbi et al., 2018; Fadhel et al., 2014; Lemieux, 2016).

4.6 Chapter Conclusions

This chapter marks a pivotal point in the journey towards establishing a practical framework for information-sharing, particularly in the context of Saudi Arabia’s e-government initiatives. The FITS framework, developed herein, is a product of thorough research and thoughtful combining of various factors identified from the academic literature, tailored to the specific needs and challenges of the Gulf countries. The framework ensures trust and precision in information-sharing processes within a secure environment, addressing technological needs and considering societal and security aspects. This holistic approach is critical, as it acknowledges the intertwining of social and technical challenges in implementing effective information-sharing systems.

This study stands out for its specific focus on the Saudi context, exploring technology factors in information-sharing pertinent to education and employment. While some parallels exist with other studies, primarily in business applications, this research uniquely delves into the nuances of the Saudi landscape. The FITS framework thus represents a significant stride in understanding and addressing the complexities of technology-enabled information-sharing in this region as illustrated in Figure 4.4).

In conclusion, this chapter set the foundation for further exploring and validating the FITS framework. The subsequent chapter will engage with experts to affirm and refine the framework, enhancing it with professional insights and contributions. This step is crucial in ensuring that the framework resonates with academic research and holds practical relevance and applicability in the real-world context of Saudi Arabia's e-government initiatives. The journey continues to forge a theoretically sound, practically viable framework that effectively enhances information-sharing processes.

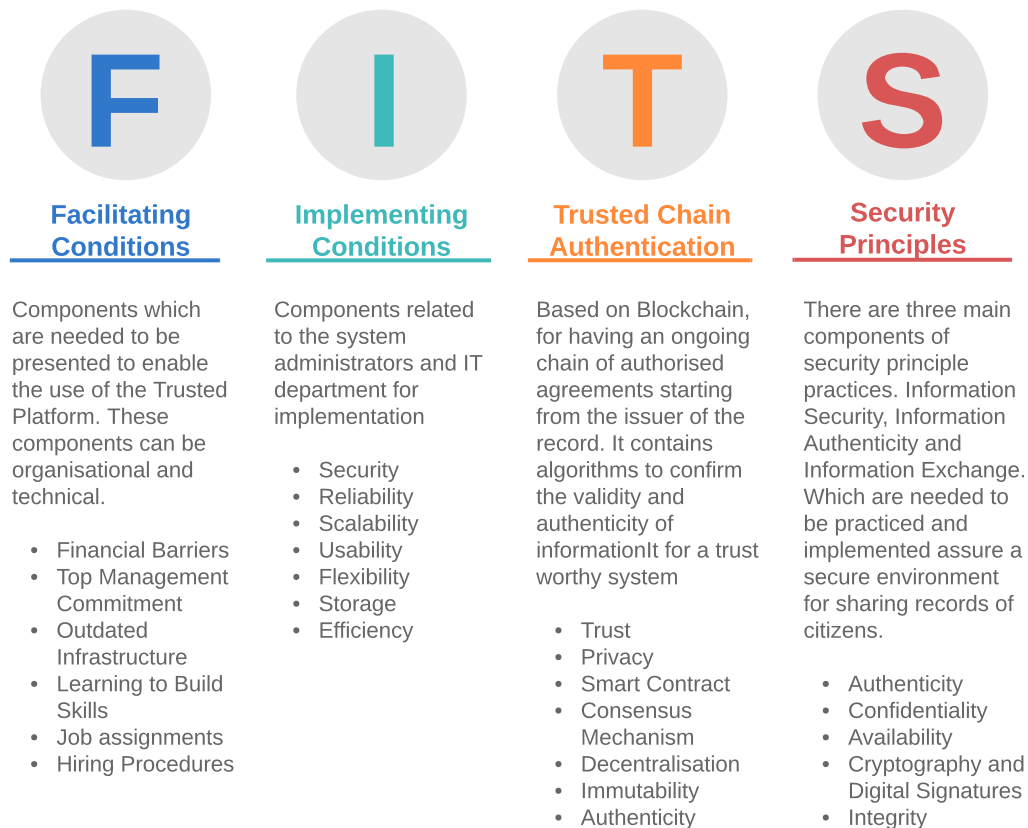


FIGURE 4.4: FITS Proposed Framework and Categories Definition

Chapter 5

Using Experts Reviews to Confirm a Framework for Information-Sharing (FIST)

Following the foundational work in Chapter 4, where it established the FITS Framework through thorough desk studies, this chapter delves into the observed phase of our research. Here, the focus is on validating and refining the FITS Framework by employing a robust research methodology. The chapter aims to firm the framework's dimensions and factors, utilising a triangulation method that intertwines dual literature reviews with expert analysis (as depicted in Figure 5.1). This methodological approach reinforces the framework's validity and ensures a well-rounded perspective, integrating theoretical insights with practical expertise.

5.1 Research Methods Used to Confirm the Framework

This section provides details of the research questions, how they were approached and the methods that were used. This study confirms the identified dimensions and their factors that comprise the FITS Framework. The method used is **Triangulation Technique Method** to show the consistency of three dimensions, two types of literature review and the expert review shown in Figure 5.1. Research Methods Used for the First Research Question are illustrated on Figure 5.3.

Figure 5.1 shows the triangulation to be deployed for the first research question, as shown in Figure 5.1. The first research question to be addressed during this phase is:

What is a suitable framework for ensuring the accuracy of information shared between Saudi Arabian educational and employment agencies?

A detailed experts review is available at Appendix B and Appendix G.

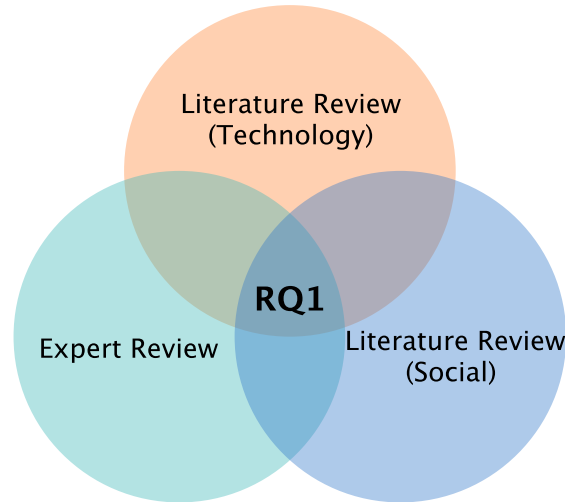


FIGURE 5.1: Triangle Technique Applied for the First Research Question

5.2 Expert Interviews

The reason for conducting the expert interviews was to collect data for analysis and thus obtain findings by which to examine the proposed framework, shown in the form of main categories with factors within them.

Qualitative data collection to understand the experts' response was conducted through open-ended discussions in interviews. The aim of interviewing the experts is to confirm the initial factors and dimensions of the proposed framework.

The goal is to analyse the findings of the conducted interviews. Interviews were conducted with experts from industry in relation to employment and education. The experts were 15 in number, with various associations and professional experience of not less than three years. The reasons for undertaking expert interviews is to examine the framework emerging in the form of major categories and factors within them. The factors relate to data sharing and elaborating trust involved in sharing such information. These interviews made it possible to confirm the framework and add new factors.

5.2.1 Demographic Information of Exerts

The first step was communicating with experts in e-government and e-government developers (see Figure 5.1). The magic number was 15 because it reached information saturation, and topics began to be repeated. A fantastic level of cooperation and interest

became apparent: more than eight experts agreed to stand by in Riyadh. Unfortunately, in the two days available, only five could be interviewed. The remaining expert interviews made using virtual meetings tools (See Table C.1).

The first batch of interviews were carried out face to face at a development company that specialises in e-government services. They had the capacity to examine the framework and provide feedback since they work on developing back-end systems for government. The interview process started on 8 March 2020 and continued until 25 October 2020. The second batch of the interviews were conducted through a virtual portal. Both types of interviews were audio recorded for later analysis. Before recording, the experts were asked for their consent both verbally and on a form. When the interview started, the interviewer announced ‘I am now starting to record’. None of the experts had any issues, since the recordings were used exclusively for later transcription and analysis.

TABLE 5.1: Demographic Information of Experts

Industry	Sector	Association	Number of Experts
Employment	Private	e-Gov Development	5
		Energy	3
		Construction	1
Education	Public	Educational Institutes	4
		Planning	2

5.2.2 Analysis of Expert Findings

The approach to the expert interviews was to address the main category and explain it, then ask each expert to help by keeping their responses to topics related to the framework. The interviews were conducted in Arabic. Due to the language barrier, some translations needed some clarification in parentheses, thus: ‘(The expert means...)’. This was to give an explanation of the meaning of elements that were lost in translation. While using a thematic analysis based on Braun and Clarke (2006) in Figure 5.2, the following points show how the analyse was conducted:

1. Record the conversation in the expert’s interview, which was conducted in Arabic.
2. Transcribe all conversations through an application that uses online resources to turn the conversation into Arabic script. While analysing the texts from the documents, the accuracy problems meant that transcripts were below 60% accurate.
3. To address the problem of transcript inaccuracy, listen to all the recordings. Together, they total roughly 16 hours.
4. Remove topics unrelated to the framework. This was essential, as the transcripts took up more than 80 pages. This left more than 18,500 words in 390 phrases, on around 36 pages.

5. Analyse the experts' findings in Arabic.
6. Use online translators to translate from Arabic to English.
7. Ensure the translation conveys what the expert was trying to say.
8. Group by themes, which later become categories.
9. Group by factors.
10. Write up an analysis of what experts say on related factors. When complete, add all transcripts to Appendix C.

When the analysis was done, all transcript were added to Appendix C

Phase		Description of Process
Understand Data	1	Transcript Arabic audio files Reading and understanding the Arabic transcript Data re-reading then translate related into English (initial Ideas)
Generating Initial Codes	2	Done: Underline words in a thematic way (Factor or Catgory). Next: Using NVivo.
Themes Searching	3	Done: Collecting by themes then allocate into Factors or Categories. Next: Using NVivo.
Reviewing Themes	4	Checking themes relevance related to Factors and Categories. Generate a thematic map for analysis.
Defining Themes	5	Analysis to refine specie themed category. Assure factors under correct categories to articulate a clear story.
Report Producing	6	Produce a report of analysis. Relating to Research Questions. Relating to Research Objectives.

FIGURE 5.2: Thematic Analysis Used on this Phases of the Research

5.2.3 Selection Criteria of Exerts

The role of the experts in this study is to confirm the framework and provide feedback, derived from their experience in the field, on the relevant factors to be added, updated and modified. The experts are from the Ministry of Human Resources & Social Development and MOE. They are knowledgeable about fields relating to education and employment and have expertise in at least one of information-sharing, security, e-government, human development and blockchain.

5.2.4 Reaction of experts to categories

Before each interview, each expert was sent an email with several documents attached (Participant Information Sheet, Consent Form and the Expert Review Questioner). On the day of the interview, the expert was sent a reminder by email or a phone call. The interviews began with a preliminary procedure (See Appendix B) to provide the background of the research and how the expert might contribute. Then the expert was asked about his or her expertise to guide the interviewer to present the most appropriate scenario to trigger the expert's thinking. Each interview was conducted in Arabic as an open-ended discussion on topics related to the research.

Strong Emphasis (SE): When experts discovered or mentioned a factor without being prompted by any hints, it meant that they arrived at the factor on their own, without the interviewer explaining or indicating anything other than an explanation of the main category. This signifies the strongest emphasis.

Medium Emphasis (ME): When experts did not mention a factor and it had to be mentioned and explained, this factors may still have been strongly emphasised yet, because it was suggested by the interviewer, it was assigned medium emphasis.

Low Emphasis (LE): This response was recorded when experts showed only polite agreement.

Negative Emphasis (NE): When experts disagreed or rejected a factor, making negative comments or other indications that it should be disregarded, it scored negative emphasis.

5.2.5 Ethical Approval

Before interviewing the experts or distributing questioners to participants. Ethical approval was obtained form the University of Southampton's Ethics Committee. The reference for the ethical approval is **ERGO/FEPS/55047**.

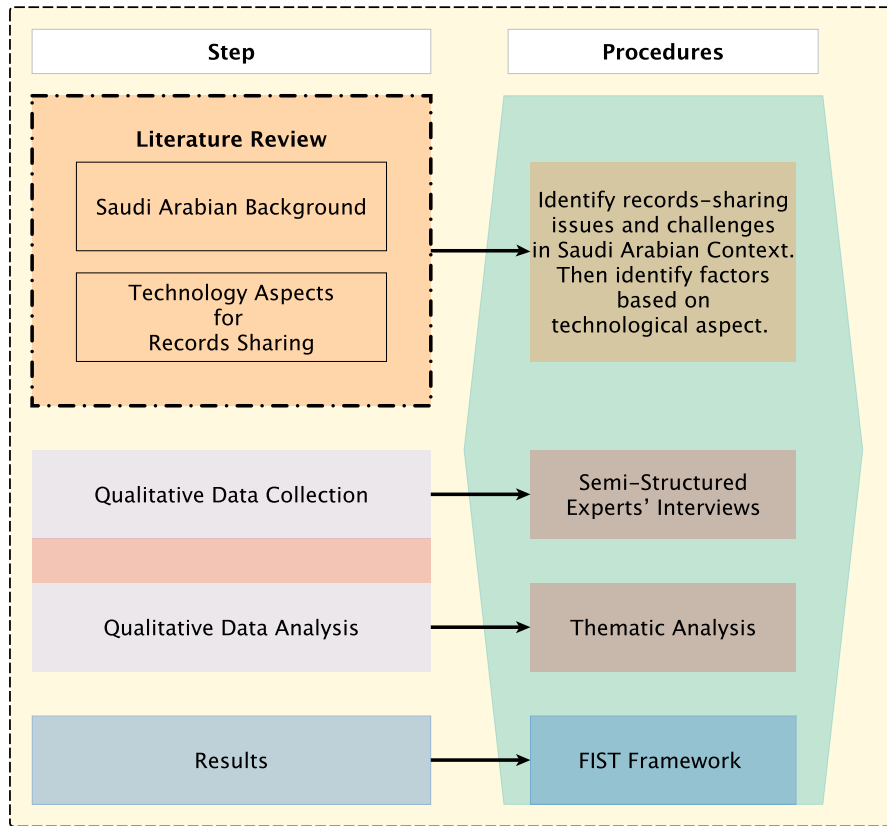


FIGURE 5.3: Research Method Used for FIST Framework to Answer First Research Question

5.2.6 Expert Interview Data Collection Procedure

The data collection for this study was meticulously carried out via paper-based records, capturing the nuances of open-ended conversations during the interviews. These interviews, conducted with a balanced mix of in-person and virtual interactions, spanned from March to October 2020. To gain a comprehensive understanding of each dimension and factor within the framework, experts were engaged in detailed discussions and provided with paper forms. On these forms, they could note any additional factors pertinent to the category under discussion and elaborate on their insights.

The selection criteria for our experts were designed to enclose a diverse range of perspectives. This included professionals from the public and private sectors, specifically those involved in employment and education. Furthermore, the study incorporated inputs from e-government developers and individuals at the management level, ensuring prosperous viewpoints. These experts were not just contributors but also key discussion facilitators, bringing valuable insights and depth to the research.

TABLE 5.2: Experts' Qualifications

Expert	Job Description and Experience
A 01	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services.
B 02	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services. Has 9 years of experience on back-end database servers. Has knowledge on developing systems.
C 03	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services.
D 04	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services.
E 05	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services. Software engineer and project manager with 6 years of experience
F 06	Faculty member at a university. Supervises students through mentoring. Also, works on the e-government platforms. Their speciality cloud systems and technologies related to e-government services. More than 10 years of experience.
G 07	Has work Experience more than 7 Years in the field of information sharing and information security. Works in private sector. His background is in security, monitoring activities (computer and network) and blockchain. Infrastructure Monitoring. Also, holds a master's degree in MBA.
H 08	Cyber security engineer. Deployment new project at a management level. Information security project manager. Has more than 20 years of experience in networking and security.
I 09	Student's advisor (Training and academic advice outside the institute) and Human resources advisor. Also, information-sharing developer with more than 3 years of experience
J 10	Faculty member at a university. Make interviews to hire employees, and mock-up interviews for students. Also works at admission to have standardised and fair acceptance for new students. More than 5 years of experience.
K 11	Security engineer, has more than 15 years of experience. Has some training for blockchain. Has few Cisco certifications. Works on networks and firewalls.
L 12	Faculty member at government training institute. Head of department. Decides on candidates for hiring. Main participation is distance learning. Has some knowledge on Blockchain. Previously worked in IT and gained system security experience. 13 years of experience.
M 13	Chief Technology Officer with experience more than 25 years between different ladders in the Information Technology and Security which includes being an exceptive officer and at top management. Experience in both public and private sector. Has numerous trainings certificates and expertise. Worked in different countries such as Saudi Arabia and Canada. Has postgraduate certificates. Responsibilities includes hiring and interviewing highly qualified and experienced employees. After HR choose and evaluate a candidate, this person evaluates candidate knowledge.
N 14	Blockchain expert, certified, trainer, speaker and enthusiast. Has blockchain experience for more 4 years and 12 years of experience on IT Management. Works in public sector in an educational training institute. Has experience in system security development and information sharing in database.
O 15	Works at the Ministry of Education headquarter. Has a PhD degree. Works on the development and planning. Has experience on sharing information. Security consultant. Human resources and hiring advisor. Has more than 8 years of experience.

5.3 Changes and Updates to the Framework

This section shows the updated, changed, added and renamed with the reason behind changes.

5.3.1 New Additional Factors

Some factors were redefined and combined with another. This section shows the updated and changed names and the reasons behind the alteration. Some new factors from experts were made without mentioning anything other than the main category, so further research and investigation are required. A factor was added if it was mentioned by at least **half of the experts**, they were grouped as follows:

5.3.1.1 Added Value

A factor was added to the framework if there was always a form of question about how it would benefit the expert's organisation, and some experts specifically asked what is the value added to this framework by this system.

5.3.1.2 Accuracy

Experts had concerns about the data and how to make sure they are accurate. The initial reaction was to include this factor as a part of 'Misrepresented Information'; however, further investigation is required.

5.3.2 Dimensions Sequence Changes From FITS to FIST

In Chapter 4, the initial phase of building the framework is presented, which is based on desk studies. Subsequently, in this Chapter 5, the framework developed from the desk studies is validated through expert reviews and analysis. The modification in the sequence of development was influenced by the significance of the dimensions highlighted in the experts' analysis. The resulting conclusion is that to establish a new system for information-sharing, four key requests must be addressed:

1. **Adoption and Facilitation:** The system requires a responsible entity to adopt and facilitate it, guided by six crucial factors.
2. **System Development:** A dedicated team or individual is needed to develop the system.
3. **Secure Data Access:** Before sharing, the system must include a mechanism to ensure access and the security of the data.

4. **Trust and Allocation** The system should be capable of effectively allocating, assigning, encapsulating, and distributing the information, thereby establishing trust in its functionality."

5.3.2.1 Implementation Conditions to IT Operations

The main focus of the experts was not the implementation end, it was the actual building of the system and how would it operate. This dimension represents the factors that is required during the development of a new system for information sharing.

5.3.2.2 Trust Chain Authentication to Trust Assurance

The expert analysis indicated that while trust is a significant concern, it is not necessarily in a sequential or chained manner. Instead, the emphasis is on trust in the system's integration ability. The system must guarantee secure transactions of shared information, creating a foundation for trust. Establishing trust is critical to ensuring the accuracy of the shared information.

5.3.3 Changed and Combined FITS Factors

Few factors were based on hyper-ledger. When the experts were interviewed, they showed interest in the framework and in how would it tackle the issues. Hyper-ledger is a technology that can solve the problems, yet it is not the only solution. So, hyper-ledger factors were disregarded since both blockchain expert and non-blockchain experts observed that blockchain technology is complicated for the framework and that factors based on other technologies can solve the issues.

Factors were combined with others or become more generalised, as described:

5.3.3.1 Financial Barriers

Experts showed that this factor is considered to be more of a support than a barrier, so it was changed to "**Resource Support**".

5.3.3.2 Top Management Commitment, Cooperation and Collaboration

These became a single factor. The experts showed that, without top management enforcement, nothing is relevant to cooperation or collaboration. These two factors are now called "**Top Management Support**".

5.3.3.3 Outdated Infrastructure

According to the experts, infrastructure is more than networking and devices so 'adoptive infrastructure' is more relevant to the Facilitating Conditions category. The factor is now termed "**Adoptive Infrastructure**".

5.3.3.4 Immutability

This factor was restricted to hyperledger; however, the function of ensuring the accurate of historical records and their author is understood by experts as information provenance. This factor was thus renamed "**Provenance**".

5.3.3.5 Consensus Mechanism

This factor is related to detecting wrong information and how to respond. Since it is about accuracy, it is termed "**Misrepresented information**".

5.3.3.6 Security

This is a concern for both IT Operation and Management; however, to reduce duplication, it now has its own category.

5.3.3.7 Trust

This is an important factor that acts as the main contribution to the Framework, so it now has its own category.

5.3.4 Disregarded FITS Factors

These factors were redundant either as they fall into another category or can be inherited from or achieved by from another factor.

5.3.4.1 Smart Contract

This factor is based on blockchain. It was deleted because there was not enough feedback to focus on blockchain factors: the response of two experts (Expert L & Expert N) was not enough to retain this factor.

5.3.4.2 Training and Experience, Job assignments

These two factors became one because, according to the experts, they are more related to performance and data analysis. Also, the data analysis could have an impact on finding the right candidate for the required job description. These two factors became one, now called "**KPI - Data Analysis Capabilities**".

5.4 Experts Review Findings and Discussions

This section contains the expert review findings and discussion. A **qualitative** approach was deployed for expert interviews to extract findings. Also, this section shows how the experts' findings shaped the Framework. The analysis was initially carried out using a qualitative, top-down approach; then, the findings were grouped by theme. By analysis of the experts' opinions, each theme became a factor. Detailed transcripts of the top-down approach are available in Appendix C. The second approach was through a themed, bottom-up approach to the findings that did not relate to the current Framework; this serves as a baseline for future work and development. Moreover, the bottom-up approach identified discussions where experts suggested or provided solutions to the problem. These transcripts are available in Appendix D.

A detailed analysis of the findings and how they affect the refined Framework is provided. The final Framework is based on the analysis by 15 experts. After analysis, the experts' responses were grouped based on their emphases during open-ended discussions on topics related to the four main categories. The findings were revealed by presenting scenarios and inviting the experts to engage with them. First came an explanation of the main category, then a request for the expert to elaborate on it, saying whether it should be a concern or a relevant factor. By the end of the interviews, the importance of solving the issue at hand was assured for each category.

One of the main findings reflected the Framework to be changed from **FITS** to **FIST** (Changes are shown in Figures 5.5, 5.6, 5.7 and 5.8). The Category Security came before trust. For this Framework to achieve trust, it requires security. Security becoming before trust is relevant for the flow of factors and their connections with categories, as shown in Figure 5.9. This chapter's analysis reshaped the categories as shown in Figure 5.4, which made the entire Framework more connected and had a more precise flow.

At the beginning of the second phase of conducting interviews with experts, the question format was based on four main categories of factors, each with a few secondaries. The first main category was assumed to be administrative, the second software development, the third the security of both system and data and the final blockchain technologies. Since the interviews involved open discussion and questions that did not specify any factors, just broad categories, it became clear that more was involved in the first than

administration. Moreover, ‘development’ should cover infrastructure; both hardware and software and security should cover information exclusively; since the main requirement is to enhance the levels of trust and accuracy, there was no need to restrict the Framework to a single technology such as blockchain.

A summary at the end of this chapter presents the conclusions drawn from this approach.

5.4.1 Facilitating Conditions

The experts were asked what they think about factors or reasons that could facilitate a new system in practice and the fundamental factors to be addressed, alongside any concerns. Discussions were held on what could improve the system: in other words, from the perspective of influencing entities, what concerns, if addressed, might enhance the FIST Framework.

Experts demonstrated good interaction and comprehension of this category of Facilitating Conditions. They implied that government agencies had responsibility for its adoption; in other words, they looked on it as governance factors. The suggested ministries were the Ministry of Economy and Planning (MEP), the Ministry of Education (MOE) and Ministry of Human Resources and Social Development (HRSD). They would be the main beneficiaries and would own and sponsor the system. In Arabic, the correct term is ‘Adoption Intuitive’, where adoption refers to sponsoring a beneficiary. The interviews were conducted in Arabic, and the closest word in English is ‘adoption’.

All 15 experts strongly emphasised that it was important that Facilitating Conditions should be a main category, while there were a various perspectives on the suggested factors. These are about acceptance in the form of assigning a beneficiary to adopt the system and take responsibility. They are factors concerning the actual beneficiary to act as the main stakeholder, whether MEP, MOE or HRSD. It involves convincing and assigning the main stakeholders, who would have the higher influence n administrative changes that would affect multiple sectors.

Experts responded with strong emphasis to the point that a system like this requires government intervention. They showed concern at the security and privacy of information if there is no right of access other than for the issuers and the ministry at which it is located. Also, they had concerns about whether people could be convinced to adopt the system. Some experts indicated that this factor is an ‘administrative decision’, as it is one of the strongest influences on the system. Also, experts focused on the involvement of the public sector rather than the private sector. The main beneficiary would adopt the system as long as: (1) it has added value (strong reason or cause); (2) a top manager is assigned to ensure that the system adheres to plans; (3) there are laws and regulations; (4) the system has measurement capabilities; (5) the top manager enforces cooperation; and (6) support is allocated.

5.4.1.1 Added Value

Experts from both the private and public sectors regarded added value as a new factor. Often it took the form of a question, ‘What is its added value?’ The added value of such a system, in fact, depends on the stakeholders. Until now, the main prospective stakeholders have been the public sector, government sector, head-hunters and job-seekers. With added value, the public domain could provide a social service in a form of strategic planning and human capital development. However, the private sector is focused more on actual financial returns and material profit. In addition, candidates seek jobs in order to secure employment. Finally, at an organisational level, stakeholders include human resources departments, employers and recruitment agencies.

Nine of the 15 experts mentioned this factor by either hinting or giving some indication. Hence, it became new factor and was a concern in both the public and private sector. The added value at several ministries could be weighed, and the one with the greatest benefits would be the best adopter for the system. One of the reasons why this factor is favoured by the government sector is that this focuses on social welfare.

5.4.1.2 Top Management Support

Nearly all experts, 14 of 15, strongly emphasised the importance of top management’s commitment and support. This factor’s wording changed from commitment to support. Support implies commitment, which leads to cooperation and collaboration by everyone. This was the factor that was most addressed and mentioned, and 12 experts mentioned it more than once.

Top management represents the role with the capabilities and connections to enforce cooperation and resource allocation. This role takes actions and pushes forward. One of its main responsibilities is to allocate services and Service Level Agreements (SLAs), for example G-Cloud, related to government-based cloud services in this framework. Top management is present in both the public and private sectors. In the private sector, there is a need to allocate resources on the basis of spending and revenues gained; however, most experts emphasised that the role should be in the public sector. One of its most important tasks is to generate ideas or systems that are in line with their organisation’s vision and goals. This is because top management changes and each post-holder comes with fresh initiatives; however, if the system has clear added value and procedures it will benefit the organisation, thus will continue to be supported and developed.

5.4.1.3 Laws and Regulations

This factor concerns the laws that the National Information Center and ministries require; in other words, the controls needed to authorise the way that they share information.

Regulations may also be understood as the standardisation required for information-sharing. Also, it is about requesting information from various organisations, because each involves different requirements to be compatible with its system. Each employment organisation has restrictions on accessing its data. If the request to be granted access follows the law and regulations, it will be accepted.

Information-sharing and organisational integration cannot happen without proper permissions that abide by government laws on data privacy. There is a need to study and analyse what changes need to happen. These take the form of issuing regulations on how data should be stored by the issuer and distributed by the system.

Some experts mentioned the importance of continuing to work on how data handling is conducted, because that already adheres to regulations, and starting a new system from scratch involves difficulties that could lead to stalling the system. In other words, the system should continue to add features to current systems and not try to ‘reinvent the wheel’. Regulation is important to formulate how to request sharing of data, otherwise it will lead to reliability issues. Laws are already in place because of data regulation, for example the UK General Data Protection Regulation (GDPR), and are available on request.

Some experts mentioned that assent for jobs is not standardised outside any particular organisation, thus a study on this type of standardisation is vital. Imposing standardisation on the storage and release of data is important, especially from a security perspective, as laws and standardisation regarding what data are to be shared or released will ensure privacy.

5.4.1.4 Clear KPI - Performance Measurement and Achievements

As many as 12 of the 15 experts spoke about the capabilities for processing data. The processed data could take the form of a resumé builder using a requested set of parameters. It should be able to analyse the data accurately without bias regarding gender, age or personal attributes and be able to evaluate certain performance indicators, for Key Performance Indicators (KPI). Finally, these data management capabilities would support managers, organisations and agencies to show KPI.

This factor scored a somewhat negative overall impact as it involved a conflict of interest; however, even those experts who were negative agreed that it is an important factor. It measures the performance of employees and whether they are doing their assigned tasks. This could help to catch low-performance employees to suggest a training programme. The main problem is that these KPI are in the hands of the direct supervisor, which sometimes causes social conflict.

Assessment can be based on two aspects: performance and qualifications. This aspect is based on assessment, which is based on performance. A senior manager expert mentioned that, whether an organisation accepts them or not, individuals write their own personal achievements, so a conflict of interest is not an issue. One of the main issues with performance measurement is the involvement of a single individual, which is a social factor. There is no system available that can be standardised across all organisations as a set procedure to measure performance. Most KPI systems are internal or customised to the organisation's needs. Unfortunately, most direct managers have some inaccurate influence, whether positive or negative. One expert illustrated the challenge not being able to record every achievement. Some (4 experts) viewed this as a negative factor and said that it would show organisations or individuals to have a negative impact; regardless, this factor is important, despite the negative feedback. Some challenges could be addressed by involving a computerised system or the human resources department to achieve a more neutral assessment.

Some measures of performance are based on conciliation rather than actual performance. In conclusion, and this is approved by the experts, the safest way to overcome most social barriers is a job description with clear goals, then to measure performance against each of these goals.

5.4.1.5 Cooperation and Collaboration

There was much consideration of this factor, which was at one point dropped then appeared again. It was deleted as it was regarded as being under the heading of top management support, yet it comprises not only individuals' request to cooperate. This factor takes many other forms, such as resource allocation, SLAs, individual cooperation and organisational cooperation.

Cooperation is generally enforced best by the public sector, giving it added value. There is a major issue with the public sector, especially when changes or new tasks are required. One expert who works as a software engineer to develop government services referred to this factor as critical, since they had experienced challenges in obtaining data. Cooperation is not only about working together for a specific reason but to provide and release information. So, cooperation is not only among individuals as actions but has a technical perspective.

5.4.1.6 Financial Support or Resource support

As many as 12 experts strongly emphasised the importance of this factor of support. They stated that support is not only a monetary value but concerns the allocation of personnel to the development team, human resources and staffing. Also, it is not only

about spending money to develop the system but staff's income. Some support may take the form of time off, or time, money spent, money gained, allocated jobs and human resources, so it can be understood as both resource gained and invested. Having a goal with clear benefits will favour decisions over this kind of support. This factor signifies the full range of support to get the system running.

Notably, this factor goes beyond resource support, as it is another way to get developers to build the system. These developers might have new requirements that involve infrastructure changes in terms of providing systems and physical infrastructure, securing and developing the systems, employing new teams, making contact with a developer or providing the platform. This resource support is the main basis for a new category in this study, IT Operations, which is explained in the next section.

5.4.2 IT Operations

The previous category of Facilitating Conditions, which focuses on ownership and assigning responsibilities for infrastructure development, upon experts' reflection gave rise to the new category of IT Operations. This comprises the main factors behind the operation of the system. Experts were asked what they felt are the main considerations for infrastructure developers.

This factor assigns the responsibility for the infrastructure for development (software) and requirements (hardware): infrastructure covers both software (application) and hardware, basically everything needed from the development side. Some infrastructure can be requested by other organisations in the form of service, through a SLA. These firms develop rather than become involved with the actual data, mostly requesting SLA for the data and the infrastructure to solve the problems. They also monitor the traffic, and support and maintain the system.

All 15 experts emphasised that the various factors of IT Operations (previously termed Implementing Conditions) should be included as a main category for the system. This addresses IT Operations and system development concerns. This category can request the support of the previously discussed 'Support Allocation' factor and comprises mainly factors for system running, deploying, developing or demanding additional requirements. Such factors include having a system on an adoptive infrastructure for current systems, having a system that supports increases in demand over time, choosing how to store data, being usable by many users and running on multiple platforms, being flexible to adapt to changing conditions and infrastructure, reliable in doing its required tasks and providing services.

5.4.2.1 Adoptive Infrastructure

Expert B observed that infrastructure comprises not only hardware but software. This expert noted that there are two types of required infrastructures and agreed on the importance of the IT Operation factors; however, when speaking, Expert B focused on the software infrastructure to be considered. After analysing the response of this expert and 14 others, the decision was made to move the factor of Adoptive Infrastructure from the category of Facilitating Conditions to IT Operations. After analysing all 15 experts; the reasoning was that the main category Facilitating Conditions contains factors that have more of a management perspective. As previously discussed, top management will strongly enforce changes, cooperation and resource allocation and support. Resource allocation examples would be shown when assigning the whole category of IT Operations to a developer or a IT management team. Hence, infrastructure becomes the responsibility of IT Operations on the assumption that it will be a enforcement issue from the previous category. Since infrastructure is either hardware, software or network, this is in line with the system requirements, meaning that IT Operations has to build the infrastructure requirements with the support of the previous category – the decision-makers.

Adoptive infrastructure means supportive changes, interaction and updates in line with the system requirements. These can be met through studying what the new system might need, perhaps at a new system planning phase. Also, this factor helps in understanding what changes are needed to the current available infrastructure. This factor shows that some infrastructure is more human than operational, since so many related divisions work on it.

One of the most important factors in this framework is system integration. Without allocating the mandatory infrastructure requirement for integration, the system will fail. It is responsible for creating an adoptable infrastructure capable of integrating and interacting with the existing system. In other words, this factor is responsible for proposing the system requirement, developing it and finally maintaining it.

5.4.2.2 Scalability

Scalability is about the system working on a massive number of systems and users, back-end and front-end. It is not only about the data, as some experts describe, but about the services' functioning accurately at a large scale. Another aspect is the ability to handle system expansion and growth in various ways, such as for users, functions and networking, both for adding and requesting records.

5.4.2.3 Storage

The factor of storage emerged as one of the most controversial in this research. Six experts strongly emphasised its importance, three afforded it low importance and, unexpectedly, six experts strongly disagreed and rejected it. Even among those who approved of it, two experts said that it should be undertaken using government cloud services.

After analysing the experts' responses, it seems that storage puts great responsibilities on the system. To mitigate the risks to stored data, a detailed study must be carried out and storage limited to small amounts. Regarding storage in the private sector from a business perspective, experts mostly agreed that it is not favourable and will involve drawbacks. Those who approved it had no issues as long as the storage is hosted by government services and follows the law and regulations.

That said, this proposed framework is about sharing records, not storing them. The factor was retained, even though it was rejected by six experts, only because there might be a need to store some kind of data in other forms, such as data pointers. The stored data would be useful for calculations and analysis. A pointer is useful to link to where the data are stored, not to store the actual data. For example, when someone who is hunting for work publishes their resumé, the pointer linked to the candidate's data is stored for head-hunters to discover prospective candidates.

Storage is not a concern, since it will be for sharing, not holding actual data. Most of the stored data will be pointers. Nonetheless, since it is an infrastructure factor, a request for system requirements will be made.

5.4.2.4 Usability

This factor of usability means an easy-to-use interface, with nothing complicated for the average end-user. Also, it means an easy experience for an average untrained user who deploys the web application. Difficulties are reduced by having a clear, user-friendly interface. This factor is focused on the end-user, not the developer. It was addressed by eight experts who strongly emphasised this factor.

5.4.2.5 Flexibility

Flexibility has a trade-off with complexity and performance. A more flexible system means less complexity and less performance; however, experts discussed this factor from the point of view of the end-user and mentioned that the system should be flexible regarding the operating environment.

The flexibility factor is one of the factors that are supported by the IT Operations category, and it is less of value than others, yet it is considered to be a requirement

for end-users. It was discussed by six experts, of which one rejected it, saying that it would be a web application and that most users would be familiar with it. The other nine experts put little emphasis on this factor, perhaps since all worked, studied or developed systems. Nonetheless, this factor remains in the framework because those experts qualified in systems interaction discussed how, by default, it is available on all systems.

5.4.2.6 Reliability

The reliability of a recently developed system is critical, and it is a system requirement for developers to ensure that it will have no issues or problems, will function well and be consistent in its tasks and services.

The experts extended this definition by regarding reliability as a system's ability to be resilient (strong) in use. When the system goes live, it must perform correctly. At some point, the system will need enhancement, and to continue to be reliable it should support updating features and the continuation of development through the support of updates and system patches. Ten of the 15 experts emphasised strongly the importance of reliability, while the remaining five scored it low emphasis; even so, it is a system requirement and should be studied.

One topic was mentioned many times, the suggestion that the system operates on e-government platforms (such as G-Cloud), cited by all the experts at some point for its high level of reliance. So, a reliant system that can run its required tasks would suggest that it can be trusted to handle secure private data. Hence, the next category of Security Principles emerged.

5.4.3 Security Principles

All 15 experts emphasised how the security of the shared information must be included. Two experts raised the point that it was a concern only if it were managed by a third party, outside of government agency. This category had the approval of 13 experts if it were managed by government and all 15 if it were managed by a third party. The assumption is that the government will implement and manage this system. This assumes that the government approves such a system for its significant utility; only one expert (J) did not value security, actually giving it negative emphasis by saying: *“When you build a system, you do not need the over headache of security, not everything should be about security”*. Later in the interview, this expert contradicted what was said earlier and added, *“in any online system, web based or local system, security is a major concern, and it is the first concern to work on”*.

Security is the main reason to reduce risks to information. Security practices are in place to mitigate any undesirable impact. Expert E best described this category, saying: *“If there are any kind interaction with information, either information access or information retrieval, the system must be secure and assure authenticity, authorisation, confidentiality, availability and integrity”*.

This category was shaped by asking experts about it in relation to record-sharing, as in the example below:

- What is your requirement list when assuring security of the information?
- What are major security concerns on these types of data?
- What are factors that must be available regarding security or this system is considered inadequate?
- How can security bring added value to the table?

These questions engaged the expert in discussion about security and their concerns from their own perspective. Some experts interpreted this category as being extended and the availability of support patches when a risk is discovered; however, it is shaped by the data rather than by the application or system. Also, some talked about network security, system isolation, security and isolation from interference.

There was an extended mention of conflict of interest when information is shared. Few experts suggested the valid point of data classification, whereby an organisation that classifies its data would retain some sense of control when sharing only what it views as acceptable to be released. This security is extended to every user of the system, individuals, employment organisations and educational institutes. The experts reported that some systems already host student information up to high-school level, without graduate certificates. There was more acceptance of information-sharing by educational institutes than for employment achievements or history.

Some experts added disaster recovery, data leakage prevention, data governance and data monitoring as security factors; however, this category is just about assuring the security of the actual data while they are being distributed by the data owners or data issuers. The factors mentioned were valid, yet they are the responsibility of organisations' security operation departments.

After the analysis of the findings, the security concept in this research is divided into two ways. Security was the most discussed topic by experts and at some occasions experts contradicted themselves. The experts contradictions required another analysis after the whole framework was done. This helped with the findings what is security from the prospective of the experts. The findings were clearer as security is viewed in FIST framework as the security of the infrastructure and security of the records inside the infrastructure.

Although some experts view security as a task and other as a statement, in the end, as a category and a major concern, security is always vital in every form. The main

idea behind this category is the security of the actual data, not the system or the application. There will be forms of information exchange that require access: authorisation and authentication. Also, information distribution involves confidentiality, availability, encryption and integrity.

5.4.3.1 Confidentiality

This factor is defined as the property that allows only approved users or entities to receive the information. Other than that, it is kept private. This is a crucial factor while information is being distributed. It also answers some experts' concerns. For example, one warned: *"You should consider who would view information..."*.

Confidentiality is in place when the information is distributed and no longer within the organisation. When it is out, what ensures that it will be used only by those who have authorised access is the attribute of confidentiality. Losing confidentiality means losing trust in the system, which also means failing the interests of the stakeholders.

The experts' reaction to this factor was that 10 strongly emphasised it, one lent it medium emphasis and the remaining four gave it low emphasis. There was no negative emphasis.

5.4.3.2 Authentication

Authentication is the process of proving that something is valid. It extends to specific authentication protocols. In this framework, authentication means access to the information. Generally speaking, the term is used to verify the identity of the user. Authentication happens when two parties, such as a server and a user, have data on something that you are, something that you know or something that you have. When data are provided, the pair is checked for user verification. When someone is authorised, it means that they have access to a system.

Some experts looked at authentication as the procedure of authenticating the information, not the access rights to it, which is the process of confirming the issue of the information and the data's integrity. In their understanding, it means getting the data to the correct data owner then validating the integrity of that data. Nonetheless, this factor is about the data, not the procedure. The importance of data authentication was raised after conducting the expert interviews, and now it falls under another category, 'Trust and Accuracy', which is responsible for data distribution and movement.

The analysis found that nine experts strongly emphasised the importance of having some form of user authentication for the data. They had concerns about how to access data and how to authenticate users. Six experts scored low emphasis for this factor and did not make any further comment. The analysis found that eight experts believe that

authentication and authorisation are not separate and always go together when accessing data.

5.4.3.3 Authorisation

Authorisation is a new factor that was discovered after conducting the expert interviews. It was not on the interviewer's list of questions, yet it was raised by 11 of 15 experts with no prompting.

This factor is debatable, as this system is for sharing verified information that is issued by an organisation or an institute. The framework is about users requesting to share verified information from the issuers and not to change the information provided; however, there might be scenarios in which this is necessary, hence the factor arises, defined as access without enabling information change. In this framework, authorisation means that users have the privilege to access the information without any control, based on privileges that determine access.

The analysis found that eight experts explained that authentication and authorisation are not separate and always go together when accessing data. Moreover, for a system that works with private data, 11 experts gave this factor strong emphasis.

5.4.3.4 Data Availability

This term, data availability, is in relation to the system's ability to be up and running, as it is expected to be web-based. In this framework, it is the availability of its information to both access and verification. Some experts assigned the factor to technology. The concept of data availability was much discussed and strongly emphasised by eight experts and, even if it is achieved by a specific technology, it is important. Availability on more than one system should be considered. This term is discussed under the decentralisation factor, which will reduce the potential number of single points of failure. Two experts said that availability is important but is not time sensitive, when talking in the context of application and service availability. Data availability handles only data, not applications or systems. Accordingly, data availability in this system might have two locations: one at the organisation with the original data; and the other at the proposed system while hosting information on prospective job candidates. There were few deep discussions on this factor but, since it is a security principle related to data, it remains in the framework. Two experts scored this factor medium emphasis and five low emphasis.

5.4.3.5 Encryption

This factor did not come up in deep discussion, and some experts actually said that it has low importance because they trust the government systems to provide encryption. Two experts said that if the data were from government systems then encryption would be important. Another two afforded the factor negative emphasis and said that it should be dropped; however, eight strongly emphasised its importance, compared to five giving it low emphasis and two rejecting it with negative feedback. To conclude experts analysis, encryption is a fundamental aspect of data security and privacy, as emphasised by various experts. It is particularly crucial when third parties are involved in handling information or when personal data is outside government services. Encryption ensures the integrity and authenticity of data, preventing data leakage and unauthorised access. Some mentioned that it is automatically implemented by systems that employ authentication servers. While encryption may not be deemed necessary for publicly available information like resumes, it becomes vital for safeguarding sensitive data such as health records. Encryption plays a significant role in information exchange, especially when multiple servers are involved. It is essential during data transmission and storage. Blockchain technology also utilises encryption to guarantee privacy and security. Overall, encryption is widely recognised as a critical component for protecting sensitive information and maintaining the security of data.

5.4.3.6 Integrity

Data integrity is defined as the attribute of data being accurate and valid. It guarantees the traceability of their origin or source. This factor can assure the origin and traceability of data. In this framework, data traceability is vital to reveal the origin. There will be some combined data on the system that were collected from different systems. The integrity of each set of data and where it originated are critical. Experts did not discuss this factor in detail; it was afforded strong emphasis by 11 experts, medium emphasis by two and low emphasis by the remaining two. Data integrity is the final stage of securing data before they leave the origin. Regarding this framework, data integrity is essential. Since the system validates data through records from different systems, it is crucial to the success of the next category, Trust Authentication.

5.4.4 Trust and Accuracy

All 15 experts strongly emphasised and engaged with the statement that assuring trust is mandatory, and showed much interest in discussing how information would be assured and validated. The more technical experts required a demonstration. This category was the one that most experts reacted to. Due to the language barrier, some experts used the term ‘Trust and Authentication’ to avoid conflict with the previously mentioned factor

of Authentication. There is a difference. When an expert said data authentication or authenticated data, it meant the process. When an expert mentioned users or entities together with the term ‘authentication’, they meant user authentication. Experts were asked questions to indicate their engagement with this category. If they did not respond, an example on provenance was provided. The experts were asked:

- What are the factors responsible for raise trust through enhancing accuracy?
- What factors do you think are needed during information exchange or information distribution?
- (At the end of the interview) Do you have any information about hyperledger or blockchain and, if you do, how would it fit into this category?

Some experts claimed that the best practice to raise trust and accuracy is to collect information then combine it to represent requested records or information. To enhance accuracy, experts suggested a chain of previous trusts to accumulate and assure trust through accuracy. Assurance is based on validation, and many talked about validation. Having trust validation would raise accuracy. Trust is, to some extent, people’s social trust. Trust of government is when it provides all the services that it promises. Since there is information-sharing and allocating, the accuracy of the information about a specific person is vital. It is to be assumed that the information is on the intended person. This category comes into practice when there is secure information ready to be shared by following the security principles and arranging for the appropriate infrastructure for sharing by the IT Operations category. Now, after assuring the security and infrastructure, these factors act to show trust through the data flow from one location into sharing the actual information. Now the information is secure and ready to be shared in a system, what factors are important? Chains of trust help to make the right decision. Not only is accuracy important, but confirmation of the verified information.

5.4.4.1 System integration

System integration is a newly discovered factor mentioned by six experts (Experts B, C, D, L, M & N). They raised this factor regarding the framework for sharing information. Then the remaining either hint it or gave it less emphasis.

System integration is a key aspect discussed by all 15 experts. They emphasise the need to gather and combine accurate information from various sources to build a reliable system. Integration involves connecting different entities, such as educational institutes, employment organisations, and government agencies, to create a unified platform. The system should ensure data integrity, trust, and accuracy by establishing clear connections and provenance between data sources. Infrastructure readiness, including servers, networks, and connectivity, is crucial for successful integration. The involvement of top management and government support is seen as essential for cooperation and resource

allocation. The system should facilitate information sharing and validation without storing unnecessary data, using an intermediary interface or API integration. Cross-platform compatibility, user-friendly design, and ease of use are important considerations. Challenges related to permits, stakeholder cooperation, and data access may arise, but can be overcome through collaboration and a government-oriented approach. Integration with existing systems, adherence to privacy regulations, and focus on backend development are recommended. Overall, system integration aims to bring together diverse organisations and data sources to ensure accurate, validated, and efficient information exchange.

5.4.4.2 Privacy

Privacy is examined here rather than under security, because security assures the privacy of the information while here it is in the context of information-sharing and making sure it is private and reaches who it is intended to. Also, it has some control over what individuals or organisations show in their resumés. This could be stronger when it has information classifications. Classification assures everyone's privacy and confidentiality, yet in the sense of handling information it shows who has control over their data. Among organisations, this is a major area of conflict of interest.

Experts engaged on this topic more than 16 times, and it was one of the most-discussed factors in two ways: the classification of information; and the conflict of interest when corporates provide employee data.

5.4.4.3 Data Verification and Validation

An expert mentioned how the liability for or task of verification should not lie with the issuer, who should only provide validated and accurate certificates. The system adopters should be responsible for the process of verification, in this system. Expert K contradicted several points. They showed interest in a unified system to verify and validate the records; then, later in the interview, they said that is the responsibility of the institute that issues the certificate and suggested using some kind of a digital mark, such as a barcode or QR code. This expert cared to undertake verification only through well-documented procedures, not an app. A form of data validation is required, whether technical or physical. Some current practices involve an interview with the claimant. Also, the data require their accuracy to be validated. Some forms of validation are time limited: for example, a training certificate may expire after two years.

5.4.4.4 Provenance

Experts has mentioned having a provenance factor would provide full history of ownership or the information and from where it was issued or originated.

However, some experts viewed the factor of provenance as the attribute of transparency when hiring. This system does not recruit individuals; rather, it shares their records to bring them together in one place for the purpose of hiring. It is not a hiring system. It simply assures the records and their validation.

5.4.4.5 Misrepresented information

Misrepresented information means giving too much emphasis to or overstating the information, or not giving enough information. Also, it arises even if a certificate is accurate: What if it was later revoked? What about unclear information if the user is constructing their very first resumé?

The system needs to consider information without a source, also misrepresentation due to a wrong evaluation: while it may show where it came from, it may still be factually wrong. Moreover, it is conceivable that part of the information is correct yet another part is not.

5.4.4.6 Distributed Decentralisation

Decentralisation runs counter to centralisation. There was little feedback on this factor other than indirect allusions using the word ‘cloud’ or ‘G-Cloud’. Decentralisation is not only about the information storage and location. To some extent, it also handles the administrative perspective. This factor was added on the basis of performance evaluation being carried out not only by a direct supervisor but by a neutral party, such as HR. This factor remains in the framework even though it did not have much feedback. It is beneficial for certain information and some experts said that it should be limited. The reason for its remaining is to cover the circumstances if there is industry shutdown, as this would mean a single owner of information and a possibility that that information is lost.

5.5 Dissections of the Findings (contradictions)

This framework focuses mainly on information-sharing to enhance the accuracy of a given resumé. Only those topics related to information-sharing were considered and analysed, although there was mention of adoption or acceptance, which lies beyond the scope of this framework. The findings do not cover sharing records, therefore a trust platform for record-sharing was introduced.

Some experts focused on the benefits and how to improve the hiring procedure through talent and employee acquisition. Their discussions were taken into consideration and

analysed for future work following this research. This project is about information-sharing of validated information to improve the accuracy of resumés through a trust-based system.

There was a clear attention to KPI and performance evaluation. As it was mentioned by 22 experts, this became a factor, nonetheless the framework does not evaluate performance but suggests its importance. How the experts indicated it does not evaluate an employee's performance. Further research is needed to be undertaken beyond this research.

5.6 Future work Factors

This sub section has factors that were mentioned by experts who has capabilities of being decision makers or has experience for more than 10 years. These factors are beyond the boundaries of this research.

5.6.0.1 Standardisation

A factor mentioned by five experts who had worked on database and servers, for whom it is a major concern. Moreover, this needs further investigation as it was mentioned and addressed by an expert with more than **10** years' experience.

5.6.0.2 Audit-ability

A factor mentioned by only one expert; however, he is a chief technical officer and who has more than 25 years' experience. Further investigation is required for this factor because it was mentioned and addressed by an expert who is a decision maker.

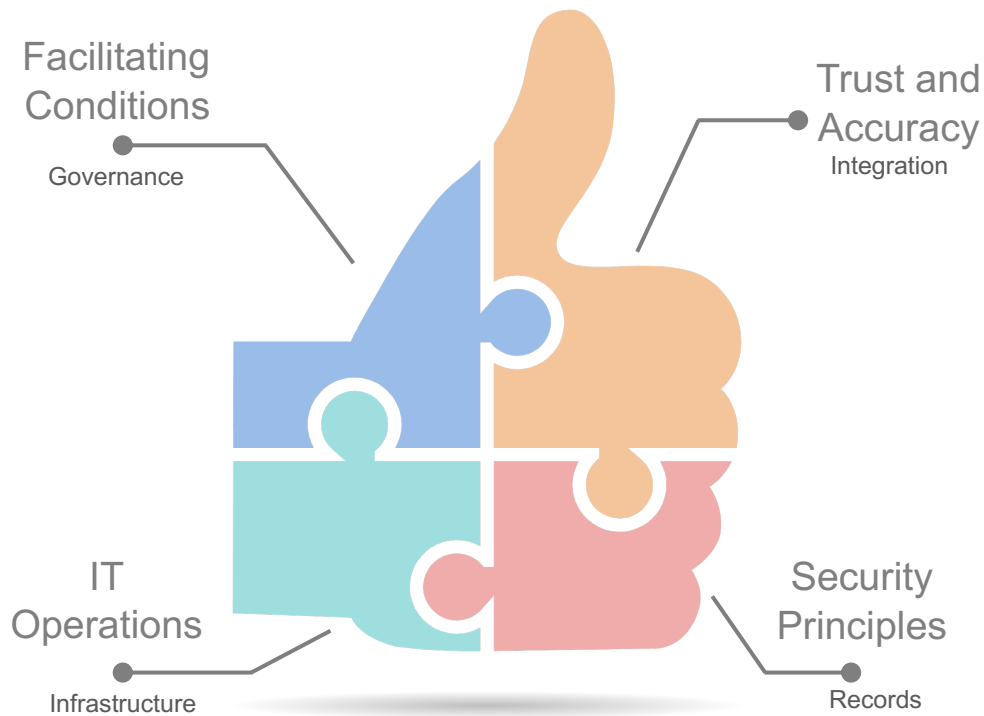


FIGURE 5.4: FIST Main Categories Framework

5.7 Chapter Summary

This chapter has served as a pivotal bridge in our research journey, transitioning from the theoretical construction of the FITS Framework to its empirical validation and refinement. Through a multi-method approach, encompassing literature reviews and semi-structured expert interviews, we have achieved a thematic analysis that confirms the initial framework and brings forth necessary modifications and updates. This methodical approach has allowed for a comprehensive examination and enhancement of the framework, ensuring its relevance and applicability.

As the research progresses, the next chapter will address the second research question through a Delphi method involving experts. This phase aims to unearth and understand the trust issues inherent within the framework as it currently stands. This systematic approach will involve a triangulation technique, incorporating expert analysis through the Delphi method, literature review, and insights from the first research question. The goal is to refine the framework further, ensuring it is robust, relevant, and effectively addresses the complex dynamics of information-sharing, particularly in e-government.

In summary, the insights and modifications derived from this chapter's expert analysis have been instrumental in evolving the FITS Framework into a more interconnected and coherent structure, now aptly renamed the FIST Framework. This progression is visually represented in Figures 5.5, 5.6, 5.7, 5.8, and final complete version in 5.9, showcasing the

framework’s evolution and the intricate flow of its components. The subsequent chapter will build on this foundation, aiming to further enhance the framework’s efficacy and trustworthiness through expert-led Delphi studies.

1-0	Facilitating Conditions	1-0	Facilitating Conditions
1-1	Financial Barriers	1-1	Added Value
1-2	Top Management Commitment	1-2	Top Management Support
1-3	Cooperation and Collaboration	1-3	Laws and Regulations
1-4	Outdated Infrastructure	1-4	Performance (KPI)
1-5	Learning to Build Skills	1-5	Cooperation
1-6	Job assignments	1-6	Resource Support
1-7	Hiring Procedures		

FIGURE 5.5: Changes in FIST Framework: Revised First Dimension, Factors, Sequence and Naming

2-0	Implementing Conditions	2-0	IT Operations
2-1	Security	2-1	Adoptive Infrastructure
2-2	Reliability	2-2	Scalability
2-3	Scalability	2-3	Storage
2-4	Usability	2-4	Usability
2-5	Flexibility	2-5	Flexibility
2-6	Storage	2-6	Reliability
2-7	Efficiency		

FIGURE 5.6: Changes in FIST Framework: Revised Second Dimension, Factors, Sequence and Naming

3-0	Trusted Chain Authentication	3-0	Security Principles
3-1	Authenticity	3-1	Confidentiality
3-2	Trust	3-2	Authentication
3-3	Privacy	3-3	Authorisation
3-4	Smart Contract	3-4	Availability
2-5	Consensus Mechanism	3-5	Encryption
3-6	Decentralisation	3-6	Integrity
3-7	Immutability		

FIGURE 5.7: Changes in FIST Framework: Revised Third Dimension, Factors, Sequence and Naming

4-0	Security Principles	4-0	Trust and Accuracy
4-1	Authenticity	4-1	System Integration
4-2	Confidentiality	4-2	Private Information
4-3	Data Availability	4-3	Data Verification and Validation
4-4	Cryptography and Digital Signatures	4-4	Provenance
4-5	Integrity	4-5	Misrepresented Information
		4-6	Distributed Records

FIGURE 5.8: Changes in FIST Framework: Revised Fourth Dimension, Factors, Sequence and Naming

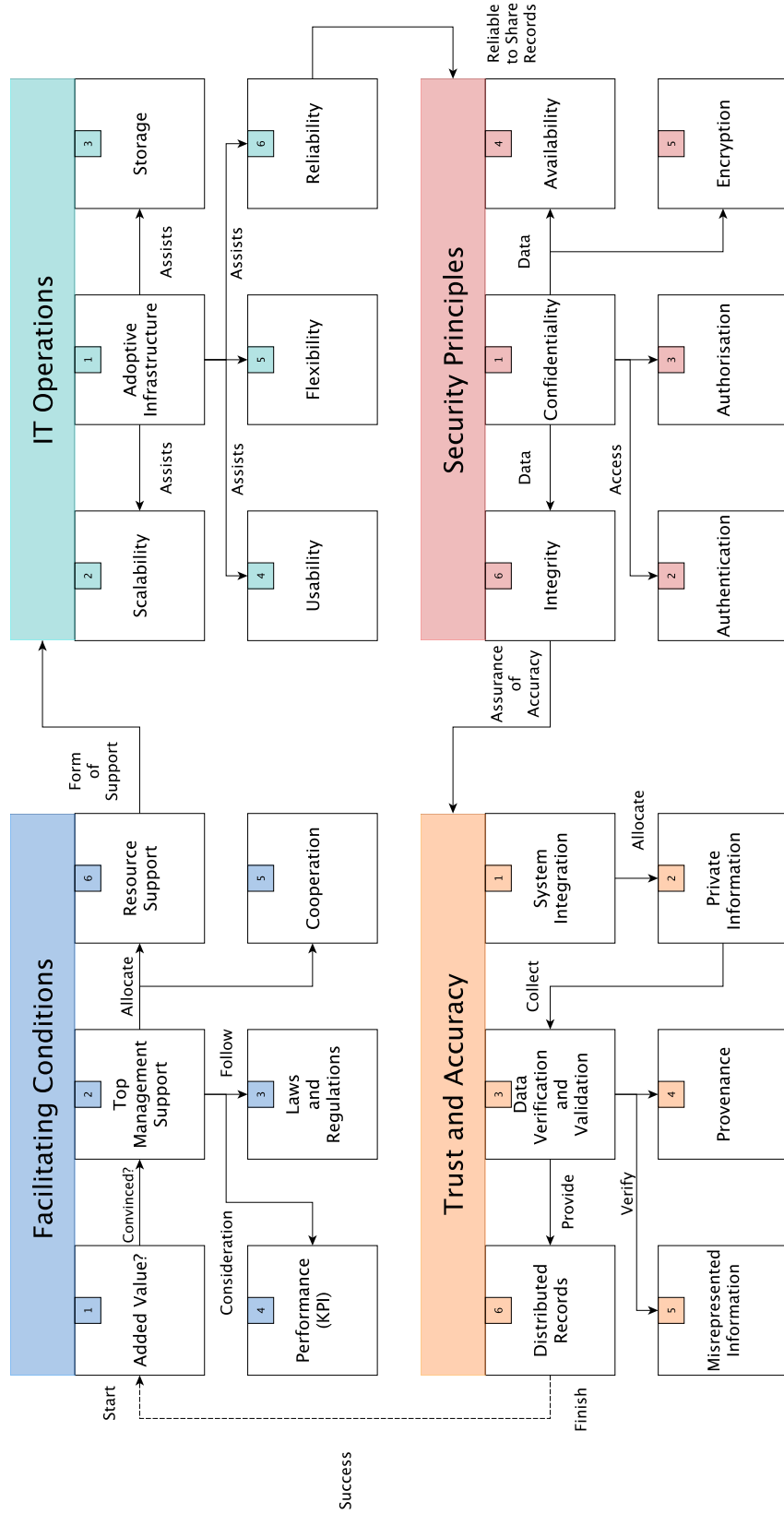


FIGURE 5.9: FIST Confirmed Framework Categories and Factors with Flow and Connections

Chapter 6

Trust Issues in Information-Sharing Frameworks (Delphi Approach)

The previous chapter (see Chapter 5) concluded with an open-ended discussion by 15 experts, solidifying the domain of the framework. This chapter progresses with insights from five of these experts, marking the dialogue as "Round 2", building upon "Round 1" from Chapter 5. This sequential approach facilitates a rich environment of collective intelligence, enhancing the framework's accuracy and reliability. While "Round 1" explored the framework's impact on labour and education, "Round 2" delves into defining the story problem and system requirements. "Round 3" specifies the Key Problem within the information-sharing framework, leading to "Round 4", which aims for a cohesive flow and consensus on various scenarios. Figure 6.1 shows all stages and an overall.

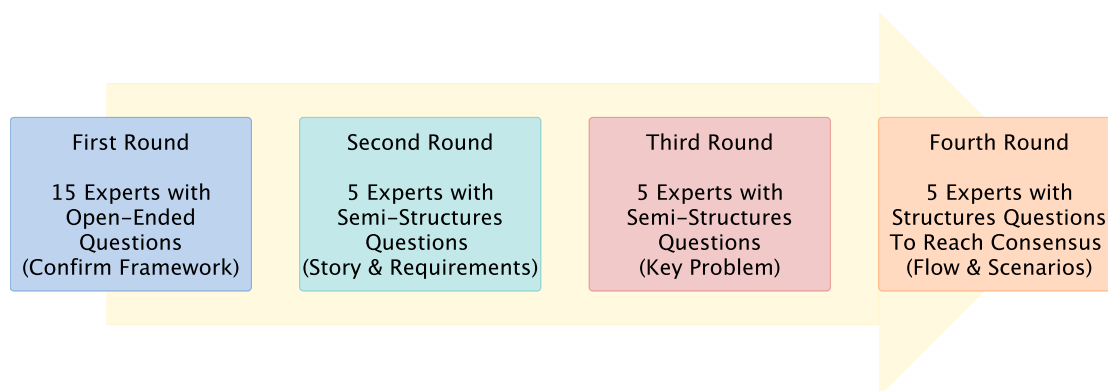


FIGURE 6.1: The Applied Delphi Method

This chapter employs the Delphi method to identify the Key Problem and enrich the framework's analysis through a collaborative intelligence environment. This methodological choice ensures a thorough and credible framework development, setting the stage for its evolution into a system in succeeding chapters.

The expert analysis is structured into three distinct parts, executed through Delphi methodology rounds:

Initial Dialogue: This phase revisits insights from the first round, refreshing the research problem and the FIST framework, thereby setting the stage for further discussion.

Framework Discussion: Here, experts engage in semi-structured dialogues based on the Goal Question Metric (GQM) methodology, concentrating on the FIST framework and unravelling deeper insights into the research problem.

Consolidation of Insights : Concluding the round, this segment focuses on reaching a consensus. Using the **T**ell me more, **E**xplain, **D**escribe, and **W**alk me through (TEDW - Model), experts refine their understanding of the Story Problem and requirements, culminating in a unified vision for subsequent stages.

6.1 Research Methods Used to Confirm the Framework

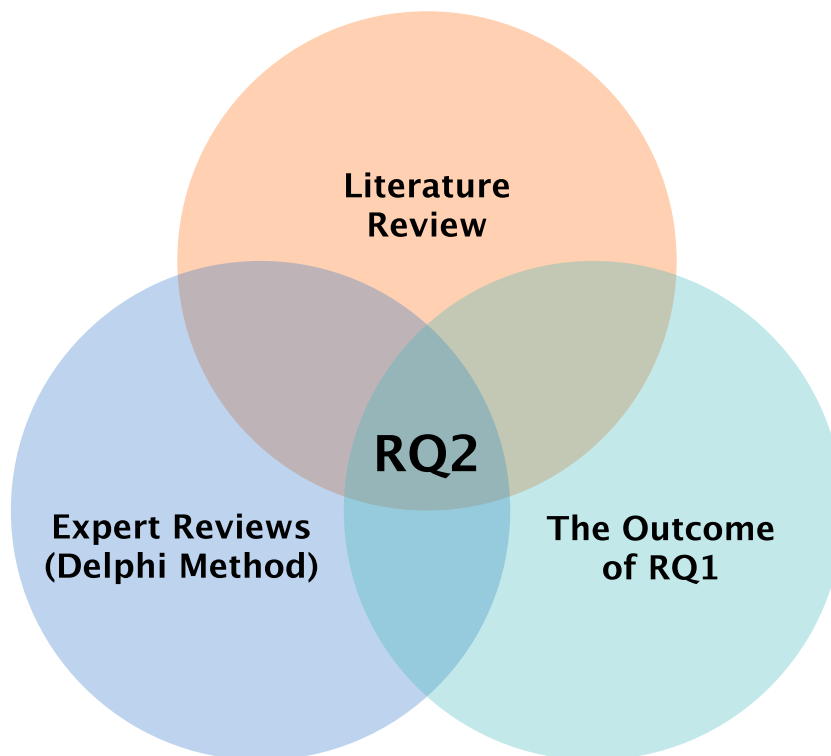


FIGURE 6.2: Research Methodology Used

6.1.1 Experts Interviews

"Round 1" was achieved by conducting and collecting data to analyse the initial (FITS - FIST) Framework by examining responses and feedback from open-ended discussions

with 15 experts. The goal was to find a framework inspired by the Employment and Education sectors. Qualitative data collection reflected on interviewing the experts and confirmed the initial factors and dimensions. The findings were four dimensions: sponsoring, developing, accessing controls, and accuracy. The factors related to the main dimensions were the main points that should be addressed under each dimension.

However, additional investigation is needed since it did not discover the root or cause of such a problem. This chapter provides three additional Delphi rounds that made a story for the framework and scenarios from the factors (Requirements Later). Both scenarios and stories created what seemed like a journey. Stories and scenarios help to focus on the end-user experience by envisioning how the user will interact. Scenarios can describe the interaction of the user with the system and the expected system response, which helps identify the necessary system features and functionalities that provide both system (Human) and model (Machine) requirements.

Finally, examining expert interviews using the Delphi method (again) showed the key problem by identifying issues and challenges that needed to be clarified in the early framework stages. The GQM method kept the experts engaged only on the "Round 1" framework factors through limited closed-end subjective questions. Rejected factors were asked for a reason and then to be replaced with a more suitable factor towards the final round of expert interviews. Experts asked to prioritise dimensions and factors. Understanding the expert prioritise made a journey and their most critical factors and dimensions, which later gave a story for the framework and its importance.

6.1.2 The Analysis of Expert Interviews

The approach to the experts interviews was to address the main cause of the problem with a focus on the FIST framework and its dimensions and factors. During the interview, the interviewer kindly requested each expert to approve or disapprove of either dimensions or factors only. They were requested to elaborate on what a replacement or more precise factor would submit to the dimension and the main framework problem if there were a rejection. At the end of the interview, experts were allowed to give their feedback (the interviewer conducted the interviews in Arabic).

The following points show how the interviewer conducted the analysis:

1. Ask for the Experts' permission to start recordings.
2. Record the conversation during the expert's interview (Conducted in Arabic).
3. When the recording starts, another verbal consent is asked.
4. Provide experts with an explanation of the Delphi method (to ask permission to contact them again).
5. Reminding experts that this is an extension to the original open-ended discussion that already happened.

6. Provide a summary of the research problem and issues that this research aims to address
7. A reminder of what we discussed last time in our meeting.
8. A discussion about what another expert said towards the end of the interview session (To make sure it will not affect their feedback).
9. Transcribe all conversations manually into Arabic scripts.
10. Analysing the information in Arabic.
11. Translating the analysis from Arabic to English.
12. Use grammar software to check for issues.
13. Ensure the translation conveys what the expert was trying to say.
14. Write up an analysis of what experts say on related factors.
15. When complete, add all (new) transcripts to Appendix D.

6.1.3 Demographic Information of Experts

The first step was to re-communicate with experts from the first discussion was back in October 2020. Only 8 of the 15 agreed to keep in touch for any future questions or if there is a required additional feedback. The Delphi method pool of experts were chosen based on; has a computer science (or related degree), employed, worked developing e-government services, works in educational institutes and work experience more than 3 years. Also, from those 8, the section criteria focus on who has the most years of experience or decision makers.

The selected experts (See 6.1) were specifically examined in the fields of e-government development, educational institutes and a security expert who understand both fields. The interview took place online using virtual portal meeting tools. The data were collected through virtual meetings and online recordings of GQM method interviews, with some closed-end into the topic and problem at hand. This study was conducted between November and December 2021. The experts were asked specific questions on the framework dimensions and its factors and to only elaborate when the dimension or category is rejected.

TABLE 6.1: Demographic Information of Experts for the Delphi Method + GQM

Industry	Sector	Association	Number of Experts
Employment	Private	e-Gov Development	2
		Energy	1
Education	Public	Educational Institutes	1
		Planning	1

6.1.4 Selection Criteria of Experts

The role of the experts in this study is to provide additional confirmation of the framework and expanding on the root of the issue. The selection criteria is derived from their experience in their prospective fields. The experts are selected based of two sectors; employment and educational. Additionally, all selected experts (on this chapter) possess degrees or substantial knowledge related to computer science, covering areas of software engineering, information security, software development and planning. Table (See Table 6.2) for the selected experts showing their job description and expertise. The Experts's have their information hidden, however, the of each expert written in the same way when from their first participation. Names were kept for future analysis.

TABLE 6.2: The Selected Experts' Qualifications

Expert	Job Description and Experience
A 01	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services.
E 05	Employed at private sector. Works at a company that specialised in the security industry. The company's main service is developing e-Government services. Software engineer and project manager with 6 years of experience
H 08	Cyber security engineer. Deployment new project at a management level. Information security project manager. Has more than 20 years of experience in networking and security.
I 09	Student's advisor (Training and academic advice outside the institute) and Human resources advisor. Also, information-sharing developer with more than 3 years of experience
J 10	Faculty member at a university. Make interviews to hire employees, and mock-up interviews for students. Also works at admission to have standardised and fair acceptance for new students. More than 5 years of experience.

6.1.5 Reactions of the Experts

Before each interview, each expert was sent an email or a text message to request their feedback and if they are willing to participate again. They were informed that this is an extension to the same research and the same forms including the consent still apply. On the day of the interview, the experts got a phone call or a text message as reminder of the time. Before the start of the meeting by 5 minutes, there were sent either by email or a text message the virtual meeting ID and Password. Then each expert got reminded of their contribution and how that affected the framework then given a summery on how the confirmed framework on final confirmation. They were given a recap on what is the problem that the research is about. Then after each round, they were provided of a recap of their insights about the issue and how is it changing each round based on their feedback and other experts. The Delphi + GQM were interview in three (3) rounds, described on the following:

6.1.5.1 Round 1:

This created a chapter specialised on confirming the framework (See Chapter 5), it was an Open-end discussion that confirmed the main Dimensions and its Factors.

6.1.5.2 Round 2:

Round 2 consists of two parts; the first involves semi-structured questions focused solely on the framework, and the second aims to engage the experts in identifying the story problem and its requirements. The first part is distinctive for its application of the GQM methodology in synchrony with the Delphi method; in this round, the illustrated complementarity of Delphi and GQM can be found in Appendix D (See Tables D.3, D.4, D.5, D.6 and D.7).

This process relies ON a specific set of questions targeting the dimensions and factors of the FIST framework. In contrast to the previously applied method, there is no opportunity for open-ended feedback. The interviewer asked experts to accept or propose enhancements to the dimensions or factors. They are encouraged to elaborate on their reasons and provide detailed feedback when suggesting enhancements. Experts were given by the interviewer a clear understanding of the research problem with questions probing the effectiveness of the dimensions in effectively addressing the problem. They are also made aware that when addressing the "Aspects of the Problem," the construction (assembly) of the FITS framework dimensions reflects these aspects. Conversely, when these dimensions are deconstructed (disassembled), each factor independently mirrors its parent dimension's scope, enabling each factor to support a suitable dimension's solution. The following criteria are the focus:

1. **FITS Framework** (FIST Assembled): Not enough of something and over saturation of else, worked out the best way is information sharing is the scope for remedy. The focus is on how to sponsor, what to focus on when developing, how to access information and finally, trust the system it will share information.
2. **Facilitating Conditions** (F-disassembled): The main focus is the system sponsors, which means factors concerning convincing sponsors of such a system.
3. **IT Operations** (I-disassembled): The main focus is the system developers. The goal is to focus on developing the software and what is the expected requirements and needs of software developers.
4. **Security Principles** (S-disassembled): The main focus is access to the information itself. Factors were built to provide security and information privacy before sharing.
5. **Trust and Accuracy** (T-disassembled): The main focus is on what to create assurance and provide trust in how the information should be allocated and released.

Then they were asked if the dimensions still contribute to the research problem and if the factors still relate to the primary (parent) dimension. Based on their interactions, they were required to provide the story problem and system requirements based on the FIST Framework.

6.1.5.3 Round 3:

This round has the same questions as the previous round (Round 2), however, it was on the updated and new version. This step is important to assure all experts agree on FIST framework dimensions and factors. At the end of each expert's session, experts given the chance to provide their feedback on how could the FIST framework be beneficial and what the FIST framework could solve. Based on the feedback on this round, there were discussions on what is the key problem.

6.1.5.4 Round 4:

This round had only had two purposes. the first one is requesting the experts to rearrange the factors in a sequential order to illustrate a plausible scenario. After that, they were kindly requested on creating scenarios (or a business case) to provide a scope for FIST framework usage.

6.1.6 Ethical Approval

This is an extension on the same research with exactly the same goals; FIST framework. The Ethical approval was obtained form the University of Southampton's Ethics Committee. The reference for the ethical approval is **ERGO/FEPS/55047**.

6.1.7 Expert Interview Data Collection Procedure

The data were collected through multiple (Delphi) virtual meetings by recordings the online meeting. By applying the GQM method on experts interviews, it enabled focused questions with specific goals. This closed-end focused only at the topic and problem at hand. This study was conducted between November and December 2021. The experts were asked specific questions on the framework dimensions and its factors and to only elaborate when the dimension or category is rejected.

6.2 Deploying Delphi Methodology

By deploying both methods, Delphi + GQM, it allowed Dimension name improvement for clarity, change factors, factors sequential orders. This sections contains experts reviews findings and discussions through a qualitative approach. One of the main reasons of using the Delphi combined with GQM, is to have all experts agreeing and providing acceptance of same output. This analysis took place on 5 experts and they were interviewed 3 times (total 4 times).

One of the main findings of the experts analyse is identifying the main problem with using and applying FIST framework to provide a scope of the solution of this research problem. Also, providing seniors on how they would use such a system. This chapter reshaped the FIST framework and gave it more clarity and connection with the research problem. At the end of this chapter the discover cause of the problem combined with scenarios provided a clearer flow and more connection to the problem.

Delphi + GQM The integration of the Goal Question Metric (GQM) approach with the Delphi method forms a combination for achieving precise and consensus-based outcomes while analysing the FIST framework. The GQM approach, originally introduced for software measurement, presents a structured methodology for deriving precise measurements from achievable goals. On the other hand, the Delphi method is a structured communication technique, developed an interactive method which relies on a panel of experts. GQM methodology was applied to Round 2, Round 3 and Round 4. Each finding at each round contributed gracefully to FIST framework, each round has full explanation on how it contributed to this research. GQM was applied in the following way:

6.2.1 Delphi Round 1

The Chapter 5 ended on a confirmed framework by 15 experts. Please see figure 6.3. This section is just a recap this 5.9 of while adding numbering to factors and dimensions.

1-0 Facilitating Conditions			2-0 IT Operations		
1-1 Added Value?	1-2 Top Management Support	1-3 Laws and Regulations	2-1 Adoptive Infrastructure	2-2 Scalability	2-3 Storage
1-4 Performance (KPI)	1-5 Cooperation	1-6 Resource Support	2-4 Usability	2-5 Flexibility	2-6 Reliability
4-0 Trust and Accuracy			3-0 Security Principles		
4-1 System Integration	4-2 Private Information	4-3 Data Verification and Validation	3-1 Confidentiality	3-2 Authentication	3-3 Authorisation
4-4 Provenance	4-5 Misrepresented Information	4-6 Distributed Records	3-4 Availability	3-5 Encryption	3-6 Integrity

FIGURE 6.3: Round 1: FIST Framework Dimensions and Factors with its Assigned Numbers (Mentioned in Chapter 5 and Figure 5.9)

6.2.2 Delphi Round 2

This round focused on practising the GQM method and then TEDW to allow the experts to provide the Story Problem and the requirements to ensure the focus is on the dimensions and factors; it has been through three parts as described below:

PART 1 : The meeting starts with explaining each time to each expert that there would be at least two more rounds (Delphi Method). Upon their agreement on further feedback and future meetings, the meeting starts by reminding the expert about the problem and then showing FITS and FIST framework figures, then with their content; the meeting starts recording and proceeds. The first interaction is requesting them to explain the general problem and how the framework would contribute to it.

PART 2 : Upon making sure they understood the scope of the general problem and the general scope of the framework while practising the GQM method to ensure the focus is on the dimensions and factors, experts get asked the questions and interacted with Figure 6.3 while the moderator (the researcher) was reading the Goal, Question and Metric shown on tables D.3, D.4, D.5, D.6 and D.7. and the experts' interactions with full related transcripts is available at D.3. Table 6.3 Summarises the findings.

PART 3 : Deploying the TEDW methodology to engage experts as the following shows:

TEDW: Please tell me more by elaborating on the challenges of finding the right balance of graduates. Please tell me more.

TEDW: Please Explain; Why you think an over-saturation or insufficient numbers of graduates in a profession contribute to our research problem?

TEDW: Please Describe the essential requirements for mitigating the root causes of these problems?

TEDW: Imagine a centralised system designed to address the research problem. Please Walk me through how you could guide me through its interactions and the potential actors involved.

6.2.2.1 Applying GQM

This section delves into the application of the Goal-Question-Metric (GQM) methodology. The GQM approach is applied five times in total - an initial application to the four dimensions collectively, followed by four separate applications to each dimension. This section aligns with Figure 34 for numerical arrangements and Figure 37 for comprehensive evaluation using the GQM approach analysis for clarity and accurate referencing. How the questions came are explained in D.3.

6.2.2.2 Applying TEDW

Please refer to Part 3 of section 6.2.2. Also, please view the spoken sentences "A.R2.07" and "A.R2.08" shown on table D.30. Also, please view section D.4.0.5.

6.2.2.3 Findings of Delphi Round 2

After careful analysis, the panel of five distinguished experts reached a unanimous consensus to make changes to both dimensions and factors. This modification aligns seamlessly with the scope of the FIST Framework, reflecting its objectives and enhancing its overall coherence. This clarification strengthens the integration of the four dimensions, further reinforcing the core essence of the FIST Framework in addressing the scope of the research problem. Table 6.3 show the dimensions and factors and all experts reactions on them.

Renamed Dimensions: “IT Operations” and “Security Principles”

IT Operations: All five experts agreed that this factor to be renamed to “IT Services” because this dimension is about both the development and operation of a new system.

Security Principles: All five experts agreed that this factor to be renamed to “Secure Access” because this dimension is about the access to the data and the word ‘Principles’ is too vague.

Deleted Factors “KPI Performance” and “Misrepresented Information”

KPI Performance: All five experts rejected this factor, they were focusing on what is information sharing. Many discussions happened but all included the same concept; KPI performance is not related to information sharing. It could be an additional feature later but not now.

Misrepresented Information: All five experts rejected this factor, it was vague to them. The way the dimensions interacts, the misrepresentation means both Verification and Validation.

New Factors “Service Level Agreements”¹

SLA: “Service Level Agreements” This factor was originally introduced by an expert then accepted by all other 4. It is critical to have an agreement on what data to be shared, what data to be provided. also, as sponsors of new systems, they have SLA to include agreements on how they going to benefit themselves and the stakeholders.

Exchanged Factors Swapping “Encryption” with “Private Information”

The suggestion to relocate “Encryption” instead of “Private Information” was initially emphasised by just one expert. In the subsequent round (Round 3), this recommendation was presented to all the other experts, highlighting the importance of encryption before sharing information. The analysis underlined the principle of encapsulation, considering the data is collected and allocated accordingly. Thus, encryption applies to the allocated data before it is shared, confirming the crucial role of this security measure. However, “Private Information” is about the consent of what data to be shared and have control on it, which should be happening during the “Security Access on the data”.

Renamed Factors Miscellaneous

There were not so called renaming, but more of adding words for clarification. For example, Encryption now is Encryption by data encapsulation. Another example; validation which means the information is up to date.

¹This factor was mentioned by only expert ‘Expert C’ on the fist experts analysis, but it was disregarded

6.2.2.4 Round 2 Conclusions

In conclusion, after applying the changes, FIST framework is shown in figure 6.4 shows factors and dimensions reflecting their correct names.

1-0 Facilitating Conditions			2-0 IT Services		
1-1 Added Value?	1-2 Top Management Support	1-3 Laws and Regulations	2-1 Adoptive Infrastructure	2-2 Scalability	2-3 Storage
1-4 Service Level Agreement (SLA)	1-5 Cooperation	1-6 Resource Support	2-4 Usability	2-5 Flexibility	2-6 Reliability
4-0 Trust and Accuracy			3-0 Secure Access		
4-1 System Integration	4-2 Data Encryption	4-3 Data Verification	3-1 Confidentiality	3-2 Authentication	3-3 Authorisation
4-4 Provenance	4-5 Data Validation	4-6 Information Integration	3-4 Availability	3-5 Privacy (Consent to Share)	3-6 Integrity

FIGURE 6.4: Round 2: FIST Framework Dimensions and Factors with its Assigned Numbers

TABLE 6.3: Findings of Round 2

Factor	Expert A	Expert E	Expert H	Expert I	Expert J	Notes
1-0	✓	✓	✓	✓	✓	Accepted
2-0	X	X	X	X	X	Change
3-0	X	X	X	X	X	Change
4-0	✓	✓	✓	✓	✓	Accepted
1-1	✓	✓	✓	✓	✓	Accepted
1-2	✓	✓	✓	✓	✓	Accepted
1-3	✓	✓	✓	✓	✓	Accepted
1-4	✓	X	X	X	X	Change
1-5	✓	✓	✓	✓	✓	Accepted
1-6	✓	✓	✓	✓	✓	Accepted
2-1	✓	✓	✓	✓	✓	Accepted
2-2	✓	✓	✓	✓	✓	Accepted
2-3	✓	✓	✓	✓	✓	Accepted
2-4	✓	✓	✓	✓	✓	Accepted
2-5	✓	✓	✓	✓	✓	Accepted
2-6	✓	✓	✓	✓	✓	Accepted
3-1	✓	✓	✓	✓	✓	Accepted
3-2	✓	✓	✓	✓	✓	Accepted
3-3	✓	✓	✓	✓	✓	Accepted
3-4	✓	✓	✓	✓	✓	Accepted
3-5	✓	✓	X	X	X	Change
3-6	✓	✓	✓	✓	✓	Accepted
4-1	✓	✓	✓	✓	✓	Accepted
4-2	✓	✓	X	X	X	Change
4-3	X	X	X	X	X	Change
4-4	✓	✓	✓	✓	✓	Accepted
4-5	X	X	X	X	X	Change
4-6	X	X	X	X	X	Change

6.2.3 Delphi Round 3

While ‘Round 2’ was in on a specific set of questions (GQM), the emphasis in this round shifted towards the experts themselves. This phase was designed to incorporate the experts’ insights, verifying their comprehension of the research problem, and aligning their understanding with the scope as defined by the FIST framework. Serving as a guiding scaffold, the FIST framework facilitated the identification of key problems, significant findings and the drawing of insightful conclusions. Each interaction was initiated with a set of questions aimed at gauging the experts’ grasp of the issue at hand:

1. Can you confirm the existence of the problem?
2. Could you describe the problem in your own words?
3. How do you perceive the connection between the Framework and research problem?

4. In your opinion, what is the root cause of the problem?
5. Why do you think trustworthiness poses a significant issue?

Through these topic discussions, they foster a deep and shared understanding of the problem's scope. The full transcripts can be found later. All experts confirmed the existent of the problem, and they did describe it well. Full details on how this part was applied, please see D.3.1.

6.2.4 Experts Analysis and Findings

In this section, the spotlight shifted to the individual interactions with each expert. This section scoops into critically analysing outcomes from applying the Delphi methodology. Each interaction offers unique insights that help understand the expert's perspective. Focusing on individual responses allows a more subtle view of collective expert knowledge. Using the Delphi method has yielded a rich tapestry of perspectives, each contributing to a more robust understanding of the subject matter. The systematic approach allows us to draw more nuanced conclusions by dissecting each expert's viewpoint individually.

Therefore, this analysis presents an aggregation of expert opinions and a complex interchange of insights that enhances the depth and scope of the findings. The objective here is to make sense of the information collected and outline patterns, trends, and themes from this body of expert knowledge.

6.2.4.1 Expert A Analysis and Findings

This expert is expressing several key concerns about job applications and personal data sharing. They recount an instance where they were brought in for a personal interview only to find that the job didn't exist, leaving them with the impression that their time was wasted for the sake of 'Job Market Research'. They also voice frustration about the lack of responses to numerous job applications on online platforms, which has led to their personal information being spread widely without any perceived benefit. The individual insists on the condition that their information should only be shared when there is a potential for a compelling offer or opportunity. They express a strong desire for privacy and accurate information representation in any system that they use. Lastly, as a user (has a candidate or vacancy profile), they express a desire for a platform that allows them to publish accountable profiles (candidate or vacancies) and attract suitable candidates.

6.2.4.2 Expert E Analysis and Findings

This expert is highlighting the potential benefits of having a consolidated system (in one place) for labour market necessary data. They believe that such a system would facilitate

precise studies of job market needs, leading to more desirable outcomes (to tackle the research problem). The individual also expresses strong privacy concerns, emphasising that when applying for a job, there must be a genuine vacancy. They refuse to share their personal information unless a position is open, stressing the importance of not sharing their personal data if no job openings are available. Lastly, they see potential advantages of the system in the context of company audits for Saudization, where it could provide quicker, more accurate access to available profiles.

6.2.4.3 Expert H Analysis and Findings

This expert expresses several concerns related to security, privacy, and data usage in the system. The notion of corresponding data exchange is stressed, implying a balance of giving and receiving within the system. The importance of strict access control is emphasised to prevent disruptions and misuse of data. Furthermore, they show concern for data accuracy and insist that only authorised personnel should be able to modify or create information. They also express discomfort about the possibility of their information being exploited by headhunters via public email domains. Lastly, while they're open to their profile being utilised for social improvements, they strongly oppose its use for profit-oriented activities. Essentially, they are seeking assurances that the system will respect and uphold their rights, expectations, and privacy in these regards.

6.2.4.4 Expert I Analysis and Findings

The expert emphasises the importance of balanced data exchange within the system, ensuring the relevance of the exchanged data. They express a desire for transparency in the system, especially when it comes to availability of job vacancies and prospective candidates. As a job seeker, they want certainty that a vacancy is genuinely available, and as an employer, they seek confirmation that there are actually interested and committed candidates. Trust within the system's back-end interactions is deemed crucial for accuracy. The expert stresses the need for the system to accurately reflect availability and terminate promoting once it is filled (unavailable).

6.2.4.5 Expert I Analysis and Findings

Finding relevance information from this expert was very challenging, this expert works in close connections with CEOALM ², they do have the research problem this research is addressing. However, since they are aware of the problems, the most challenging part was to get information from this expert to relate to FIST framework. The moderator

²Centre for Alignment of Educational Outcomes with the Labour Market

had to keep asking the same questions with different ways each time just to shift this expert's focus into how the FIST framework has the scope and not CEOALM practices.

The expert strongly emphasises the need to bridge the gap between graduate outcomes and labour market requirements. While universities are actively mandated to keep track of graduate employability, the incorporation of AI or recommendation algorithms into a sharing system is suggested to expedite job matches. The expert underlines the importance of strategic planning over conventional human resource approaches and stresses on fostering transparency and trust in the system. The current recruitment practices often lack credibility and induce a dependency on recruiters and head-hunters, demanding an effective transparent recruitment system.

6.2.5 Round 3 Conclusions

The experts raise significant concerns about the lack of privacy, authenticity, and control in the current job application process, with scathing criticisms about the uncontrolled dissemination of personal data and lack of genuine job opportunities. They expect a system to facilitate accurate job market analysis, improve job matching, and effectively address the research problem. Vital issues for the experts include a balanced data exchange. They also underscore the importance of system transparency, especially regarding genuine job vacancies and committed candidates, and expect the system to remove promoting roles once filled. In summary, the experts seek a system that respects their data, ensuring its accuracy. In conclusion, the experts focused on the viewpoint of a transaction, information exchange can be likened to a reciprocal exchange of interests; an offer is made only when another offer is received in return.

The Key problem: In conclusion, Experts advanced the concept of trust in information exchange from the perspective of a reciprocal transaction. They require mutual assurance for any information exchange and assert that they will provide information only if there is a corresponding offer in return.

TABLE 6.4: Findings of Round 3

Factor	Expert A	Expert E	Expert H	Expert I	Expert J	Notes
1-0	✓	✓	✓	✓	✓	Accepted
2-0	✓	✓	✓	✓	✓	Accepted
3-0	✓	✓	✓	✓	✓	Accepted
4-0	✓	✓	✓	✓	✓	Accepted
1-1	✓	✓	✓	✓	✓	Accepted
1-2	✓	✓	✓	✓	✓	Accepted
1-3	✓	✓	✓	✓	✓	Accepted
1-4	✓	✓	✓	✓	✓	Accepted
1-5	✓	✓	✓	✓	✓	Accepted
1-6	✓	✓	✓	✓	✓	Accepted
2-1	✓	✓	✓	✓	✓	Accepted
2-2	✓	✓	✓	✓	✓	Accepted
2-3	✓	✓	✓	✓	✓	Accepted
2-4	✓	✓	✓	✓	✓	Accepted
2-5	✓	✓	✓	✓	✓	Accepted
2-6	✓	✓	✓	✓	✓	Accepted
3-1	✓	✓	✓	✓	✓	Accepted
3-2	✓	✓	✓	✓	✓	Accepted
3-3	✓	✓	✓	✓	✓	Accepted
3-4	✓	✓	✓	✓	✓	Accepted
3-5	✓	✓	✓	✓	✓	Accepted
3-6	✓	✓	✓	✓	✓	Accepted
4-1	✓	✓	✓	✓	✓	Accepted
4-2	✓	✓	✓	✓	✓	Accepted
4-3	✓	✓	✓	✓	✓	Accepted
4-4	✓	✓	✓	✓	✓	Accepted
4-5	✓	✓	✓	✓	✓	Accepted
4-6	✓	✓	✓	✓	✓	Accepted

6.3 Round 4

This round had only had two purposes. the first one is requesting the experts to rearrange the factors in a sequential order to illustrate a plausible scenario. After that, they were kindly requested on creating scenarios (or a business case) to provide a scope for FIST framework usage.

6.3.1 Findings of Round 4

This section emphasis on providing clarity and detailed relationships within the framework and exploring how each of its dimensions and factors are interconnected. The

progression of these dimensions and factors are focused on information sharing. Experts in the field during this stage were requested to give feedback on the framework sequence and correlation of the FIST framework. Then Finally they were asked to provide a scenario or a business model on how this framework would be beneficial to them. Please see Figure 6.5 for output of this section.

1-0 Facilitating Conditions			2-0 IT Services		
1-1 Added Value?	1-2 Laws and Regulations	1-3 Top Management Support	2-1 Adoptive Infrastructure	2-2 Scalability	2-3 Storage
1-4 Cooperation	1-5 Resource Support	1-6 Service Level Agreement (SLA)	2-4 Flexibility	2-5 Usability	2-6 Reliability
4-0 Trust and Accuracy			3-0 Secure Access		
4-1 System Integration	4-2 Data Provenance	4-3 Data Verification	3-1 Authentication	3-2 Authorisation	3-3 Confidentiality
4-4 Data Validation	4-5 Data Encryption	4-6 Information Integration (Share/Exchange)	3-4 Integrity	3-5 Availability	3-6 Privacy (Consent to Share)

FIGURE 6.5: Round 3: FIST Framework Dimensions and Factors

TABLE 6.5: Round 4: Sequence of Factors

Factor	Expert A	Expert B	Expert C	Expert D	Expert E	Overall Score
1-1	1	1	1	1	1	05/5 \approx 1
1-2	2	3	2	3	3	13/5 \approx 3
1-3	3	2	3	2	2	12/5 \approx 2
1-4	6	6	5	6	5	28/5 \approx 6
1-5	4	4	4	5	4	21/5 \approx 4
1-6	5	5	6	4	6	26/5 \approx 5
2-1	1	1	1	1	1	05/5 \approx 1
2-2	2	2	2	2	2	10/5 \approx 2
2-3	3	3	3	3	3	15/5 \approx 3
2-4	5	5	5	4	4	23/5 \approx 5
2-5	4	4	4	5	5	22/5 \approx 4
2-6	6	6	6	6	6	30/5 \approx 6
3-1	3	3	3	1	3	13/5 \approx 3
3-2	1	1	1	2	1	06/5 \approx 1
3-3	2	2	2	3	2	11/5 \approx 2
3-4	5	5	5	4	5	24/5 \approx 5
3-5	6	6	6	6	6	30/5 \approx 6
3-6	4	4	4	5	4	21/5 \approx 4
4-1	1	1	1	1	1	05/5 \approx 1
4-2	4	4	4	4	4	20/5 \approx 4
4-3	3	3	3	3	3	15/5 \approx 3
4-4	2	2	2	2	2	10/5 \approx 2
4-5	5	5	5	5	5	25/5 \approx 5
4-6	6	6	6	6	6	30/5 \approx 6

6.4 Chapter Summary

The discussions around information distribution are indeed valid. Notably, experts have been examining the framework from the perspective of a typical user. However, part of this framework's purpose is future planning and development, meaning the allocated information will be utilised not only for information exchange but also for research and development. Experts have illustrated this through examples of asset transactions. The term 'Data Exchange' was used because it encompasses both Data Sharing and Data Transaction."

The First Key problem Identified:

Experts advanced the concept of "Trust in Information Exchange" from the perspective of a reciprocal transaction.

The Second Key problem Identified:

*Experts highlighted the lack of **Accuracy**, attributing it to incomplete provenance in shared information, where the official entity creating the information plays a crucial part.*

They require mutual assurance for any information exchange and assert that they will provide information only if there is a corresponding offer in return.

A confirmed framework and clearly defined requirements are fundamental for building a system to meet specific objectives. A framework provides guidelines and an overall structure for the system, outlining the standards for the system's design and implementation. On the other hand, requirements help identify end-users needs and expectations. They specify what the system is supposed to do and how it should perform, offering insights that guide the design and development process. By understanding these requirements, developers can ensure the system provides the desired functionality. Together, a framework and requirements provide a comprehensive roadmap for system development.

Chapter 7

Building Trust Requirements in Information-Sharing Systems

This chapter marks a pivotal transition from the conceptual framework to practical system requirements. It leverages a narrative approach to abstract system and model requirements, a methodology inspired by the third round of the Delphi method application in expert interviews. This approach has been instrumental in extracting key insights, particularly concerning the need for enhanced accuracy and trust in data transactions. This narrative synthesis of experts' scenarios and dimensions aids in distilling the core issues and translating them into actionable system requirements.

The chapter unfolds in four integral parts: User-Driven, Human-Centred, System-Centred, and Model-Driven. Each segment adds a layer of depth and specificity to our understanding, starting from human interactions to the mechanical aspects of the system. This structured progression reflects a shift from the broader framework-centric view of the previous chapter to a more granular, system-oriented focus here. The previous chapter's insights into critical problems set the stage for this exploration, moving from theoretical groundwork to the practicalities of system requirements.

Additionally, the narrative evolves from theoretical underpinnings to practical applications, illustrating the shift from a framework to a system-based approach in research and analysis. The previous chapter explored both key problems, which is further summarised in:

The First Key problem Identified:

*Experts advanced the concept of “**Trust in Information Exchange**” from the perspective of a reciprocal transaction.*

The Second Key problem Identified:

*Experts highlighted the lack of **Accuracy**, attributing it to incomplete provenance in shared information, where the official entity creating the information plays a crucial part.*

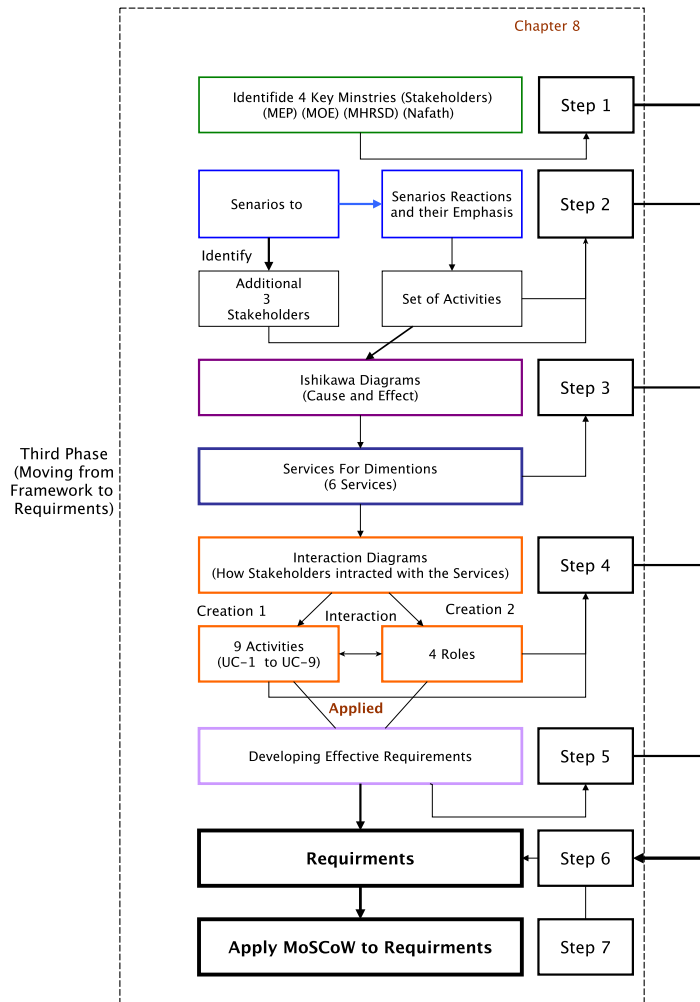


FIGURE 7.1: Mapping This Chapter Steps that helped to reach the Requirements

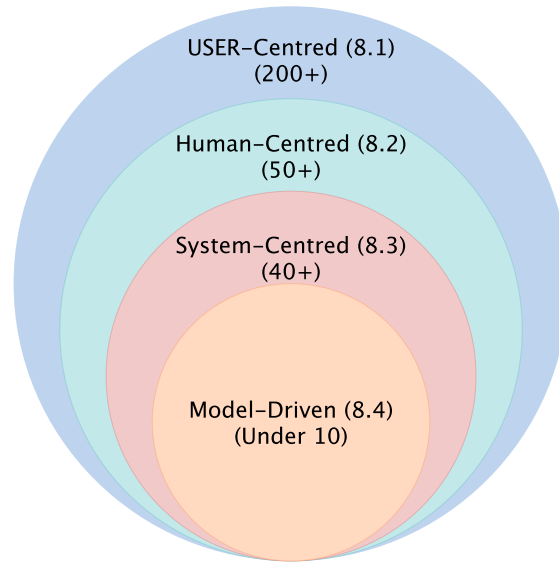


FIGURE 7.2: Building Requirements for Trust in Information Exchange

7.1 User-Centred Approach

This section focuses on the system's end users, which has been created based on combining the user requirements of all the experts in Chapters 7 and 6. Upon employing the User-Centred Approach, more than 200 requirements surfaced. Given the sheer volume of these requirements, which originated from each of the 15 experts, an in-depth analysis could have been more valuable. The substantial quantity weakened the significance of the individual requirements, making the analysis potentially unproductive, leading to disregarding the analysis.

This section focuses on the system's end users, drawing from the combined user requirements gathered from experts in previous chapters. Upon employing the User-Centred Approach, more than 200 distinct requirements surfaced. Given the substantial volume of these requirements from each of the 15 experts, a deeper analysis would have been more insightful. However, the sheer quantity of individual requirements diluted their significance, potentially rendering a straightforward analysis unproductive. For a meaningful system, the approach shifted towards organising these users into distinct stakeholder groups and analysing their perspectives.

This reorganisation facilitated a more focused User-Centred Analysis. Examining each stakeholder group's tasks and potential outcomes clarified their unique needs and priorities. Further, this process involved creating user-centred requests by assigning a user-type number. This classification streamlined the analysis and set a foundation for the following sections, ensuring a more structured and efficient evaluation of the user requirements within the broader system context.

7.1.1 Stakeholder

In alignment with the focus on user interactions in this section, a clear understanding of the stakeholders is essential. This comprehension originates from the user-centred approach adopted in previous chapters, where stakeholders' perspectives and needs were a key consideration. From the literature review, four main stakeholders were initially identified. They are:

1. **MEP** (Ministry of Economy and Planning): As the primary beneficiary of this system.
2. **HRS D** (Ministry of Human Resources and Social Development): Responsible for maintaining employment information, history, and records.
3. **MOE** (Ministry of Education): Holding certificates and training records.
4. **Nafath**: Serving as the "Identity Authentication Management."

Further analysis, particularly revisiting the expert reviews in Chapter 6, illuminated additional insights. The experts provided examples and scenarios identifying three more stakeholders, expanding the understanding of the user base. These additional stakeholders are:

5. **Seeker**: The entity responsible for finding or allocating a vacancy and providing credentials such as certificates and employment history.
6. **Recruiter**: The entity that enlists or enrolls candidates (Seekers) into provided vacancies.
7. **FIST System**: The entity representing the system itself, which provides a platform for information sharing.

Identifying and analysing these stakeholders are instrumental in our User-Centred Approach, allowing us to understand better and categorise the over 200 distinct user requirements gathered earlier. This stakeholder framework sets the stage for a more nuanced and compelling analysis of user interactions and system design.

7.1.2 User-Centred Requirements based on Experts Interviews Reactions

This sub-section analyses the requirements and activities identified through scenarios and expert reactions. These sub-section analyses are shown in two parts for clarity and depth. The first part investigates the experts' interview responses, mainly focusing on their reviews' "Standouts" aspects. It involves a detailed examination of their reactions and the emphases they placed during the discussions (Shown in Table 7.1). The second part focuses exclusively on these "Standouts," aiming to clarify their specific activities and outcomes highlighted by the experts. This methodical breakdown ensures a

comprehensive understanding of the user-centred requirements, aligning closely with the stakeholder-focused perspective established earlier.

7.1.2.1 User-Centred Experts Interview Reactions

After analysing all 15 experts, it concluded that the first three dimensions are already provided and are being practised (to some extent). However, the new part is raising trust in a new system that would provide accuracy for the shared information and assurance of an information exchange. This finding led to the analysis of their reactions and what stood out. Number 1 They all agreed that the entity that sponsors a system would contribute to facilitating it and be involved through support to provide it with all its requirements. Number 2, there will be an entity that will create a new system and administrate its operations. Number 3 is the required information, which the data creators, such as Ministries responsible for certificates, employment records and identity, provide.

Going back to expert reviews that were carried out or described or undertaken in Chapter 6, at this sub-section, the findings were reviewed as a whole using the top-down, bottom-up approach, then used a table to map all users and reactions to the categories and factors. This indicates something is a general concern of such a system. This approach was done with software engineering techniques. That approach discovered the focus of what experts were leaning on. Full 4 Tables are shown in E.

Mapping the experts' reactions with their experts has raised some new perspectives on the functional requirements for such a system. The four tables are shown in Appendix E. Anomalies were illustrated in a single table (see table 7.1) to summarise every anomaly and what stood out in factors with experts' reactions. Anomalies were based on reactions of a factor or a category that all experts agreed on with a strong emphasis (or at least 14 of 15). Also, this anomaly finding revealed that only one factor had any rejection. The found factors are:

Storage (2-3) Returning to the analysis, it mentions that this factor was the only controversial factor; it has a strong emphasis and is the only rejected one. Four experts rejected it. The previous analysis discovered that this puts the system under additional responsibility. Also, experts mentioned that there is a risk undertaken when storing information. Finally, all the e.gov developers' experts gave the example of the e.gov system that was developed, and they mentioned that as long as government services host the storage and follow the law and regulations,

This anomaly points out that storing information in a given infrastructure is critical. Also, to gain access to critical information, it must be monitored by e.gov-based services and systems.

Security Principles (3-0) This anomaly is about the main category of security principles. Analysing the expert reviews shows that the data's security is crucial for a system's success. Also, this anomaly means accessing critical data should be done using identity checks based on e-gov services and systems. Experts at the e-gov development systems emphasised the importance of using the "Saudi National Digital Identity Management" provided (IAM) by Nafat. More than half of the experts mentioned this for the Authentication and Authentication Level.

Trust and Assurance (4-0) This anomaly is about the main category of trusting the system that it will satisfy its function of information sharing. This dimension is based on a system already developed with specific criteria (ITO Factors) and has the proper user identity checks (SP Factors).

System Integrations (4-1) This anomaly is based on system integrations and interactions with different systems to allocate information.

Private Information (4-2) This anomaly focuses on assuring privacy. The experts meant privacy for every user of the system.

Provenance (4-3) This anomaly is based on a trust chain; the system must be capable of allocating information from the source of the information.

Distribution (4-6) This anomaly is based on the final step of the allocated information to be sent and distributed to different data requests.

TABLE 7.1: The "Standouts" for Experts Reactions, yellow means strong emphasis, red, means rejection

Factor	Emphasis	Expert															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
2-3	SE		✓					✓	✓	✓			✓		✓	✓	
	ME				✓							✓					
	LE	✓									✓						
	NE			✓		✓	✓							✓			
3-0	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4-0	SE	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	
4-1	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4-2	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4-3	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
4-6	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	

7.1.2.2 Stakeholders Activities and Outcomes

This subsection digs deeper into the specific activities and anticipated outcomes of each stakeholder group identified in the previous subsection of User-Centred Requirements. Examining the stakeholders' interactions with the system aims to clarify how their activities and the consequent outcomes align with and impact different dimensions of the framework.

TABLE 7.2: User-Centred Requirements Based on Standout Anomalies

No	Anomaly	User-Centred Requirement
R01	(2-3)	The system focused on information sharing without storage requirements
R02	(4-0)	The system ensures the execution of required functions while maintaining Trust and Accuracy
R03	(4-0)	Information is traceable to its source
R04	(4-0)	Information is directly obtained from the originated source
R05	(4-1)	Gathers accurate information from various locations for allocation
R06	(4-1)	Combines allocated information from different sources
R07	(4-1)	Information is traceable to its source
R08	(4-2)	Information access is restricted to its owner
R09	(4-2)	Information access is restricted to its creator
R10	(4-2)	Administrators have viewing rights to the information
R11	(4-2)	Access to information granted based on privileges
R12	(4-3)	Information possesses clear and comprehensive provenance
R13	(4-6)	Allocate data from various systems into a unified platform

Each stakeholder possesses unique activities integral to the system's functionality and success. These activities, when executed, lead to specific outcomes that either reinforce or challenge various aspects of the framework. Understanding these activities and the outcomes is crucial, as they collectively shape the system's effectiveness and user experience.

This exploration will provide insights into the engaged interplay between stakeholder activities and framework dimensions. Examining these relationships can further refine our understanding of the system's design and operation, ensuring that it aligns closely with the user-centred requirements and the overarching goals of the framework. This analysis is services in crafting an efficient and wealthy system with the needs and expectations of its diverse stakeholders. Table 7.3 shows the seven stakeholders, tasks, outcome and the dimension the task affects.

TABLE 7.3: Mapping Stakeholders to Dimensions through the focus on the expected outcome with its benefit

UserType	Stakeholder	Activity	Outcome	Dimension
1	Economy and Planning (MEP)	Requested Reports	Reports for Human Resources & Reports for Future Planning and Social Development	Covers FC Covers TA
2	Employment History (HRDS)	Provides information for Employment History	Assigns who is the Main Issuer for Employment History to Provide Accurate Information. Also, Information Keeper	Covers FC Covers SP
3	Educational Certificates (MOE)	Provides information for Educational Certificates	Main Issuer for a record for Educational Certificates Provide Accurate Information	Covers FC Covers SP
4	Security Checker (Nafath)	Credential Checks for Users and Assign information to Users	Provides Authentication service (With Authentication Level) & User Identity Validation and Provisioning	Covers FC Covers SP
5	Seeker (Vacancy Seeker)	Search for Available Vacancies & Allow information sharing for "Recruiters"	Vacancy allocation from Recruiters to become a candidate	Covers IO Covers TA
6	Recruiter (Vacancy Provider)	Promote vacancy information "Seekers" & Request information sharing for "Seekers"	Candidates allocation from "Seekers"	Covers IO Covers TA
7	FIST System	Host all Stakeholders Interactions and requests	Allocate, Assign, Encapsulate and distribute Trusted information through interactions with different stakeholders	Covers FC Covers IO Covers SP Covers TA

7.2 Human-Centred Approach

In this section, the spot focuses on the human-centred aspects of the system, integrating insights from the comprehensive human needs requirements identified by experts in the previous chapter. Implementing a human-centred approach unveiled over 50 requirements, each reflecting the 15 experts' unique perspectives by grouping. Despite the richness of this data, the vast number of requirements posed a challenge. While individually significant, their collective volume risked weakening the distinct value of each requirement, potentially causing a deep-dive analysis to be less effective. This complexity underscored the need for a strategic approach to managing and interpreting these human-centred requirements. To address this complexity, the focus shifted to developing a detailed understanding of the actors, their tasks, and user stories. This involves crafting scenarios based on the suggested expert's feedback, which not only illuminate the real-world implications of the requirements but also align closely with the specific needs and goals of the system users. These narratives serve as a foundation for a more subtle exploration of the human elements within the system. Furthermore, a vital component of this section is a comprehensive table that outlines the connections between the requirements, the actors, and the various dimensions of the framework (See Table X). This table is a crucial tool, linking each actor and their respective user stories to specific aspects of the framework, thus providing a clear roadmap of how each human-centred requirement

is addressed within the system. The following Human-Centred Requirements, ranging from profile management to data privacy, will be explored in detail:

- **HC1:** Users should be able to create and manage profiles that accurately reflect their skills and qualifications. Participants should be able to create and manage profiles that accurately reflect their skills and qualifications.
- **HC2:** Participants should be able to effectively search for suitable job vacancies or potential candidates.
- **HC3:** Participants should feel confident in the authenticity and accuracy of the profiles they interact with, ensured by strong data validation and verification mechanisms.
- **HC4:** Participants should feel their data is secure and private, maintained through strict access controls, data encryption, and careful sharing protocols requiring user consent.
- **HC5:** Participants should have access to meaningful statistics and reports that can help them make informed decisions and contribute to social improvement.
- **HC6:** Participants should be presented with comprehensive and accurate information about job vacancies and candidates, including clear job descriptions with salary ranges.
- **HC7:** Participants should have complete control over their data privacy and sharing preferences, ensuring their information is used comfortably.
- **HC8:** Participants should experience an intuitive and user-friendly interface, enabling seamless navigation and interaction with the system's features.
- **HC9:** Participants should have access to responsive support services for assistance with system usage, troubleshooting, or inquiries.
- **HC10:** Participants should be able to customise their experience according to their preferences, including interface personalisation and notification settings.
- **HC11:** Participants should receive timely and relevant updates or alerts, enhancing their engagement and awareness of new opportunities or changes.
- **HC12:** Participants should benefit from adaptive technologies that cater to diverse accessibility needs, ensuring inclusivity and equal access for all users across different platforms.

This structure facilitates a more organised evaluation of user requirements and ensures a robust, human-centred design approach that resonates with the system's Participants (end users).

7.2.1 Actors Engagement and Task Definition in FIST Based Framework

This human-centred section delves into the crucial task of understanding diverse stakeholders and their distinct scenarios to effectively construct actors for a FIST-based system. These actors, representing the roles stakeholders assume during their interactions

with the system, are vital in a context that matches job vacancies with candidates and offers data analysis for labor market insights. The following potential actors have been identified by combining the roles of stakeholders with specific scenarios (as detailed in D):

Vacancy Seeker

Task :Request and Provide information

Justification :As job seekers, they naturally require access to job-related information, such as vacancy details, company profiles, and job market trends while providing their profile.

Employment Organisation

Task :Request, Provide and Create information

Justification :Employment organisations, being primary users, have a vested interest in the system's success. They can contribute insights and resources that enhance the system's value, like industry knowledge and job market trends.

Educational Institution

Task :Request, Provide and Create information

Justification :Educational institutions can supply updated educational data and credentials, contributing to the richness and accuracy of information within the system.

System Professionals

Task :Administrate and create the system.

Justification :These professionals are responsible for the technical development, management, and maintenance of the system, ensuring its functionality and security.

Data Analyst

Task :Request information.

Justification :Data analysts play a crucial role in interpreting system data, thus requiring them to request specific information and assign meaning or categorisations to the data for analysis purposes. This is for planning and development.

Regulatory Authority

Task :Ensure compliance and monitor information quality.

Justification :As regulatory bodies, they oversee the legal and ethical aspects of the system, ensuring data accuracy and privacy standards are met.

Employment Database

Task :Store and Provide information.

Justification :As a central repository, this database is a primary source of employment-related data, crucial for the system's operations.

Educational Database

Task :Store and Provide information.

Justification :This entity is key in providing current and comprehensive educational data, ensuring the system's information remains relevant and accurate.

API Platform

Task :Facilitate information exchange and integration.

Justification :Serving as an interface, the API platform enables the system to interact with external sources for data exchange, broadening the system's scope and capabilities.

7.2.2 UserType Requests and Processes

Now the focus shifts only on the stakeholders and what is expected outcome from their tasks and how would their requests affect the process. This step to provide user stories.

After creating tasks for Stakeholders with their expected outcome, the below is assigning a User Type to a Stakeholder.

1. **User Type 1:** Ministry of Economy and Planning the main beneficiary and adopter of the system.
2. **User Type 2:** Ministry of Human Resources and Social Development. Provide Employment Records and Employment Organisations.
3. **User Type 3:** Ministry of Education. Provide Educational Certificates and Educational Instituters.
4. **User Type 4:** Security Checker "Nafath". Assures User Credentials and User Information.
5. **User Type 5:** FIST System. Host different User Types interactions.
6. **User Type 6:** Seeker. A vacancy seeker.
7. **User Type 7:** Reciter. A vacancy provider.

After Understanding Stakeholders tasks, outcome and interactions with the Dimensions, then combining Stakeholders with User Types. The next step is giving each User Type some goals and requests, and what would the process be and what is the process involvement with different User Types. Table 7.4 shows the full picture.

TABLE 7.4: Requests and Goals for the User Type

User Type	Goals	Requests	Process	Affected UserTypes
1	Reports	Reports for Vacancy	Security Checks	4
		Reports for Seekers	Provide Information	2,3,6,7
		Reports for Employment	Allocate Information	5
2	Issue Employment Records Share Information	Reports for Education		
		Trusted Share System	Security Checks	4
3	Issue Educational Certificate Share Information	Provide Employment Information	Allocate Information	6
		Provide Employment Organisation	Provide Information	1,7
		Share Information	Share Information	5
4	Security Checks Information Assign	Trusted Share System	Security Checks	4
		Provide Educational Information	Allocate Information	6
		Provide Educational Institute	Provide Information	1,7
5	Allocate Information Assign Information Distribute Information	Share Information	Share Information	5
		Check Security Principles	Security Checker	1,2,3,5,6,7
		Assign Information to Users	Assign a User to Educational Information	2,3,4,5,6,7
6	Share Seeker information Request Recruiter information	Assign a User to Employment Information	Assign a User to Employment Information	3,5,6,7
		Request Security Checks	Assign a User to Educational Institute	1,2,3,5,6,7
		Request Employment Information	Assign a User to Employment Organisation	1,2,3,5,6,7
7	Share Recruiter information Request Seeker information	Request Security Checks	Security Checks	4
		Request Employment Information	Allocate Information	2
		Request Educational Information	Allocate Information	3
7	Share Recruiter information Request Seeker information	Request User Information	Allocate Information	4
		Request Seeker Information	Allocate Information	6
		Request Vacancy Information	Allocate Information	7
7	Share Recruiter information Request Seeker information	Provide Information	Share Information	1,2,3,4,6,7
		Trusted Share System	Security Checks	4
		Provide User Seeker information	Provide Information	4
7	Share Recruiter information Request Seeker information	Provide Seeker Employment Information	Provide Information	2
		Request Employment Information	Provide Information	3
		Request Vacancy information	Allocate Information	4,7
7	Share Recruiter information Request Seeker information	Request Employment Organisation Information	Allocate Information	7
		Trusted Share System	Security Checks	4
		Provide User Seeker information	Provide Information	4
7	Share Recruiter information Request Seeker information	Request User Seeker information	Provide Information	2
		Request User Seeker information	Allocate Information	4,6
		Request Seeker Employment information	Allocate Information	2
7	Share Recruiter information Request Seeker information	Request Seeker Employment information	Allocate Information	2
		Request Seeker Educational information	Allocate Information	3
		Request Employment Organisation information	Provide Information	4,2
7	Share Recruiter information Request Seeker information	Request Educational Institute information	Provide Information	4,3
		Request Educational Institute information	Provide Information	4,3
		Provide Vacancy information	Provide Information	7

7.2.3 User Story Concern

Many agile projects (Such as FIST Based System) requires to records Requirements in a for of User Stories. According to Cohn (2004) *"A user story describes functionality that will be valuable to either a user or a purchaser of the system or software"*.

User generally written in a simple template (Wieggers, 2021):

As a < type of user >, I want to < perform task > so that I can < achieve goals >
(7.1)

Using template (7.1) as a base for all User Types created the output on E.2.16.

7.2.4 FIST Based System Functions

The experts interviews also found that most scenarios were given and provided while emphasising recently what is categorised as anomaly. Detailed Scenarios based on Experts interviews are found on Appendix E.

Table 7.2 shows what were the general requirements based on the anomaly factors. This introduced the following functions 4 functions:

1. **Sponsor:** An external entity that has entity that adopts this system and claims ownership as the main beneficiary.
2. **Admin:** An external entity that has no interaction with the data. The admin only view request reports while facilitating requests to build the system. This admin provide any request before the data is shared.
3. **Information:** An internal entity with three types of information functions, they are:
 - **Provider** This is about the actual owner data that is being owned by the issuer. The first creator of the information. At this case, they are MOE and MHRDS.
 - **Assign** This is about linking the date with the owner while confirming it from the information issuer. They are a Seeker for a vacancy or recruiter for a seeker.
 - **Requester** This is about providing information for a given request. It is about linking the date with with the correct owner while confirming it from the information issuer then providing it to the Requester.
4. **System** An internal entity, which is the FIST system has a purpose of information sharing.

7.3 System-Centred Design Approach

The User-Centred Approach and Human-Centred gave unproductive requirements; a system design approach is mandatory for being inconsistent. However, the System Design approach is still based on System Design based on the human interactions.

This section provides an overview of a system design rooted in the FIST framework, focusing on human interactions. As an integrated system, it comprises various components working synergistically to resolve the research problem.

This part is based on an "*Outline of the Requirements Analysis Document (RAD)*" Methodology by Bruegge and Dutoit (2013) to write a specification, and parts of this template are utilised through this section. Practising The requirements gathering to refine the main idea of the proposed FIST framework system.

7.3.1 Requirements Gathering (Elicitation)

This part was based on an "*Outline of the Requirements Analysis Document (RAD)*" from Bruegge and Dutoit (2013) to write the model specification and this template is used through this section. The requirements gathering is practiced to refine the main idea of the proposed FIST framework system which will produce the first model or design.

1. *Introduction*
 - 1.1 *Purpose of the system*
 - 1.2 *Scope of the system*
 - 1.3 *Objectives and success criteria of the project*
 - 1.4 *Definitions, acronyms, and abbreviations*
 - 1.5 *References*
 - 1.6 *Overview*
2. *Current System*
3. *Proposed System*
 - 3.1 *Overview*
 - 3.2 *Functional Requirements*
 - 3.3 *Nonfunctional Requirements*
 - 3.3.1 *Usability*
 - 3.3.2 *Reliability*
 - 3.3.3 *Performance*
 - 3.3.4 *Supportability*
 - 3.3.5 *Implementation*
 - 3.3.6 *Interface*
 - 3.3.7 *Packaging*
 - 3.3.8 *Legal*
 - 3.4 *System Models*
 - 3.4.1 *Scenarios*
 - 3.4.2 *Use case model*
 - 3.4.3 *Object model*
 - 3.4.4 *Dynamic model*
 - 3.4.5 *User interface—navigational paths and screen mock-ups*
4. *Glossary*

FIGURE 7.3: An Outline of the Requirements Analysis Document (RAD) from Bruegge and Dutoit (2013)

7.3.2 User Personas

Mentioned in the E under E.2. User personas play a crucial role in research, especially when dealing with expert analysis, as they offer a structured and empathetic approach to understanding the diverse needs and perspectives of the target audience. This research can gain deeper insights into its goals, challenges, and decision-making processes by creating detailed personas of the experts involved. This in-depth understanding enables

the tailoring of research methodologies, tools, and solutions to be more aligned with the experts' real-world contexts, ensuring that the outcomes are relevant and highly effective. Personas also facilitate better communication and stakeholder engagement, as they provide a clear and relatable representation of the users' viewpoints, making it easier to accurately address their concerns and priorities. Thus, in a research setting, user personas are instrumental in ensuring that the study is user-centric, focused, and capable of yielding meaningful and actionable insights.

7.3.3 System's Goal Scenarios

By examining specific scenarios, it can identify and analyse potential challenges, opportunities, and user interactions that the FIST framework may encounter. These scenarios not only aid in visualising the system's practical application but also provide critical insights into optimising its design and functionality to meet targeted objectives effectively.

1. **Create (Mandatory) Information:**

The use of the word "Create" to impishness on the information being issues by a certain entity then kept. On this case study, information is previously created and managed by their assign/intended ministry. Permitted/Approved appointed/s-elected information are accessible for having SLA. Since information is already have been created and upon its mandatory availability, the Use Case Scenarios were made to illustrate its functions and how would it be applicable on other domains. The only created and additional information are the users of the system. The required information comes from 3 different sources as providers which comes in three different information types:

- (a) **Educational Information:** This is about the actual data that is being created for the first time as an academic record for which can be later labeled as an educational certificate. When information is created, it gets the full history of its creation. Any Created information gets stored and managed by MOE.
- (b) **Employment Information:** This is about the actual data that is being created for the first time as an employment history record for which can be later labeled as an employment history. When information is created, it gets the full history of its creation. Any Created information gets stored and managed by HRSD.
- (c) **Presence Information:**

This is about the existence of an entity that the information is about. In other words, any provided information, it is subject to an entity either an individual or organisation. This information created for the first time as identity of an entity. In this case study, there are two types of Presence

Information that can be gathered from a platform called “NAFTH” which are:

2. **Integrate OR Allocate Information:** This means to fetch and collect information from different system which also means allocate collect data from more than one source of information. The source of information is the information keeper and in this research are the ministers (MOE and HRSD). Furthermore, the allocated information should be assigned to and identity to its presence. This means, the allocated information is appointed to an entity with an identity that is provided by “NAFTH”.
3. **Combine Information:** This means the information that was Allocated, Assigned are verified and valid which assure trust. Then to assure data accuracy for the collected information, it gets encapsulated.
4. **Distribute Information:** This means the encapsulated information that are assured for trusted accuracy are available to be released the appropriate requester.

TABLE 7.5: Scenario:1

Scenario Name	Create Information
Scenario Goal	Creating and issuing information for the first time
Participating Actors Instance	Sam: System-Owner, Alice: Info-Creator, Bob: Info-Keeper.
Flow of Events	<p>E01: Sam Creates a $User^n$ (Alice, Bob, Joe, Marry)</p> <p>E02: Sam Assigns a $User^n$ to UserType</p> <p>E09: $Alice^n$ Creates information for identity of individual $User^n$</p> <p>E10: $Alice^n$ Creates information for identity of organisation $User^n$</p> <p>E06: $Alice^n$ Creates information Name of educational institutes</p> <p>E07: $Alice^n$ Creates information Name of employment organisation</p> <p>E03: $Alice^n$ Creates information (records) for educational certificates</p> <p>E04: $Alice^n$ Creates information (records) for employment history</p> <p>E11: Sam Assigns Bob^n UserType as information Keeper</p> <p>E12: Sam assigns Bob^n the Educational group</p> <p>E13: Sam assigns Bob^n the Employment group</p> <p>E14: Bob Creates a group for individuals</p> <p>E15: Bob Creates a group for organisation</p>

TABLE 7.6: Scenario:2

Scenario Name	Assign Information
Scenario Goal	Assign the created information to an entity
Participating Actors Instance	Bob: Info-Keeper, Joe: Info-Appointee
Flow of Events	E1: Bob recalls the individuals group E2: Bob recalls the organisation group E3: Bob recalls the Education History group E4: Bob recalls the Employment History group E5: Joe Assign individuals to the corresponding educational History E6: Joe Assign individuals to the corresponding employment History E7: Joe Assign organise to the corresponding educational History E8: Joe Assign organise to the corresponding employment History

TABLE 7.7: Scenario:3

Scenario Name	Allocate Information
Scenario Goal	When information is requested, it need to be allocated
Participating Actors Instance	Bob: Info-Keeper, Joe: Info-Appointee, Marry:Info-Demander
Flow of Events	E1: Marry request information about Joe E2: Joe allow Bob^n to provide information to Marry E3: Mary request Joe's information from Bob^n E4: Bob^1 allocate Joe's information E5: Bob^2 allocate Joe's information E6: Bob^{n+1} allocate Joe's information

7.3.3.1 System's Misuse Scenarios

There are X scenarios were built on the experts interviews analysis of their persona and their examples they provided or what was there concern.

Also, create what already been created

TABLE 7.8: Misuse Scenario:1

Scenario Name	Claim Information
Scenario Goal	When information is requested, it need to be allocated
Participating Actors Instance	Bob: Info-Keeper, Joe: Info-Appointee, Marry:Info-Demander
Flow of Events	E1: Marry request information about Joe E2: Joe allow Bob to provide information to Marry E3: Mary request Joe's information from Bob E4: Bob Does Not have information about Joe

1. **Verify Information:**

Example: I own this information. There is no issuer

Example: The employment organisation is over seas

Example: The employment organisation bankrupt

Example: The educational institutes is over seas

Example: The educational institutes closed down

2. **Validate Information:**

Example: My name is David Smith and these are my qualifications

Example: My name is James Smith and those are my qualifications

Example: I have a recent valid test

Example: The institute discover forgery after issuing

7.3.4 Functions Mapping (Functions Requirements)

This section shows the 5 UserTypes are mapped into their Factors and how they are effected by the main dimensions. The full Mappings are in Appendix E . Table 7.9 shows the Summary of the mapping.

Sponsor The entity is the owner of the system that host all interactions for information sharing, they have factors to consider.

Admin The system admins and more specifically the ones who handle the system logs.

Developer The system developers are responsible of the development of the actual system, they have factors to consider.

Information Provider The actual owner of the information and the person that is the information linked to, they have factors to consider.

TABLE 7.9: Mapping UserType With Factors and Dimensions

UserType	Dimensions Effected	Factors Effected
Sponsor	FC	1,2,3,4,5,6
	IT	1,2,3,4,5,6
	SP	6
	TA	1,4,5,6
Admin	FC	-
	IT	3
	SP	1,2
	TA	3,6
Developer	FC	5,6
	IT	1,2,3,4,5,6
	SP	6
	TA	1,4,5,6
Information Provider	FC	3,5
	IT	4,5,6
	SP	1,2,3,4,5,6
	TA	1,2,4,5,6
Information Requester	FC	4,5
	IT	4,5,6
	SP	3,6
	TA	1,4,5,6

Information Requester The entity which requests information about a person which is information linked to, they have factors to consider.

7.3.5 System's Interaction Diagrams

This section is about interaction diagrams. Interaction diagrams are essential in system design and development as they provide a clear visual representation of how different components of a system interact with each other and with users. These diagrams, this research focuses on sequence diagrams, help in understanding the flow of information and control throughout the system. By mapping out the interactions, developers and designers can ensure that the system's architecture supports its intended functionalities efficiently. Furthermore, interaction diagrams facilitate better communication among team members and stakeholders by providing a common, easy-to-understand language for discussing complex system interactions, thereby aiding in more effective and collaborative system development.

7.3.5.1 Interaction Diagrams - Clients

This section to show the involved Clients of the system within entity tasks with system tasks. Firstly, there is an interface which allow users to interact with. Secondly, Information Providers are shown as two servers, one is the education certificates issuers and another as the employment history creator. Thirdly, e.gov servers that provide identity and security checks. Finally, an application client that host interactions between information providers and requesters. Clients are either systems or servers, described below:

- **AppClient:** An interface to illustrate requests by different users.
- **ServerSec:** A Server for identity and authorisation checking which is provided by the e.government "Nafath"
- **AppFIST:**The FIST based system.
- **ServerUser:** A Server that provides identity for the claims of a User which is provided by the e.government "Nafath".
- **ServerEdu:** In this case study, it is the ministry of education that issues the educational and training certificates.
- **ServerEmp:** In this case study, it is the ministry of Human Resources and Social Development that issues the employment records and history.
- **ServerRec:** A Server with available vacancy (requesting a Seeker).
- **ServerSeeker:** A Server with available candidate (requesting a vacancy).

7.3.5.2 Interaction Diagrams - Requests

Based on the 7 stakeholders, the experts interview reactions, the experts interview requirements on the scenarios, Cause and Effect of factors and dimensions, 6 UserTypes mapped to their factors, system tasks, entity tasks and interactions clients, it created 10 system requests. Shown in Appendix E, there are 10 interactions diagrams. They are explained below as requests:

- **Request 1:** is to "**Allocate Educational Certificates**". This interaction diagram illustrated in figures E.1. This Request to find all educational certificates which is essential to development and planning.
- **Request 2:** is to "**Allocate Employment Records**". This interaction diagram illustrated in figures E.2. This Request to find all employment records which is essential to development and planning.
- **Request 3:** is to "**Allocate Available Applicants**". This interaction diagram illustrated in figures E.3. This Request to find all available applicants or seekers for an opening. This is essential to development and planning.
- **Request 4:** is to "**Allocate Available Openings**". This interaction diagram illustrated in figures E.4. This Request to find all available openings or vacancies which needs an applicant. This is essential to development and planning.

- **Request 5:** is to "**Include / advertise Information for a Candidate**". This interaction diagram illustrated in figures E.5. This means a specific candidate can promote or publish their availability as a seeker for an opening which allows recruiter to view their information.
- **Request 6:** is to "**Include / advertise Information for a Vacancy**". This interaction diagram illustrated in figures E.6. This means a specific vacancy, or an opening can be promoted as available, which allows seekers to view their vacancy information
- **Request 7:** is to "**Allocate a Candidate Information**". This interaction diagram illustrated in figures E.7. This means the Recruiters can view information about a specific candidate.
- **Request 8:** is to "**Allocate a Vacancy information**". This interaction diagram illustrated in figures E.8. This means the Seeker can view information for a specific openings
- **Request 9:** is to "**Exclude / Delete Information for a Candidate**". This means a specific candidate can delete their availability.
- **Request 10:** is to "**Exclude / Delete Information for a Vacancy**". This means a specific vacancy can delete its availability.

7.3.6 Developing Effective Requirements

To develop effective requirements, the vision statement and User Story Concerns were applied to the identified UserTypes in section 7.2.2 and Table 7.4.

7.3.6.1 Vision Statement

According to Wiegers (2021) "*A vision Statement helps to achieve shared understanding and aligned expectation*". This section used the below keywords temple to shift the focus on Stakeholders of the system. This step is important to direct attention to participants and how they should direct their focus and attention (Moore, 2014; Wiegers & Beatty, 2013).

TABLE 7.10: Stakeholders FIST Framework Vision

For	Country Developing And Future Planning, Vacancy Seekers, Seekers Recruiters, Educational Institutes, Employment Organisations, Students, Employee, Employers
Who	Seek the future planning and development. Requires qualifications validation practiced during candidates allocations. Requires a Verified C.V. Requires Confirmed records. Improve the society Knowledge. Requires a Vacancy.
The	FIST Framework Based System
Is	A backend system to Allocate, Assign, Encapsulate, Distribute information related to users, education certificates and employment history
That	Will improve e.gov services
Unlike	Current Traditional Practices which create misuse cases that lakes accuracy
Our System	Will provide accurate information. Will elevate user trust in provide their information for sharing with different users. Ease of access for its users. Will allow vacancy seekers to publish their profile and information in a secure environment while employers gain access to updated information on prospective employees. Will allow employers promote then request to vacate a job vacancy. Will Eliminate User Misuse. Will Eliminate User Misconduct.

7.3.7 Building and Priortising Requirements

To build user requirements it was based on the User stories. Then Applied The MoSCoW method. Here Applied The MoSCoW method which is a prioritisations technique (Wieggers, 2021). Also, everything up to this point on this chapter created table 7.12.

TABLE 7.11: How MoSCoW Applied

Must	If it is about sharing information it is a must
Should	the system does not do, but inherited
Could	it come from the system or provide it
Wont	It is the boundary, it sounds it can do it, so, ONLY provide the information not the action

Everything up to this point on this chapter created the below table 7.12

TABLE 7.12: System Design Requirements

No	Type	Cateegory	Description "Of The User"
REQ01	System	Must	The System Must be able to create USER accounts and their UserType
REQ02		Must	The System Must be able to verify User identity through by Nafath
REQ03		Must	The System must assure all transactions are secure
REQ11		Must	The System Must be able to keep User information private
REQ04		Must	The System Must allow a data transactions to be requested only when that USER has data to provide
REQ05		Must	The System must be able to allocate information
REQ06		Must	The System must be able to encapsulate information
REQ07		Must	The System must be able to distribute encapsulated information
REQ08		Could	The System could be able to provide STAT information
REQ09		Wont	The System will not communicate with other system users
REQ10		Wont	The System will not hire
REQ13	Seeker	Must	The Seeker Must be able to provide Employment History
REQ14		Must	The Seeker Must be able to provide educational certificates
REQ12		Should	The Seeker Should be able request vacancy information
REQ17		Could	The Seeker could be notified of a prospective vacancy
REQ00	Recruiter	Must	The Recruiter Must be able to Provide Vacancy Information
REQ19		Must	The Recruiter Must be able to request Seeker Educational Certificates
REQ20		Must	The Recruiter Must be able to request Seeker Employment History
REQ21		Should	The Recruiter Should be able to allocate a number of Seekers
REQ22		Should	The Recruiter Should be able to contact prospective Seeker
REQ18		Should	The Recruiter be able request Seeker availability
REQ24	Admins	Should	The Admin should view all vacancy
REQ25		Should	The Admin should view all seekers
REQ26		Could	The Admin could view STAT of employment history
REQ27		Could	The Admin could view STAT of educational certificates
REQ29	Info	Must	The Info-Admin Must be able to create Vacancy Information
REQ30	Admins	Must	The Info-Admin Must be able to create Recruiter Information
REQ31		Must	The Info-Admin Must be able to create Educational Certificates
REQ32		Must	The Info-Admin Must be able to create Employment History

7.4 Modelling the system:

This section is based on UMS.

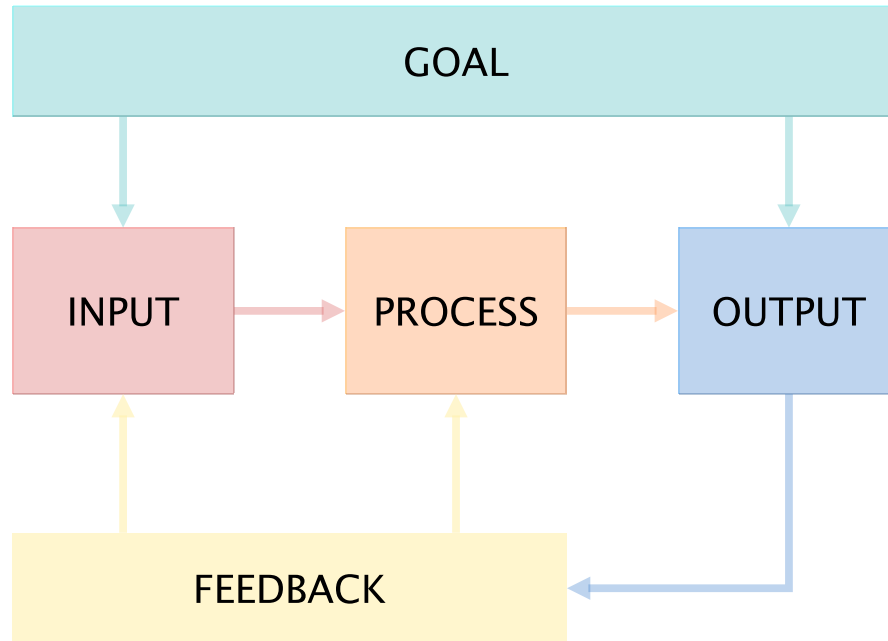


FIGURE 7.4: Universal System Modelling

Modelling the system through 3 Iterations and one abstract

7.4.1 Iteration 0: USERS and Actions

This section is based on Machines

This subsection shows an overall view of the objectives of the FIST system. The system has an entity requesting information and an entity providing information. This information is for the Supplier and its profile, a Supplier Profile (S_Profile). So, one demands a profile, another supplies the profile. Figure 7.5 shows **The Two Main USERS and Two Main Actions** while showing the system at a high level (abstract level), it is the overall picture.

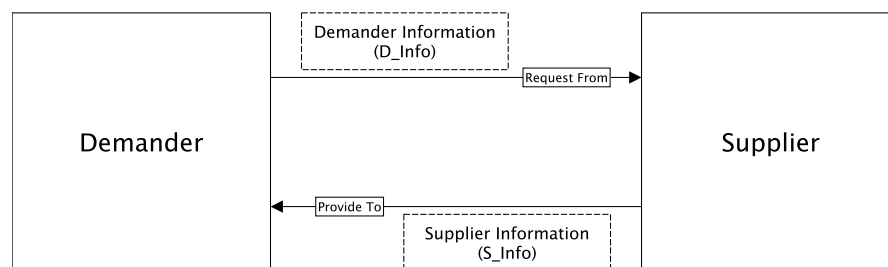


FIGURE 7.5: System Abstract: SETS

7.4.1.1 Iteration 0: The Main USERS

To illustrate the Main Users, they were addressed and named according to its purpose. There are **Two** main **USER**, are:

- **Demander:** This means this type of **USER** Request information from a different entity while presenting their information. So, presenting **Demander Info** to request different information which is **Supplier Info** and that comes from an entity that Provide information, that information providing entity is called **Supplier**.
- **Supplier:** This means this type of **USER** Provide information to a different entity. The information is Provided to an entity that Request The **Supplier Info**, that entity (Requesting Information) is called **Demander**. The **Demander** has to present their **Demander Info**.

7.4.1.2 The Main Actions

To illustrate the Main actions, they were addressed and named according to its task functions. There are **Two** main **ACTIONS**, which are:

- **Request:** While Presenting **Demander Info**, The **Demander** Request **Supplier Info** from **Supplier**.
- **Provide:** After Checking **Demander Info**, The **Supplier** Provide **Supplier Info** to **Demander's** Request.

7.4.1.3 The Main Rules

Similar to User stories shown in 7.1, rules were created (Shown in Figure 7.6) to illustrate what is allowed from the UERS and their actions and what is considered to be misuse.

1. **Allowed** : The Rules that shows what are the system tasks and functions on how the system should behave:
 - **Rule 7.2** Shows that when a demander request a profile which shows the supplier information from supplier.
 - **Rule 7.3** Shows the response of a demander request, to the profile which shows the supplier information from a supplier. The response is the supplier provide their supplier information.
2. **Not Allowed** : The Rules that shows what are the misuse on the system and what is not allowed:
 - **Rule 7.4** Shows that Demanders do not response to requests of providing information. Which means that there can not be two demanders requesting information at the same time.
 - **Rule 7.5** Shows the Suppliers cannot request information about other Suppliers. Also, it means Suppliers will not provide information to other Suppliers. However,

in some cases that will be shown later, a Supplier can request their ONLY OWN information.

ALLOWED:

As a < Demander >, I < Request >< Supplier_Info > From < Supplier > (7.2)

IN PARALLEL WITH...

As a < Supplier >, I < Provide >< Supplier_Info > to < Demander > (7.3)

NOT ALLOWED:

As a < Demander >, I < Request >< Supplier_Info > From < Demander > (7.4)

IN PARALLEL WITH...

As a < Supplier >, I < Request >< Supplier_Info > From < Supplier > (7.5)

FIGURE 7.6: The Main Rules

7.4.1.4 The Main Access Levels

There are access levels to assure each user can do their actions with their correct access level to a specific information. Each user with their action and access levels are Shown in Table 7.13. Each USER with their corresponding access levels are:

1. **Demander:** The Demander can only request data. Demanders Have no authority to change or alter data. Demanders can *Read Only* information they request.
2. **Suppliers:** As a general assumption, Suppliers provide their own information. Some information not always available which means (with restrictions) some data will be created, *Write* and altered. Some Suppliers could read their own information but not other suppliers information.

TABLE 7.13: USER Actions and Access Levels

USER	Action	Access Level	Information
Demander	Request	<i>Read Only</i>	Supplier_INFO
Supplier	Provide	<i>Read & Write</i>	Supplier_INFO

7.4.1.5 Iteration 0: Requirements

Table 7.14 is based on the Framework , 5 main requirements were built. They are:

1. **REQ1:** To exchange data, there must be two USERS , a demander and supplier.

2. **REQ2:** USER must be either a demander or supplier, there cannot be two of the same user.
3. **REQ3:** The Demander must be able present their profile to request data from a supplier. That data comes in a from of supplier information.
4. **REQ4:** The Supplier must be able check the demander profile to provide the data, the provided data is their information as Supplier Information.
5. **REQ5:** The Supplier might need to write their data.

TABLE 7.14: User Requirements

No	Category	Description "Of The User Requirements"
REQ01	Must	There must be two Users; A Demander and a Supplier
REQ02	Must	A User Must be either A Demander or a Supplier
REQ03	Must	The Demander must present Demander_INFO to be able to <u>Request</u> Supplier_INFO
REQ04	Must	The Supplier Must be able check Demander_INFO to <u>Provide</u> Supplier_INFO
REQ05	Should	The Supplier <i>Write</i> Supplier_INFO

7.4.2 Iteration 1: Add UserType & InformationType

This section shows additional interactions and controls. Adding **USER_TYPE** will assure that not all **USERS** are allowed to request information and not all users are allowed to provide information. Also, there are two types of information, one related to candidates and another related to vacancies. This means, actions depend on their User Type and Info Type. Shown in Figure 7.7 which.

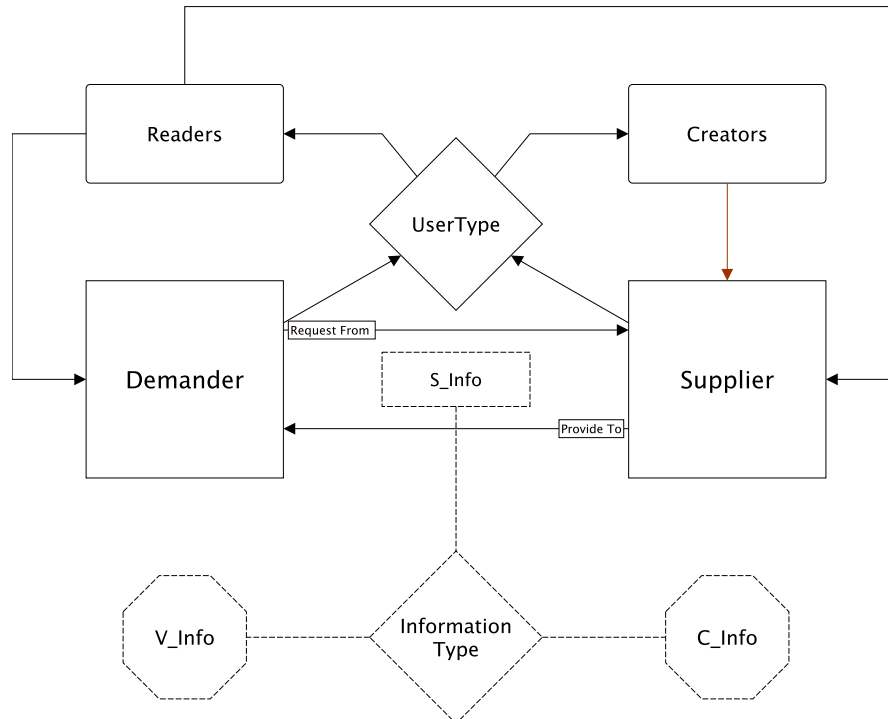


FIGURE 7.7: Ref1

7.4.3 UserType: Readers and Creators

This subsection shows that when **Demanders** request **S_Info**, they can have one **UserTypes**; *Readers*. Also, this means when **Supplier** provide **S_Info**, they can have two **UserTypes**, either *Readers* or *Creators*. Adding conditions and rules for **UserType** will assure that **Demanders** have the access level to *Read Only* information. Also, this means **Suppliers** can *Read* information and some times *Write* information. However, In this research, all information are already created and available. Clarifying the **USER_TYPE** as they can create and read information within their rights is presented to illustrate actions.

7.4.3.1 UserType: Readers

These Types of users they can only view (*Read*) information, they cannot change or alter (*Write*) information. They are usually the end users who use the system.

7.4.3.2 UserType: Creators

These Types of users are the information owners and creators. They can view (*Read*) and create (*Write*) information. In this research, they are the two main Ministries, Educational (MOE) and Employment (HRSD).

7.4.4 InformationType: C_Information and V_Information

7.4.4.1 InformationType: C_Information:

C_Information: This means creating related and required information to create Candidate Profile. This can be created by both Ministries.

7.4.4.2 InformationType: V_Information:

V_Information: This means creating related and required information to create Vacancy Profile. This can be created by both Ministries.

7.4.5 The UserType & InformationType Rules:

This creates some *Rules..* There are **Twelve** rules which are:

ALLOWED:

$$As \langle D_Readers \rangle, I \langle Request \rangle \langle S_Creators \rangle to \langle Provide \setminus Write \rangle \langle C_Info \rangle \quad (7.6)$$

IN PARALLEL WITH...

$$As \langle S_Creators \rangle, I \langle Provide \setminus Write \rangle \langle C_Info \rangle to \langle D_Readers \rangle \langle Request \rangle \quad (7.7)$$

VICE VERSA, ALLOWED:

$$As \langle D_Readers \rangle, I \langle Request \rangle \langle S_Creators \rangle to \langle Provide \setminus Write \rangle \langle V_Info \rangle \quad (7.8)$$

IN PARALLEL WITH...

$$As \langle S_Creators \rangle, I \langle Provide \setminus Write \rangle \langle V_Info \rangle to \langle D_Readers \rangle \langle Request \rangle \quad (7.9)$$

ALSO ALLOWED:

$$As \langle D_Readers \rangle, I \langle Request \rangle \langle S_Readers \rangle to \langle Provide \rangle \langle C_Info \rangle \quad (7.10)$$

IN PARALLEL WITH...

$$As \langle S_Readers \rangle, I \langle Provide \rangle \langle C_Info \rangle \text{ to } \langle D_Readers \rangle \langle Request \rangle \quad (7.11)$$

ALSO VICE VERSA, ALLOWED:

$$As \langle D_Readers \rangle, I \langle Request \rangle \langle S_Readers \rangle \text{ to } \langle Provide \rangle \langle V_Info \rangle \quad (7.12)$$

IN PARALLEL WITH...

$$As \langle S_Readers \rangle, I \langle Provide \rangle \langle V_Info \rangle \text{ to } \langle D_Readers \rangle \langle Request \rangle \quad (7.13)$$

NOT ALLOWED:

$$As \langle D_Readers \rangle, I \langle Request \rangle \langle S_Readers \rangle \text{ to } \langle Write \rangle \langle C_Info \setminus V_Info \rangle \quad (7.14)$$

IN PARALLEL WITH...

$$As \langle S_Readers \rangle, I \langle Write \rangle \langle C_Info \setminus V_Info \rangle \text{ to } \langle D_Readers \rangle \langle Request \rangle \quad (7.15)$$

ALSO, NOT ALLOWED:

$$As \langle D_Creators \rangle, I \langle Request \rangle \langle S_Creators \rangle \text{ to } \langle Provide \setminus Write \rangle \langle C_Info \setminus V_Info \rangle \quad (7.16)$$

IN PARALLEL WITH...

$$As \langle S_Creators \rangle, I \langle Provide \setminus Write \rangle \langle C_Info \setminus V_Info \rangle \text{ to } \langle D_Creators \rangle \langle Request \rangle \quad (7.17)$$

7.4.6 The UserType & InformationType Access Levels:

TABLE 7.15: USER, USERTYPE, ACCESS LEVELS

USER	UserType	Access Level	Supplier_INFO
Demander	Readers	<i>Read Only</i>	C_INFO
			V_INFO
Supplier	Readers	<i>Read Only</i>	C_INFO
			V_INFO
	Creators	<i>Read & Write</i>	C_INFO
			V_INFO

7.4.7 The UserType & InformationType Requirements:

TABLE 7.16: UserType & InformationType Requirements

No	Category	Description
REQ06	Must	There Must be two UserTypes; Readers and Creators
REQ07	Must	There Can be Readers and Creators (as Demanders or Suppliers)
REQ08	Must	There Can be Two Readers (as Demanders or Suppliers)
REQ09	Wont	There Cannot be Two Creators (as Demanders or Suppliers)
REQ10	Must	There Must be two Information Types; V Info and C Info
REQ11	Should	Creators Should Write V Info & C Info
REQ12	Could	Creators Could Read V Info & C Info
REQ13	Must	Readers Can Read V Info & C Info
REQ14	Wont	Readers Will not Write V Info & C Info

7.4.8 Iteration 2: Add Roles to UserType & Information Type

This to show you need to provide something to get something. without owning a profile, you can not request a profile.

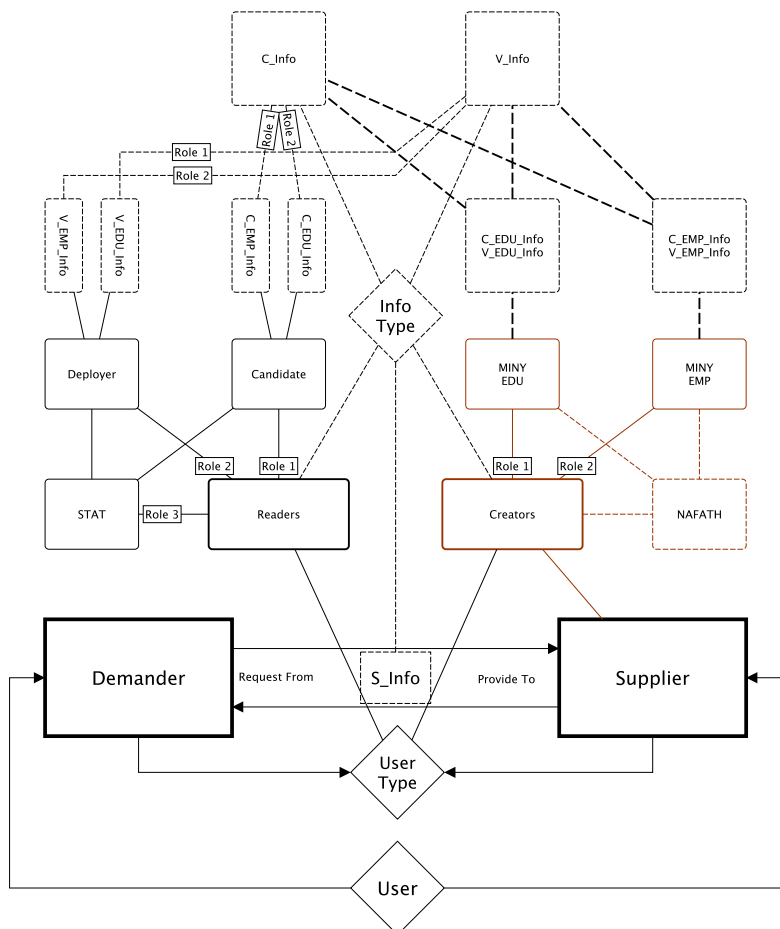


FIGURE 7.8: All in one

7.4.9 Roles for the UserType: Readers

1. **Candidate:** A **Candidate** (Wants a Vacancy) is an entity that Requests unoccupied (Available) Vacancy from A **Deployer**.
2. **Deployer:** A **Deployer** (Have a Vacancy) is an entity that Requests Prospective (Available) Candidates from A **Candidate**.
3. **STAT:** A **STAT** UserType (Economy & Planning for Human Resources and Social Development) is an entity that Requests unoccupied (Available) Vacancy from A **Deployer**. **Also**, an entity that Requests (Available) Candidates from A **Candidate**.

7.4.9.1 Candidate & Deployer

These Roles are for the purpose promoting vacancies (V_profile) which should entice prospective candidates into using the system and provide their information (C_Profile), and vice versa, for the purpose promoting candidates (C_Profile) which should entice unoccupied vacancies into using the system and provide their information (V_Profile).

7.4.9.2 STAT

This Role is for the purpose of making reports based on statistics which would assure the candidates have the right qualifications for the available (unoccupied) vacancies. In other words, to have candidates to be in line with with the vacancies needs. in addition for future planning and development. This happens by providing all vacancies informations (V_profile) and candidates informations (C_Profile).

7.4.10 Roles for the UserType: Creators

7.4.10.1 Educational

(MINY_EDU): Can *Read* and *Write* within its related educational institutes. Only within EDU!

7.4.10.2 Employment

(MINY_EMP): Can *Read* and *Write* within its related employment organisations. Only within EMP!

7.4.11 Access Levels for Roles

TABLE 7.17: USER, USERTYPE, ACCESS LEVELS

USER	UserType	Role	Access Level	Attach	Supplier_INFO
Demander	Readers	Deployer	<i>Read Only</i>	V_INFO	C_INFO (C_EMP + C_EDU)
		Candidate	<i>Read Only</i>	C_INFO	V_INFO (V_EMP OR V_EDU)
		STAT	<i>Read Only</i>		C_INFO (C_EMP OR C_EDU) V_INFO (V_EMP OR V_EDU)
Supplier	Readers	Deployer	<i>Read Only</i>	V_INFO	C_INFO (C_EMP + C_EDU)
		Candidate	<i>Read Only</i>	C_INFO	V_INFO (V_EMP OR V_EDU)
	Creators	MINY_EDU	<i>Read & Write</i>		EDU_C_INFO EDU_V_INFO
		MINY_EMP	<i>Read & Write</i>		EMP_C_INFO EMP_V_INFO

7.4.12 Requirements for Roles

TABLE 7.18: UserType & InformationType Requirements

No	Category	Description
REQ15	Must	There Must be three Readers Roles; Candidate, Deployer and STAT
REQ16	Should	While Providing C INFO, Candidate Should Read V Info
REQ17	Should	While Providing V INFO, Deployers Should Read C Info
REQ18	Should	STAT Should Read C Info and V Info
REQ19	Must	There Must be two Creators Roles; MINY EDU and MINY EMP
REQ20	Should	MINY EDU Should Write V_Info & C_Info within EDU (EDU_C_Info & EDU_V_Info)
REQ21	Should	MINY EMP Should Write V_Info & C_Info within EMP (EMP_C_Info & EMP_V_Info)
REQ22	Could	MINY EDU Could Read V_Info & C_Info within EDU (EDU_C_Info & EDU_V_Info)
REQ23	Could	MINY EMP Could Read V_Info & C_Info within EMP (EMP_C_Info & EMP_V_Info)
REQ24	Must	Deployer Role must have V_Info attached to it
REQ25	Must	Candidate Role must have C_Info attached to it

7.4.13 Iteration 3: Data Creation & Collection

Colouring: f there is any colour, it means it is active, if only dotted line, it means not active.

7.4.13.1 Data Creation

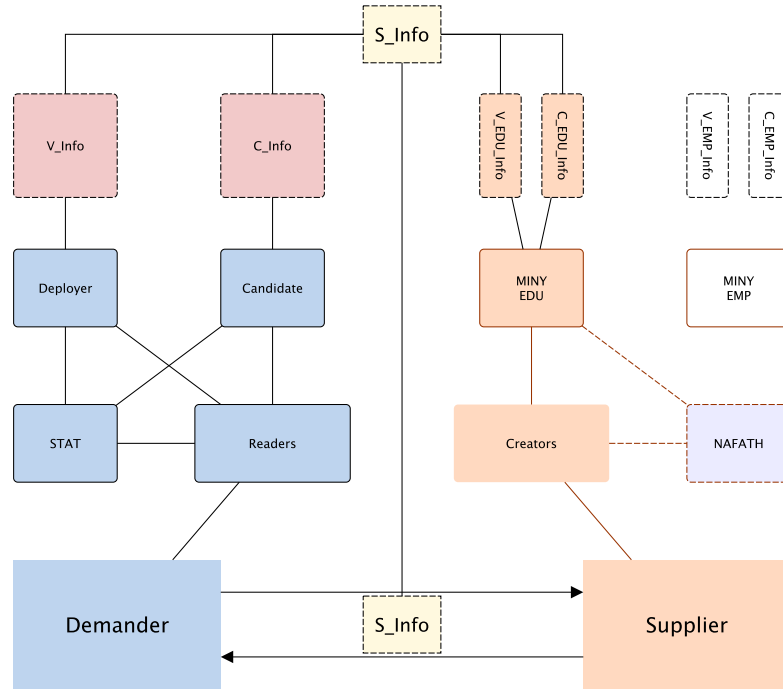


FIGURE 7.9: Creating Education Information

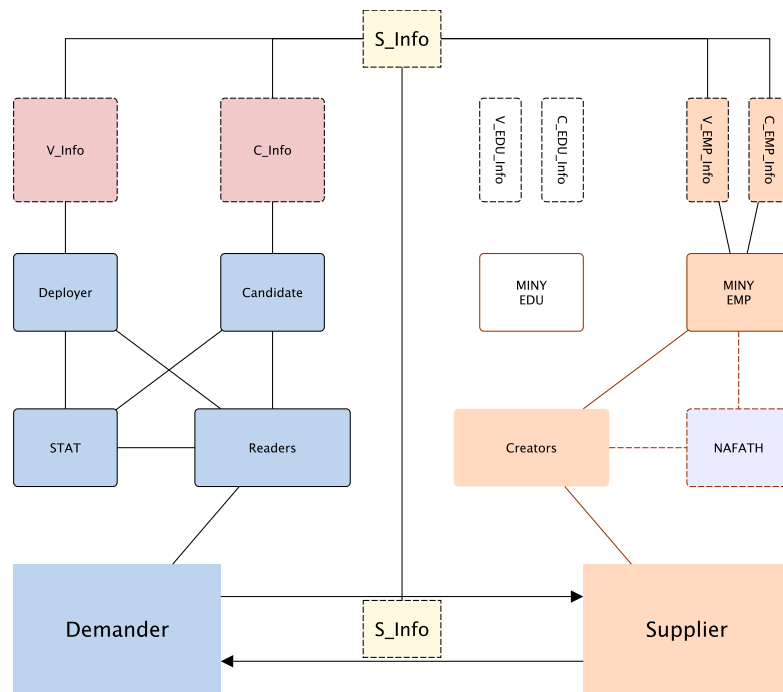


FIGURE 7.10: Creating Employment Information

7.4.13.2 Data Collection

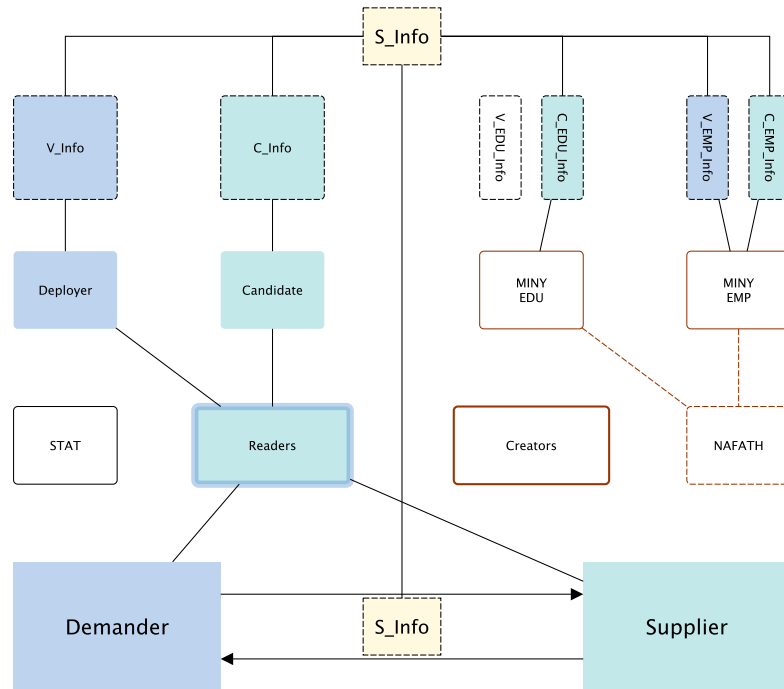


FIGURE 7.11: HAS EMPLOYMENT VACACNY REQUESTING (EMPLOYEE) CANDIDATES

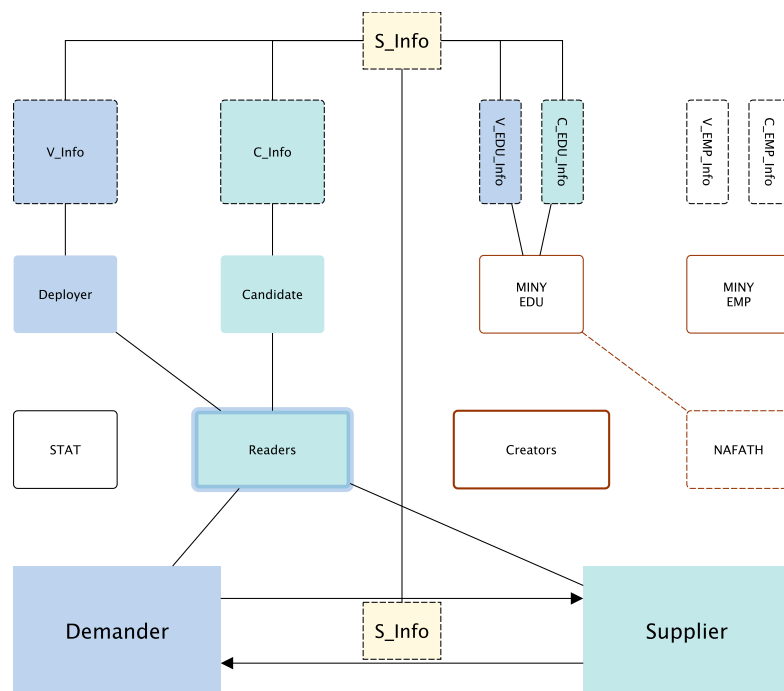


FIGURE 7.12: HAS EDUCATION VACACNY REQUESTING (STUDENTS) CANDIDATES

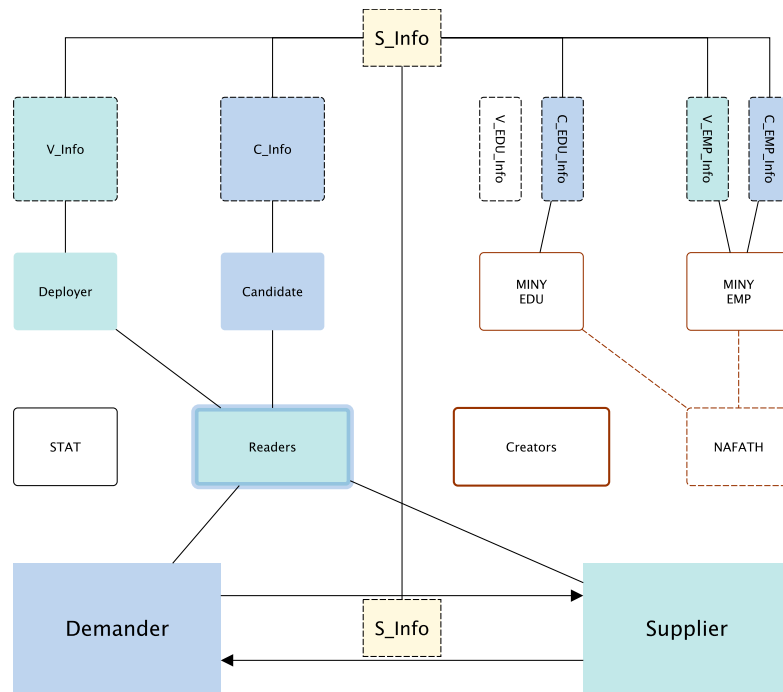


FIGURE 7.13: EMPLOYMENT CANDIDATE REQUESTING EMPLOYMENT VACANCY

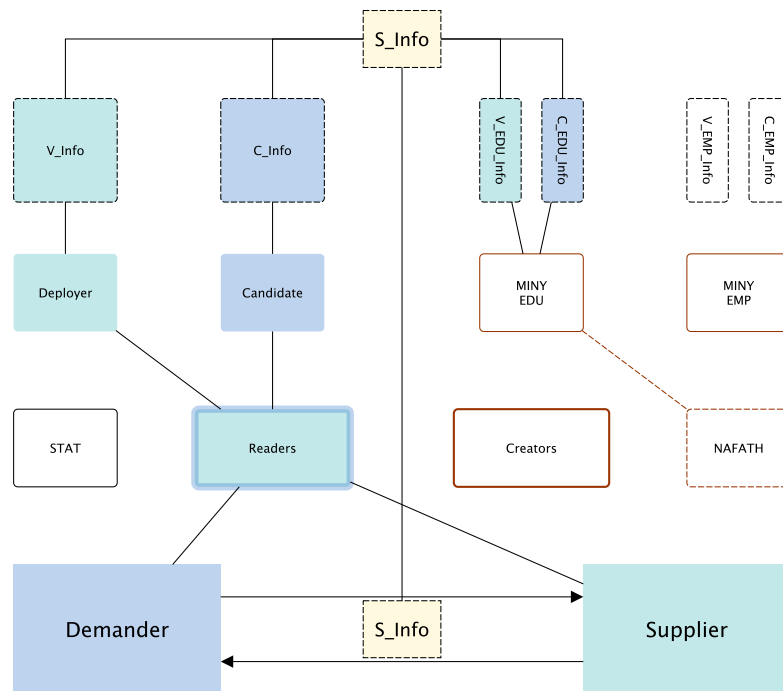


FIGURE 7.14: EDUCATION CANDIDATE REQUESTING EDUCATION VACANCY

7.4.13.3 STAT

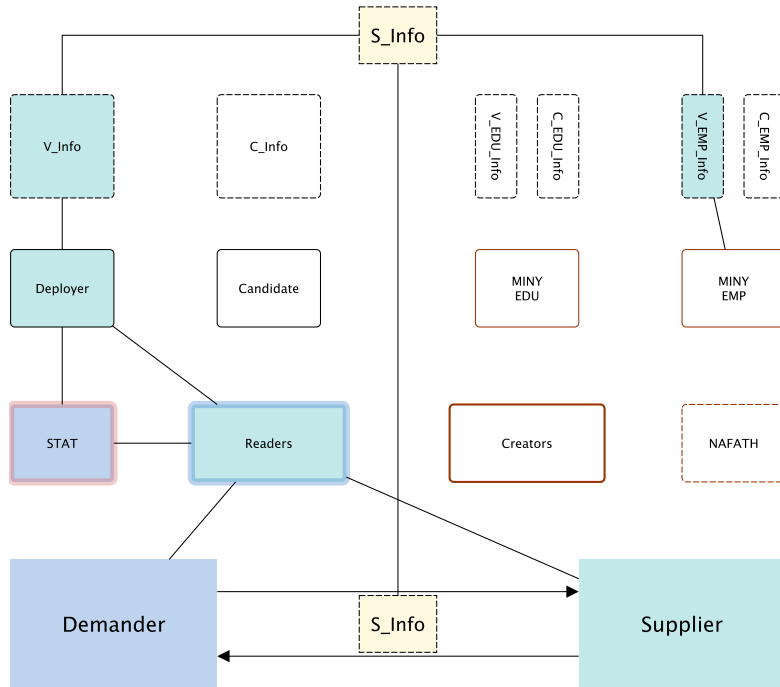


FIGURE 7.15: TO FIND ALL VACACNY IN EMPLOYMENT

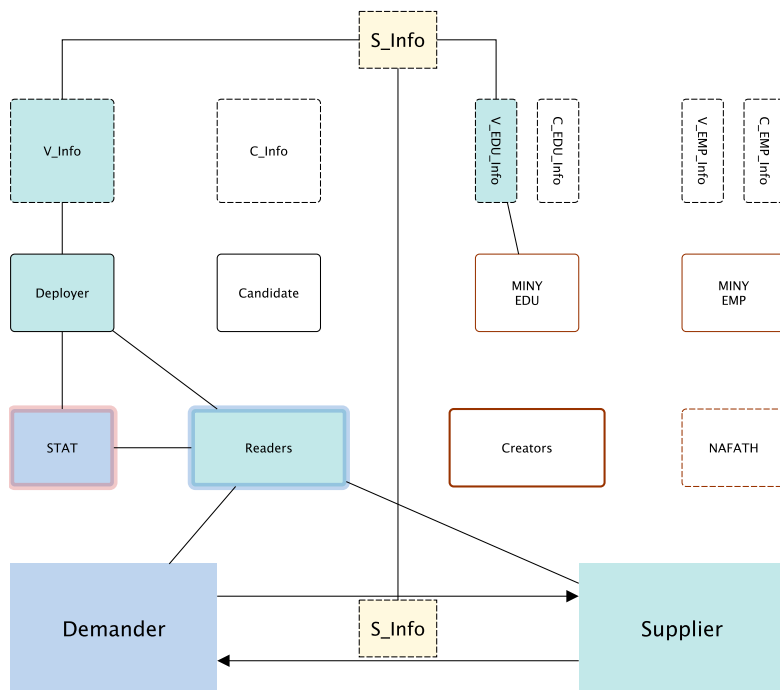


FIGURE 7.16: TO FIND ALL VACACNY IN EDUCATION

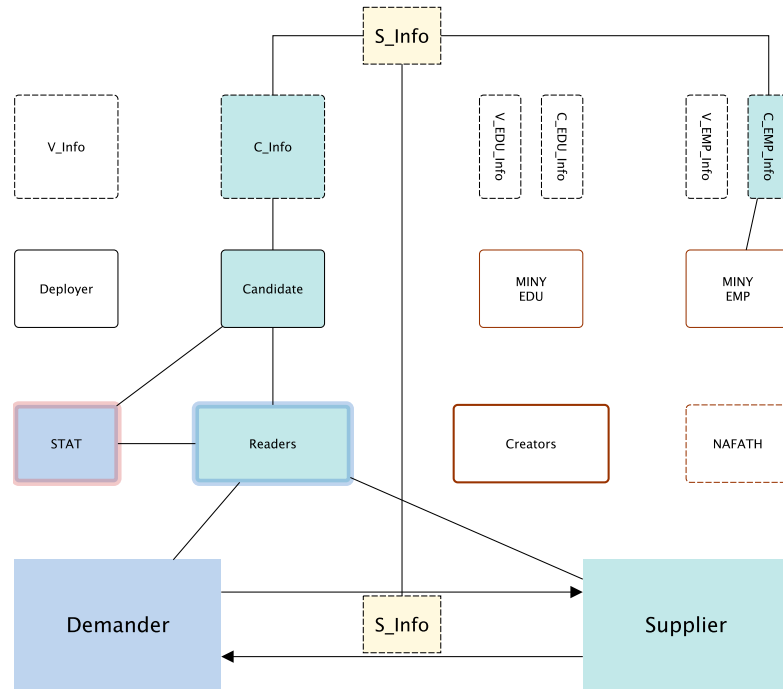


FIGURE 7.17: TO FIND ALL CANDIDATES IN EMPLOYMENT

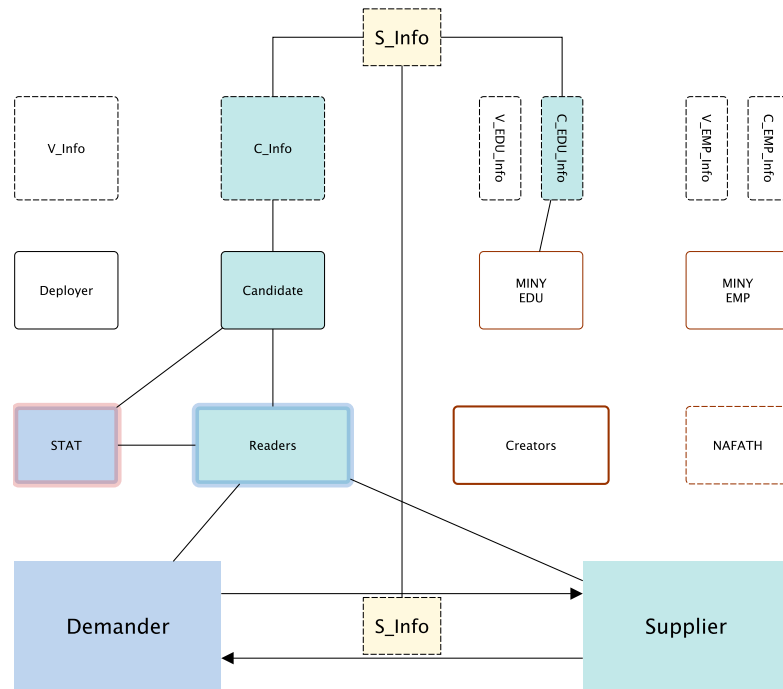


FIGURE 7.18: TO FIND ALL CANDIDATES IN EDUCATION

7.4.14 Data Allocation Requirements

TABLE 7.19: UserType & InformationType Requirements

No	Category	Description
REQ24	Must	MINY EDU Must Allocate (Create or recall) Educational Candidate Information (C_Info = C_EDU)
REQ25	Must	MINY EDU Must Allocate (Create or recall) Educational Vacancy Information (V_Info = V_EDU)
REQ26	Must	MINY EMP Must Allocate EMPLOYMENT Candidate Information (C_Info = C_EMP + C_EDU)
REQ27	Must	MINY EMP Must Allocate (Create or recall) EMPLOYMENT Vacancy Information (V_Info = V_EMP)
REQ28	Must	The Deployer Must be able to provide Employment Vacancy Information (V_Info = V_EMP)
REQ29	Must	The Deployer Must be able to provide Educational Vacancy Information (V_Info = V_EDU)
REQ30	Must	The Candidate Must be able to provide Candidate Information (C_Info = C_EMP + C_EDU)
REQ31	Must	The Candidate Must be able to request Employment Vacancy Information (V_Info = V_EMP)
REQ32	Must	The Candidate Must be able to request Educational Vacancy Information (V_Info = V_EDU)
REQ33	Must	The EDU Deployer Must be able to request Candidate Information (C_Info = C_EDU)
REQ34	Must	The EMP Deployer Must be able to request Candidate Information (C_Info = C_EMP + C_EDU)

7.5 Chapter Conclusions

The journey through this chapter has been an enlightening traversal across various dimensions; User-Centred, Human-Centred, System-Centred, and Model-Driven, each contributing distinctively to formulating trust requirements in information-sharing systems. This multifaceted approach has been essential in comprehensively understanding and addressing the complexities of building a trustworthy system. In the User-Centred phase, the focus was on collating and analysing the requirements gathered from the experts, resulting in a nuanced understanding of the stakeholders' perspectives. The Human-Centred phase highlighted the significance of individual stakeholder roles and their interactions with the system, emphasising the importance of catering to human elements within the system's architecture. The System-Centred phase delved into the system's functionalities, interactions, and structural details, highlighting the criticality of seamless operation and efficient workflow. Finally, the Model-Driven phase employed the Universal Systems Model to offer a holistic view of the system, aligning individual and collective user inputs with the system processes.

As the study moves forward, the next chapter is set to pivot on modelling the identified requirements, explicitly focusing on the critical tasks. This step will involve a detailed exploration of how these requirements translate into the system's operational blueprint, laying the groundwork for the system's development and implementation. This next phase is crucial, as it will dictate how well the system aligns with the established requirements and the overarching goal of building trust in information-sharing systems.

Chapter 8

Template for Modelling Trust in Information-Sharing Systems

Building on the foundation laid by formal methods, this chapter delves into the application of these methods in developing robust and reliable models for information exchange systems. Emphasising the importance of mathematical verification, we explore how formal methods, particularly Event-B, are instrumental in validating the integrity and safety of system designs. This approach not only enhances the precision of the models but also ensures that they are devoid of ambiguities and inconsistencies. By focusing on critical safety properties and leveraging the strength of formal methods, we aim to create models that are not just theoretically sound but also practically viable, ensuring their effectiveness in real-world applications.

Formal methods give a sense of consistency, completion and removes ambiguities. The Requirements and Scenarios will be shown in this chapter how they develop models that can be tested by Rodin tool. Formal methods would use mathematical techniques to verify the key problem on the framework. Performing mathematical analysis with formal methods would support the reliability of the designed models.

This chapter Based on the key problem that this research addresses. The **Key Problems** with information sharing are:

The First Key problem Identified:

Experts advanced the concept of “Trust in Information Exchange” from the perspective of a reciprocal transaction.

The notion of “Trust in Information Exchange” arises during the process of an information exchange request. It works to create a sense of mutual trust between the participating entities. This is accomplished through the implementation of specific countermeasures

that guarantee the availability of the exchanged information. As a result, an environment of reciprocal trust is created, based on the accuracy of the corresponding data in return.

The Second Key problem Identified:

*Experts highlighted the lack of **Accuracy**, attributing it to incomplete provenance in shared information, where the official entity creating the information plays a crucial part.*

This chapter is about modelling trust and accuracy. The research method that was used is shown in Figure 8.1 for thos **Research Question** which is:

What is an appropriate template for modelling trust in Information-Sharing?

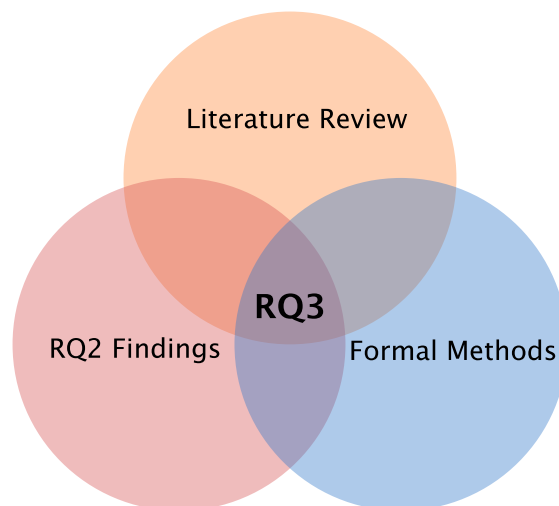


FIGURE 8.1: Triangle Technique for the Third Question

8.1 Formal Methods and Event B Modelling requirements

TABLE 8.1: Modelling Requirements for Accuracy

No	Description
RQ01	Each interaction for information sharing has two USERS: Individual Suppliers and Demanders
RQ02	During information sharing, A USER either Individual Supplier or Demanders
RQ03	Individual Supplier Can Conditionally Read Their information
RQ04	Organisational Supplier Can Write Individual Supplier Information
RQ05	Demanders Can Read Only Individual Supplier Information
RQ06	Demanders Can NOT interact with Organisational Supplier
RQ07	Each interaction, when A USER requests information, becomes Demander, and whoever has been asked from becomes Individual Supplier.

TABLE 8.2: Modelling Requirements for Trust

No	Description
RQ08	The Demander must present Demander_INFO to be able to <u>Request</u> Ind_Supplier_INFO
RQ09	The Ind_Supplier Must be able check Demander_INFO to <u>Provide</u> Ind_Supplier_INFO
RQ10	When both profiles are present Demander and Ind_Supplier can exchange information

8.2 Overview of Formal Methods and Event B

Formal modelling and verification contribute to a better comprehension of the specification and design and greater accuracy than informal or semi-formal approaches. The choice of formal methods is made to overcome the problem of lack of precision. As well as supporting accurate descriptions, testing approaches help in the detection and removal of contradictions in formal modelling languages and support the discovery and elimination of inconsistencies. It is primarily about strengthening the methods used to engineer software-based applications throughout the device creation stage, specification and configuration. Systems errors are detected and rectified as quickly as possible at an early stage. It has been known from the earliest days of software engineering that the later the error is found in development, the greater the cost of correcting any specification or design flaw (Akeel et al., 2016; Alotaibi, Hoang, & Butler, 2023; Boiten & Abrial, 2012; Butler, 2013).

Event-B is an example of a formal method developed from the B-Method (Akeel et al., 2016; Boiten & Abrial, 2012; Butler, 2013). The modelling technique is intended for the study of computer systems at an early stage. It offers a rich modelling language that enables accurate representations of expected machine behaviour (models) to be written in an abstract manner, based on set theory. It offers a mathematical definition of consistency, along with methods to spot anomalies or check consistency within a model. Through abstracting and modelling system behaviour at the specification stage, earlier in the implementation cycle than system testing, it is possible to detect and address requirement ambiguities and inconsistencies (Butler, 2017; Fathabadi et al., 2023).

A major objective of software engineering is to encourage developers to build systems that operate in a reliable matter, despite their complexity, and to work reliably. The use of formal methods, which are mathematically based languages, procedures and instruments for defining and checking certain processes, is one way to accomplish this purpose. This would not ensure the consistency of a truth claim; nonetheless, through exposing contradictions, ambiguities and incompleteness that would otherwise go undetected, they may dramatically improve our perception of a method (Clarke & Wing, 1996; Li et al., 2023).

Event-B is a formal methodology for designing and modelling software systems, particularly those with crucial safety properties. It employs mathematical proofs to ensure that models align with their specifications, making it ideal for safety-critical systems. In Event-B, models are built using elements called machines and contexts. Contexts represent the static components of a model, comprising elements like carrier sets (analogous to types), constants, and axioms. Axioms are the inherent properties of carrier sets and constants that are always true. Contexts can be expanded by incorporating additional carrier sets, constants, and axioms. An example of this is seen in the context of a basic system with two states (Morris Wright, Hoang, Snook, & Butler, 2023).

Event-B model consists of two main components: **CONTEXT** (C) and **MACHINE** (M); The **CONTEXT** consist of the static part of the model which defines **SETS**, **CONSTANTS** and **AXIOMS**. The **MACHINE** consist of the dynamic which is the changeable part of the model that include: **VARIABLES**, **INVARIANTS**, **EVENTS** and The **VARIABLES**.

8.3 Model Assumptions

This model is an abstract only on assuring trust and accuracy. The assumption this is a part of a larger system, and the modelling is only for trust and accuracy. Trust can happen when the information is written by an official entity, and assurance happen with information exchange; which will be modelled here. The assumption on this model are:

1. **Assumption 1:** The actual data are already created by its prospective data creator, such as (not limited to); identity data, educational qualifications data, employment history data, training certificated date, among other data.
2. **Assumption 2:** There is an identity management system called "Nafath", the assumption that all users and user type are created.
3. **Assumption 3:** There are security practices for allowing access on the date, The security procedures are provided by NIC.
4. **Assumption 4:** There are different types of users, such provided for each organisation or institute, they are provided by "Nafath".
5. **Assumption 5:** There are two types of Suppliers, either the normal user who can read it only, or the Information creator who has an additional write privileges.
6. **Assumption 6:** Each data supplier has one Information. That means no data redundancy.
7. **Assumption 7:** The demander can read many information.
8. **Assumption 8:** The first step a supplier must be created and write information related to them.
9. **Assumption 9:** A supplier becomes a demander when request access, but only after being created and supplied information.
10. **Assumption 10:** At one transaction, there can not be two Supplier or two Demander. Each request must be between a demander and a supplier.

8.4 Modelling Requirements for Trust and Accuracy

A model fully encompasses the mathematical progression of a Discrete Transition System comprising two types of components: machines and contexts. The dynamic aspects of a model, such as variables, invariants, theorems, variants, and events, are housed within machines. On the other hand, contexts hold the static facets of a model, including carrier sets, constants, axioms, and theorems. The components found in machines or contexts are called modelling elements (Abrial, 2010). The requirements are shown in table 8.1.

8.4.1 Context: C0

A context comprises multiple clauses, each indicated by a unique keyword (Abrial, 2010).

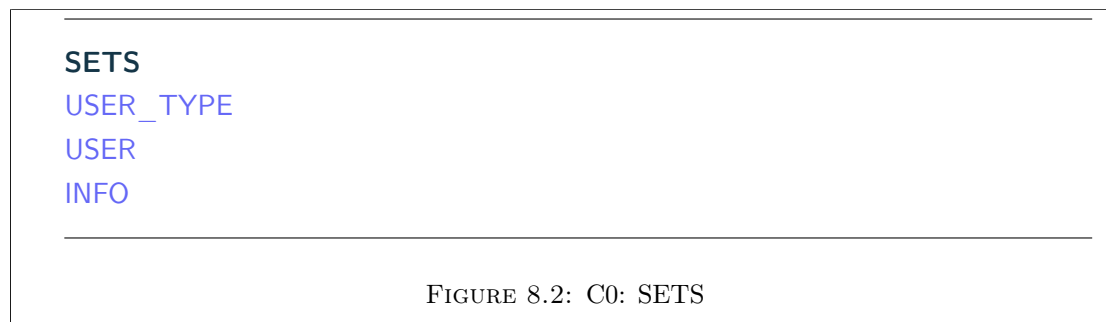
8.4.1.1 SETS

The "Sets" clause enumerates the newly introduced carrier sets delineating mutually exclusive types. The only implicit attribute we can presume about these carrier sets is their non-emptiness (Abrial, 2010).

Within Context C0, there are three distinct and unique Carrier Sets:

- **USER**: This set represents all users within the system, irrespective of their assigned privileges or access controls.
- **USER_TYPE** This set is designed to categorise users according to their access capabilities, such as read, write, or conditional read.
- **INFO** This set encapsulates all the information within the system, regardless of its nature or content.

Shown in Figure 8.2, it represents the **SETS** utilised.



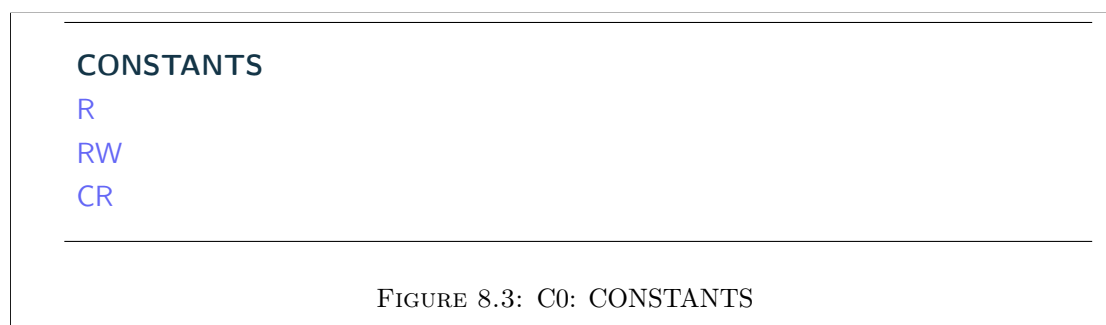
8.4.1.2 Constants

The "Constants" clause records the range of constants established within this context. These constant identifiers should all be unique and different from the identifiers of constants and sets found in the extended contexts (Abrial, 2010).

Within Context C0, there are three unique Constants:

- **R**: Represents read-only privileges; it represents normal users.
- **RW**: Signifies both read and write capabilities; it represents ministries or entities authorised to create records or attest to information.
- **CR**: Denotes conditional read, which applies under certain circumstances; it is precisely for the entity the information is regarding.

Shown in Figure 8.3, it represents the **Constants** utilised.



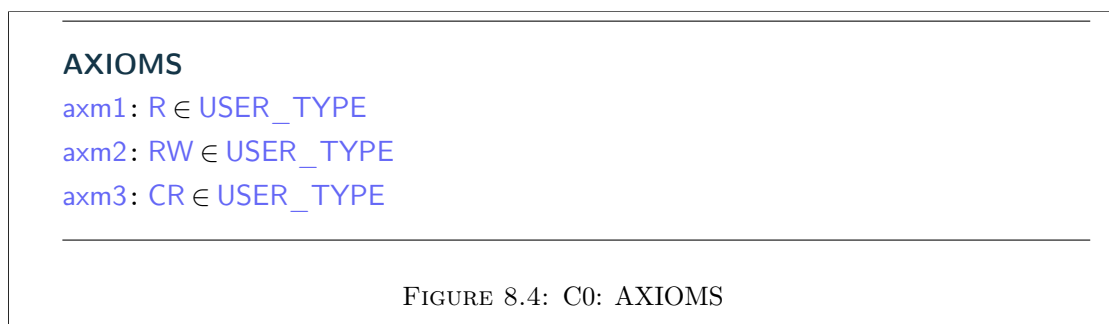
8.4.1.3 Axioms

The "Axioms" clause catalogues the array of predicates that the constants follow. These predicates will be integrated as assumptions in all proof obligations (Abrial, 2010).

Within Context C0, there are three unique Axioms, in which R, RW and CR each is a set membership from UserType SETS:

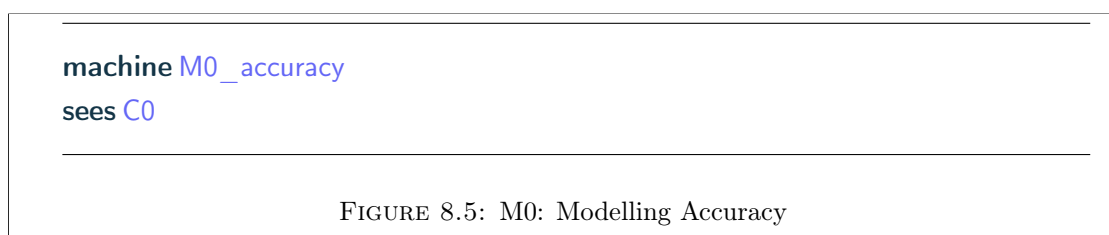
- **axm1:** "R" is a member of USER_TYPE, which means there are users who have "Read" privileges.
- **axm2:** "RW" is a member of USER_TYPE, which mean that there are users who have both "Read and Write" privileges.
- **axm3:** "CR" is a member of USER_TYPE, which mean that there are users who have "Conditional Read" privileges.

Each user is assigned one of the mentioned three USER_TYPEs based on their level of access. The following Figure 8.4 represent the **Axioms** utilised.



8.4.2 Machine: M0: Modelling Accuracy

M0 is System Abstraction for Modelling Accuracy. Accuracy According to the requirements based on the Experts, accuracy is the notion that the information is written only by an authorised organisation. This abstraction level modelling assures accuracy that the information comes from a particular entity that can write information. Figure 8.5 shows the machine and the context. The requirements are shown in table 8.2.



8.4.2.1 Variables

Here explaining the variables:

- **Demanders:** This term signifies those entities or individuals who request information from another party, often known as a supplier. The demander might be an entity encompassing a profile or seeking to fill a vacancy.
- **Org_suppliers:** This term refers to organisations or institutions responsible for producing information. These entities are authorised to generate information to build candidates' or vacancy's' profiles.
- **Ind_suppliers:** This term refers to individual suppliers, contrasting with organisational ones. The information supplied pertains to a user, who, in this context, acts as an individual supplier.
- **Access_Level:** This term signifies the level of control a particular entity has over the ability to read, write, or conditionally read the data or information.
- **Org_Supplier_info:** This is the specific information authored by the organisational supplier. An entity with the appropriate authorisation generates information.
- **Ind_Supplier_info:** This term applies to the information gathered regarding individual suppliers. Essentially, it covers any data provided about these individual suppliers.
- **Demander_Info:** This term refers to the data related to the demander; it encapsulates any information provided about the demanders.

The following 8.6 represent the **Variables** utilised.

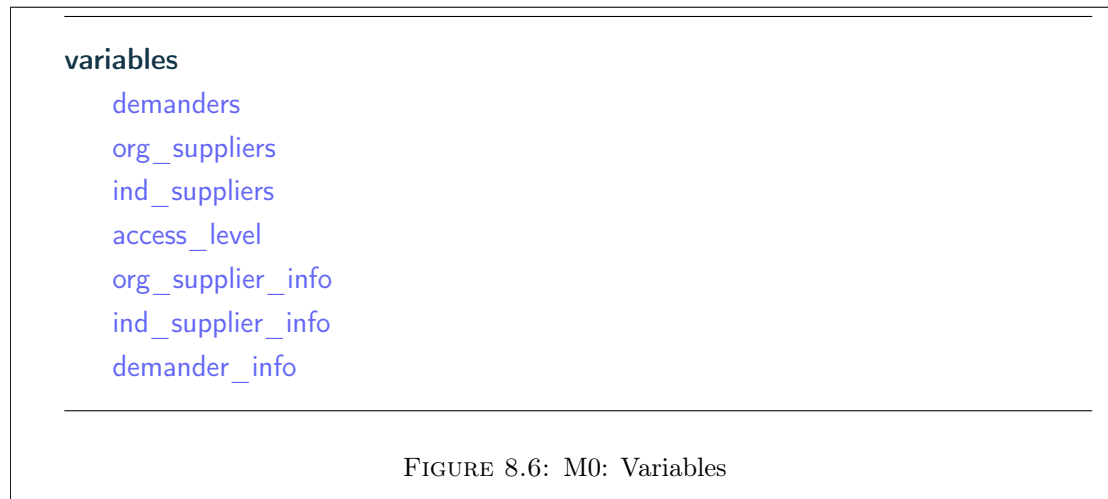


FIGURE 8.6: M0: Variables

8.4.2.2 Invariants

Here explaining the invariants.

- **Inv01:** This indicates that the set of demanders is a subset of the set of users. It implies all demanders are also users, but not all users are demanders.
- **Inv02:** This indicates that the set all organisational suppliers (org_suppliers) are a subset of the set of users. It implies all organisational suppliers are also users, but not all users are demanders

- **Inv03:** This indicates that the set all individual suppliers (*ind_suppliers*) are a subset of the set of users. It implies all individual suppliers are also users, but not all users are demanders
- **Inv04:** This indicates that the *access_level* is a function that maps from the UNION SETS of "Demanders", "Organisational Suppliers", and "Individual Suppliers" to the "USER_TYPE". This to *clarify* that every entity (demander or organisational and individual supplier) has an associated USER_TYPE that is defined by their *Access level*.
- **Inv05:** This indicates that the access levels for all *Demanders* are either "Read" (R) or "Conditional Read" (CR).
- **Inv06:** This indicates that the access levels for all *Organisational Suppliers* are "Read and Write" (RW).
- **Inv07:** This indicates that the access levels for all *Individual Suppliers* are either "Conditional Read" (CR) or "Read" (R).
- **Inv08:** This means that the *org_supplier_info* is a partial function from the set of INFO to the set of *org_suppliers*. It implies, not all but some pieces of information are associated with *org_suppliers*.
- **Inv09:** This means that the *ind_supplier_info* is a total function between the set of individual suppliers and the set of INFO. Every piece of individual supplier information is associated with one and only one individual supplier and vice versa.
- **Inv10:** This means that the *demander_info* is a total function between the set of demanders and the set of INFO. Every piece of demander information is associated with one and only one demander and vice versa.
- **Inv11:** This means that the SET of organisational suppliers does not intersect with the union set of individual suppliers and demanders. This to clarify there is no entity that is both an (organisational supplier and an individual supplier) or (organisational supplier and a demander). This to strength the meaning of an organisational suppliers only write information and can not be something else.

Figure shows all Invariants 8.7

invariants

inv1: $\text{demanders} \subseteq \text{USER}$

inv2: $\text{org_suppliers} \subseteq \text{USER}$

inv3: $\text{ind_suppliers} \subseteq \text{USER}$

inv4: $\text{access_level} \in (\text{demanders} \cup \text{org_suppliers} \cup \text{ind_suppliers}) \leftrightarrow \text{USER_TYPE}$

inv5: $\text{access_level}[\text{demanders}] \subseteq \{\text{R}, \text{CR}\} \wedge \text{demanders} \subseteq \text{dom}(\text{access_level})$

inv6: $\text{access_level}[\text{org_suppliers}] \subseteq \{\text{RW}\} \wedge \text{org_suppliers} \subseteq \text{dom}(\text{access_level})$

inv7: $\text{access_level}[\text{ind_suppliers}] \subseteq \{\text{CR}, \text{R}\} \wedge \text{ind_suppliers} \subseteq \text{dom}(\text{access_level})$

inv8: $\text{org_supplier_info} \in \text{INFO} \leftrightarrow \text{org_suppliers}$

inv9: $\text{ind_supplier_info} \in \text{INFO} \leftrightarrow \text{ind_suppliers}$

inv10: $\text{demander_info} \in \text{INFO} \leftrightarrow \text{demanders}$

inv11: $\text{org_suppliers} \cap (\text{ind_suppliers} \cup \text{demanders}) = \emptyset$

FIGURE 8.7: M0: Invariants

8.4.2.3 Events

There are seven events to assure accuracy, and they are shown in Figure 8.8

events

event INITIALISATION

event write

event collect

event access

event addDemander

event addOrgSupplier

event addIndSupplier

FIGURE 8.8: M0: Events

event INITIALISATION When defining variables, it must have an initial value. This initialisation gives a valid value to all variables in the Machine. It is allowed to be given and valued. However, since this case is based on the assumption. Figure 8.9 shows the initial empty values.

```

event INITIALISATION
then
  @act1: demanders := ∅
  @act2: org_suppliers := ∅
  @act3: ind_suppliers := ∅
  @act4: access_level := ∅
  @act5: org_supplier_info := ∅
  @act6: ind_supplier_info := ∅
  @act7: demander_info := ∅
end

```

FIGURE 8.9: M0: event INITIALISATION

event Write

- **grd1:** This guard states that 'os' must be a member of the set of Organisational Suppliers (org_suppliers).
- **grd2:** This guard states that 'info' must be a member of the set of information (INFO).
- **grd3:** This guard states that 'info' should not already be in the domain of the function 'org_supplier_info'. In other words, 'info' should not be already mapped to any *Organisational Supplier* in the org_supplier_info mapping.

THEN

- **act1:** If the above conditions (Guards) are satisfied, the action is; add a new mapping from 'info' to 'os' into the org_supplier_info mapping.

The guards here has actual guard function to stop something from occurring which checks if the data is already available, if not, is links sets. To visualise this, 'org_suppliers' is a group of organisations that supply information and 'INFO' is a set of information pieces, and 'org_supplier_info' is a record of which organisation supplied which information. The Assumption is, having a new piece of information ('info') from an organisational supplier ('os'), and this 'info' isn't already linked to a supplier in any record; only In that case, it can add this new ('info', 'os') connection into 'org_supplier_info'. This means that 'os' is now recorded as the supplier of 'info'. It's adding a new entry in database that keeps track of which supplier supplied what information. Figure 8.10 shows the Formal Modelling.

```

event write
any
  os
  info
where
  @grd1: os ∈ org_suppliers
  @grd2: info ∈ INFO
  @grd3: info ∉ dom(org_supplier_info)
then
  @act1: org_supplier_info := org_supplier_info ∪ {info ↦ os}
end

```

FIGURE 8.10: M0: event `write`

event Collect

- **grd1:** This guard states that 'is' must be an element of the set of individual suppliers (ind_suppliers).
- **grd2:** This guard states that 'info' must be within the domain of the function 'org_supplier_info'. In other words, 'info' should already be associated with at least one organisational supplier in the org_supplier_info mapping.
- **grd3:** This guard states that 'info' should not already be associated with the individual supplier 'is' in the ind_supplier_info mapping.

THEN

- **act1:** If the above conditions (Guards) are satisfied, the action is; add a new mapping from 'is' (an individual supplier) to 'info' into the ind_supplier_info mapping.

The guards here has actual guard function to stop something from occurring which checks if the data is already available, if not, is links sets. To visualise this, 'ind_suppliers' is a group of individual suppliers; 'org_supplier_info' is a record of which organisation supplied which information; 'ind_supplier_info' is a record of which individual supplier is associated with which piece of information. If the new piece of information ('info') that is already associated with an organisational supplier but is not associated with an individual supplier ('is'), then it can add this new ('is', 'info') association into 'ind_supplier_info'. This means that 'is' is now recorded as being associated with 'info'. It's like updating a database that tracks which individual supplier is associated with which piece of information based on the condition that the information is already linked to an organisational supplier. Figure 8.11 shows the Formal Modelling.

```

event collect
any
  is
  info
where
  @grd1: is ∈ ind_suppliers
  @grd2: info ∈ dom(org_supplier_info)
  @grd3: info ∉ ind_supplier_info[is]
then
  @act1: ind_supplier_info := ind_supplier_info ∪ {is ↦ info}
end

```

FIGURE 8.11: M0: event collect

event Access

- **grd1:** This guard states that 'd' must be an element of the set of demanders.
- **grd2:** This guard states that 'info' must be within the range of the function 'ind_supplier_info'. In other words, 'info' must already be connected with an individual supplier in the ind_supplier_info mapping.
- **grd3:** This guard states that 'info' should not already be in the range of the function 'demander_info'. In other words, 'info' should not already be connected with any demander in the demander_info mapping.

THEN

- **act1:** If the above conditions (Guards) are satisfied, the action is; add a new connection from 'd' (a demander) to 'info' into the demander_info mapping.

The guards here has actual guard function to stop something from occurring which checks if the data is already collected, if not, is links sets. To visualise this; 'demanders' is a group of entities requesting information. The 'ind_supplier_info' serves as a record of what information is linked with which individual supplier, and 'demander_info' keeps track of which demander is linked with what information. If there is a piece of information ('info') that is already connected with an individual supplier but is not yet linked with any demander (not accessed), and there's a demander ('d') who hasn't received this 'info' yet, then it can add this new ('d', 'info') association into 'demander_info' (to access the information). This also means; updating a database to record which demander is linked with which piece of information, given the condition that the information is already connected to an individual supplier but not yet linked to a demander. Figure 8.12 shows the Formal Modelling.

```

event access
any
  d
  info
where
  @grd1: d ∈ demanders
  @grd2: info ∈ ran(ind_supplier_info)
  @grd3: info ∉ ran(demander_info)
then
  @act1: demander_info := demander_info ∪ {d ↦ info}
end

```

FIGURE 8.12: M0: event access

event AddDemander

- **grd1**: This guard states that 'd' must be an entity in the set of all users.
- **grd2**: This guard states that 'd' should not be part of the set of demanders or the set of organisational suppliers.

THEN

- **act1**: If the above conditions (Guards) are satisfied, the first action is; adds 'd' to the set of demanders.
- **act2**: Also, if the above conditions (Guards) are satisfied, the second action is; adds a new association from 'd' to 'R' (read access) in the 'access_level' mapping.

The guards here has actual guard function to stop something from occurring which checks if the Demander is already exists, if not, is links sets. To visualise this; 'USER' is a group of entities, and 'demanders' and 'org_suppliers' as two subsets of this group. Each entity in 'USER' may have a certain level of access to some resources, defined by the 'access_level' mapping. If an entity 'd' that is a part of the overall user group but not yet classified as a demander or an organisational supplier, it can then add 'd' into the 'demanders' set. at the same time, 'd' gets a read access level (indicated by 'R'). This means, it is adding a new user to a list of users who can request information and defining the user's access rights in a database that keeps track of who can read certain resources. Figure 8.13 shows the Formal Modelling.

```

event addDemander
any
  d
where
  @grd1: d ∈ USER
  @grd2: d ∉ demanders ∪ org_suppliers
then
  @act1: demanders := demanders ∪ {d}
  @act2: access_level := access_level ∪ {d ↦ R}
end

```

FIGURE 8.13: M0: event `addDemander`**event AddSOrgSupplier**

- **grd1:** This guard states that 's' must be an entity within the set of all users.
 - **grd2:** This guard states that 's' should not already be a part of the set of organisational suppliers, individual suppliers, or demanders.
- THEN**
- **act1:** If the above conditions (Guards) are satisfied, the first action is; adds 's' into the set of organisational suppliers.
 - **act2:** Also, if the above conditions (Guards) are satisfied, the second action is; assigns the access level of 's' as 'RW' (Read and Write).

The guards here has actual guard function to stop something from occurring which checks if the Demander is already exists, if not, is links sets. To visualise this; 'USER' as a group of entities, with 'org_suppliers', 'ind_suppliers', and 'demanders' as three subsets of this pool. Each entity in 'USER' has a certain level of access to some resources, defined by the 'access_level' function. If an entity 's' that is part of the user pool but not yet classified as an organisational supplier, an individual supplier, or a demander, it can add 's' into the 'org_suppliers' set. Simultaneously, this sets the access level of 's' as 'RW' (Read and Write) in the system. Essentially, it's like adding a new user to a group of organisations that supply information and defining the user's access rights in a system that monitors write certain resources. Figure 8.14

```

event addOrgSupplier
any
  s
where
  @grd1: s ∈ USER
  @grd2: s ∉ org_suppliers ∪ ind_suppliers ∪ demanders
then
  @act1: org_suppliers := org_suppliers ∪ {s}
  @act2: access_level(s) := RW
end

```

FIGURE 8.14: M0: event addOrgSupplier

event AddIndSupplier

- **grd1:** This guard states that 'i' must be an entity within the set of all users.
- **grd2:** This guard states that 'i' should not already be a part of the set of individual suppliers or the set of organisational suppliers.

THEN

- **act1:** If the above conditions (Guards) are satisfied, the first action is; includes 'i' into the set of individual suppliers.
- **act2:** Also, if the above conditions (Guards) are satisfied, the second action is; a new association from 'i' to 'CR' (Conditional Read access) in the 'access_level' mapping.

The guards here has actual guard function to stop something from occurring which checks if the Individual Supplier is already exists, if not, is links sets. To visualise this; 'USER' is a group of entities with 'ind_suppliers' and 'org_suppliers' as two subsets of this group. Each entity in 'USER' has a certain level of access to some resources, defined by the 'access_level' mapping. If an entity 'i' that is part of the user group but not yet classified as an individual supplier or an organisational supplier, it can add 'i' into the 'ind_suppliers' set. Simultaneously, it assign 'i' a Conditional Read access level (indicated by 'CR') in the system. Essentially, it's like adding a new user to a group of individuals who supply information and defining the user's access rights in a system that monitors who can conditional read access to certain resources. Figure 8.15 Shows the Formal Modelling.

```

event addIndSupplier
any
i
where
@grd1: i ∈ USER
@grd2: i ∉ ind_suppliers ∪ org_suppliers
then
@act1: ind_suppliers := ind_suppliers ∪ {i}
@act2: access_level := access_level ∪ {i ↦ CR}
end

```

FIGURE 8.15: M0: event `addIndSupplier`

8.4.3 Machine: M1: Modelling Trust

M1 is the System Refinement. The new Variable is request. This to assure accuracy is correct. The idea of pairing information with events is introduced here. So, the supplier provide information. Then the supplier becomes the demander. When the demander is requesting, there supplier_info become demander_info. Which means now, the demander had a profile assigned to them. This is a refinement for the M0-Accuracy as shown in figure 8.16 This section to address the research problem which is:

The First Key problem Identified:

Experts advanced the concept of “Trust in Information Exchange” from the perspective of a reciprocal transaction.

```

machine M1_trust
refines M0_accuracy
sees C0

```

FIGURE 8.16: M1: Refinement

8.4.3.1 M1: Variables

Here are the refined variables explained.

- **Request:** This term refers to initiating an action aimed at facilitating the exchange of information.
- **Demander_Exchange_Info:** This refers to the occurrence when a demander initiates a request to exchange information.

variables

demanders
 org_suppliers
 ind_suppliers
 access_level
 org_supplier_info
 ind_supplier_info
 demander_info
 request
 demander_ex_info

FIGURE 8.17: M1: Variables

Figure 8.17 shows all the variables, new and the refined from M0.

8.4.3.2 M1: Invariants

Here are the refined invariants explained.

- **inv12:** This invariant means all demanders are a subset of individual suppliers. This also means that every entity classified as a demander is also classified as an individual supplier.
- **inv13:** This invariant means 'request' exists between demanders and individual suppliers.
- **inv14:** This invariant means 'demander_ex_info' is an element connecting demanders and the information (INFO). Also, it means that demander_ex_info is a kind of information that demanders require.

Figure 8.18 shows the new invariants.

invariants

@inv12: $\text{demanders} \subseteq \text{ind_suppliers}$
 @inv13: $\text{request} \in \text{demanders} \leftrightarrow \text{ind_suppliers}$
 @inv14: $\text{demander_ex_info} \in \text{demanders} \leftrightarrow \text{INFO}$

FIGURE 8.18: M1: Invariants

8.4.3.3 M1: Events

Here it explains the events.

event INITIALISATION Same as M0, but the new (two) variables assigned empty values as shown in figure 8.19

```

events
  event INITIALISATION extends INITIALISATION
  then
    @act8: request := ∅
    @act9: demander_ex_info := ∅
  end

```

FIGURE 8.19: M1: event INITIALISATION

event Write Same as M0 as shown in figure 8.20.

```

event write extends write
end

```

FIGURE 8.20: M1: event Write

event Collect Same as M0 as shown in figure 8.21.

```

event collect extends collect
end

```

FIGURE 8.21: M1: event Collect

event Access This is extended from M0 and there are additional guards as shown in figure 8.22.

- **grd4**: The guard states that 'is', must be part of the set of individual suppliers.
 - **grd5**: The guard states that a specific request must exist from the demander 'd' to the individual supplier 'is'.
 - **grd6**: The guard states that the piece of information, 'info', must be within the set of information related to the individual supplier 'is'.
- THEN**
- **act1**: This action updates the existing set of demander_ex_info by adding a pair. This pair implies that the demander 'd' is now connected with the piece of information 'info'.

The system acknowledges that 'd' now has access to 'info'.

```

event access extends access
any
  is
where
  @grd4: is ∈ ind_suppliers
  @grd5: (d ↦ is) ∈ request
  @grd6: info ∈ ind_supplier_info[is]
then
  @act2: demander_ex_info := demander_ex_info ∪ {d ↦ info}
end

```

FIGURE 8.22: M1: event Access

event AddDemander

- **grd1:** The guard states that 'd' represent a user, must be a member of the individual suppliers set.
- **grd2:** The guard states that 'd' must not be a member of either the demanders set or the organisational suppliers set

THEN

- **act1:** This action adds 'd' to the demanders set.
- **act2:** This action modifies the access level of 'd' by associating 'd' with a Read (R) privilege in the 'access-level' set.

This event represents the transition of an individual supplier 'd' to become a demander with read-only privileges, assuming the guards are satisfied. This Figure 8.23.

```

event addDemander
refines addDemander
any
  d
where
  @grd1: d ∈ ind_suppliers
  @grd2: d ∉ demanders ∪ org_suppliers
then
  @act1: demanders := demanders ∪ {d}
  @act2: access_level := access_level ∪ {d ↦ R}
end

```

FIGURE 8.23: M1: event addDemander

event x

```
event addOrgSupplier extends addOrgSupplier
end
```

FIGURE 8.24: M1: event addOrgSupplier extends addOrgSupplier

event x

```
event addIndSupplier extends addIndSupplier
end
```

FIGURE 8.25: M1: event addIndSupplier extends addIndSupplier

event Request

- **grd1:** The guard states that 'd', which could represent a user, should be part of the demanders set.
- **grd2:** The guard states that 'is' must be an element of the individual suppliers set.
- **grd3:** The guard states that there should be no existing request from 'd' to 'is'.
- **grd4:** The guard states that 'd' and 'is' should not be the same entity

THEN

- **act1:** This action adds a request from 'd' to 'is' to the request set. This event essentially represents the formation of a new request from a demander 'd' to an individual supplier 'is'.

```

event request
any
  d
  is
where
  @grd1: d ∈ demanders
  @grd2: is ∈ ind_suppliers
  @grd3: (d ↦ is) ∉ request
  @grd4: d ≠ is
then
  @act1: request := request ∪ {d ↦ is}
end

```

FIGURE 8.26: M1: event request

event exchange The guard states that

The guard states

This guard states that 'info' should not be present in the exchange information set specific to the demander 'is'.

Once all these six conditions are met, the following action takes place:

This action add 'info' to the set of exchange information specific to the demander 'is'. This event signifies addition of new information to a demander's exchange information set.

- **grd1:** The guard states that 'd' must be a part of the demanders set.
- **grd2:** The guard states that 'is' needs to be in the individual suppliers set.
- **grd3:** The guard states that that there is an existing request from 'd' to 'is'
- **grd4:** The guard states that the information 'info' should be a part of the information set specific to the demander 'd'.
- **grd5:** The guard states that there is a required condition for 'is' to be a part of the demanders set.
- **grd6:** The guard states that 'info' should not be present in the exchange information set specific to the demander 'is'.

THEN

- **act1:** This action add 'info' to the set of exchange information specific to the demander 'is'. This event signifies addition of new information to a demander's exchange information set.

```

event exchange
any
  d
  is
  info
where
  @grd1: d ∈ demanders
  @grd2: is ∈ ind_suppliers
  @grd3: (d ↦ is) ∈ request
  @grd4: info ∈ demander_info[{d}]
  @grd5: is ∈ demanders
  @grd6: info ∉ demander_ex_info[{is}]
then
  @act1: demander_ex_info := demander_ex_info ∪ {is ↦ info}
end

```

FIGURE 8.27: M1: event exchange

8.5 Chapter Conclusions

The chapter primarily explores the versatility and effectiveness of the Event-B modelling framework, underscoring its capabilities in modelling intricate constructs such as trust and accuracy in information exchange systems. These constructs manifest in various ways, from superficial reciprocal trust relationships ("you trust me, I trust you") to ensuring the authenticity of information through the designation of specific users as its creators. Utilising Event-B enabled the delineation of complex relationships between different system entities and the access levels of individual and organisational users. The precision of formal modelling provided clarity and deeper insight into the system's components and interactions.

Element Name	Total	Auto	Manual
FIST_System	40	38	2
C0	0	0	0
M0_accuracy	29	27	2
M1_trust	11	11	0

FIGURE 8.28: Statistics to Show Proof Obligation

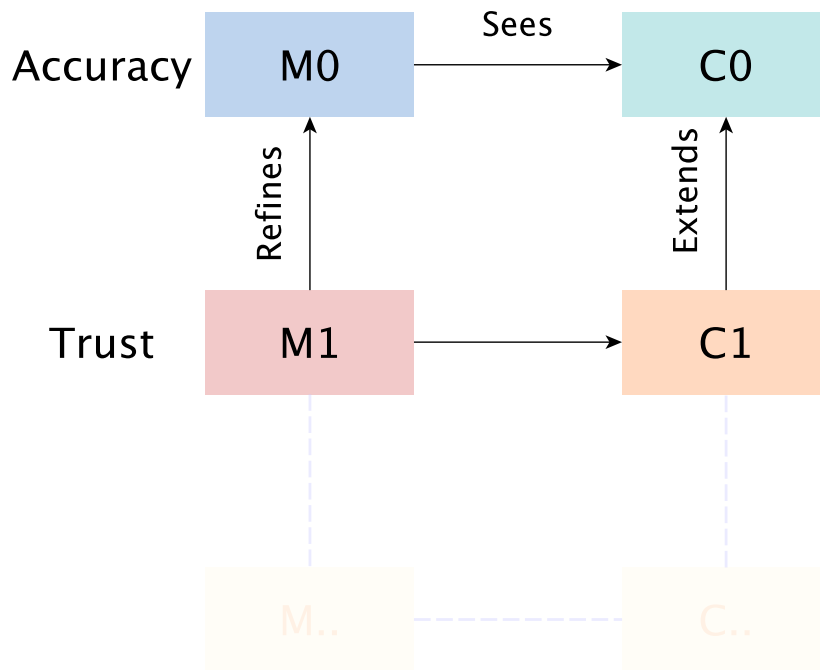


FIGURE 8.29: How the Model was in Event-B

Although the aim is to develop a comprehensive model encompassing all system requirements, this chapter focused on sections of experts who identified critical tasks. By focusing on these critical tasks, it highlights the system's most critical tasks, addressing the core functionality and ensuring seamless operation while detecting errors at early stage. The development and refinement of the complete system model will continue, incorporating all requirements in a way that faithfully reflects the system's real-world dynamics. Event-B will remain necessary to this process as a tool to untangle the complex web of relationships and operations in the system and present them in an accessible and manageable format. In conclusion, this chapter showcased how Event-B could illuminate vital system tasks, highlighting its potential in modelling trust and accuracy in complex information systems. As we continue to develop the entire system model, the insights gleaned from this chapter will undoubtedly play a critical role.

This exploration of the Event-B framework in this chapter serves as a testament to the method's robustness in handling complex system dynamics as shown in figure 8.28, especially in the realms of trust and accuracy in information exchange. The intricate modelling of trust mechanisms and data authenticity, facilitated by Event-B as seen in figure 8.29, sheds light on the nuanced interplay between various system components and user roles. Moving forward, the intention is to expand this model to encompass the entirety of system requirements, capturing the essence of the system in its full complexity. The journey ahead involves integrating all identified requirements into a cohesive model that mirrors the system's real-world functionality. The insights gained from this chapter, particularly in modelling the most critical tasks of the system, are invaluable stepping

stones in this ongoing journey. As the modelling process progresses, the role of Event-B in unravelling and articulating the complex fabric of the system will continue to be pivotal.

Chapter 9

Conclusions

The essence of this research is deeply rooted in the social and cultural context of Saudi Arabia, addressing the critical need for enhanced accuracy in information provided by job-seekers and the subsequent validation by HR departments. These challenges are amplified by the Saudi government's extensive support for its citizens, both domestically and internationally, highlighting the necessity for a robust, interconnected system that effectively bridges the gap between educational and employment sectors. The innovative solution proposed in this thesis redefines the paradigm of record-sharing, enabling more efficient and reliable system interactions. This research extends beyond social implications to encompass crucial technical elements essential for the seamless sharing and distribution of information. Early chapters laid the groundwork, identifying key factors that guided the framework's development. These factors, categorised into three distinct groups, collectively shaped the framework, each adding a unique dimension to its structure. The framework's development was heavily influenced by insights from a diverse group of 15 experts. Their perspectives illuminated underlying factors, affirmed dimensions, and sparked interest in a prototype. Their collaborative contributions were instrumental in guiding a comprehensive literature review, leading to the strategic decision to reposition blockchain and hyper-ledger technologies as ancillary elements rather than core components of the framework. Navigating language barriers and analysing over 16 hours of expert interviews yielded invaluable insights. A thorough examination led to a revised framework more attuned to real-world requirements and expert opinions. A significant pivot occurred when the focus shifted from blockchain technology to emphasising data accuracy. This pivotal moment has redefined the research's trajectory, transitioning from quantitative methods to formal methods modelling. This approach extended the research into uncharted territories, broadening its scope and depth. The application of the Delphi method brought together a collective of seasoned experts, harmonising their diverse experiences to converge on critical issues and user requirements. This consensus-building process pinpointed two main challenges: data accuracy and availability, which

became focal points of the study. The culmination of this research journey acknowledges data availability and authorisation as paramount concerns, meriting dedicated exploration. Implementing formal modelling clarified these concepts, enhancing engagement and deepening the interaction with expert contributors. This conclusion marks a milestone in exploring the complex interplay between social and technical aspects of Saudi Arabia's job market. Figure 9.1 encapsulates the entire trajectory of the FIST framework, illustrating its evolution from an initial concept to a fully functional system. Additionally, Figure 6.1 intricately maps the Delphi method's stages and rounds, showcasing the specific outcomes identified at each phase. As we look towards the future, this research paves the way for further exploration and application in similar contexts. The insights and methodologies developed here could serve as a blueprint for other nations or sectors seeking to create interconnected, trustworthy systems. The journey of discovery collaboration and innovation highlighted in this thesis resolves specific challenges

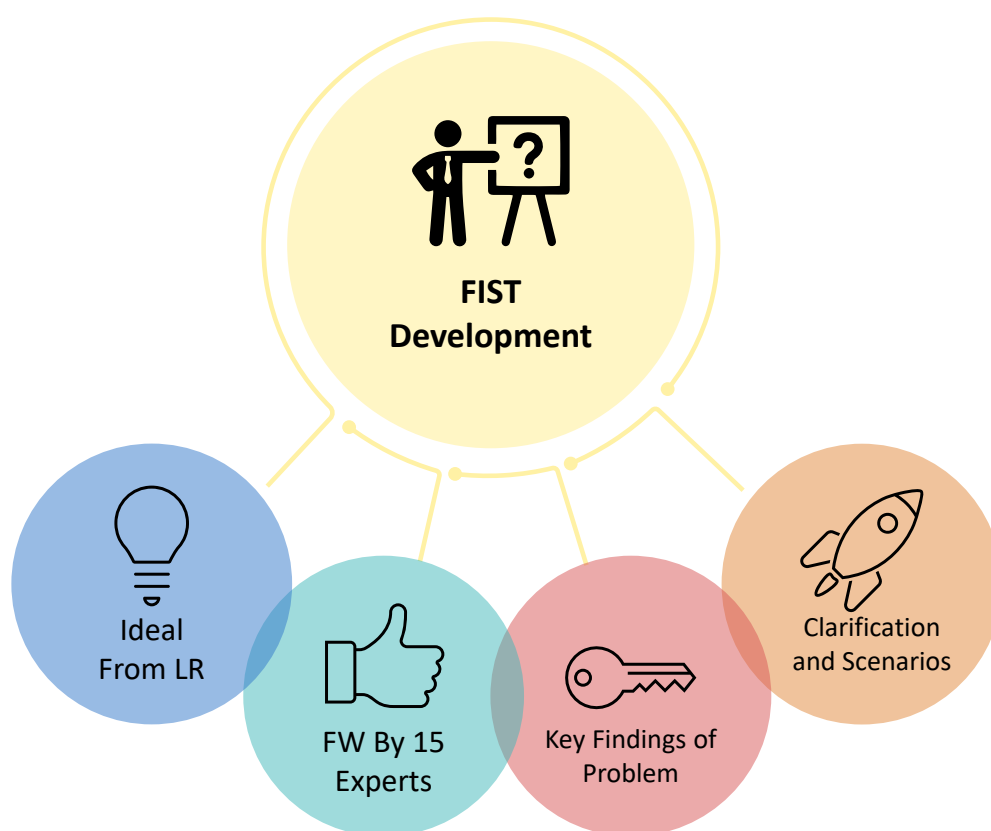


FIGURE 9.1: FIST Overall

9.1 Research Opportunities

Throughout this thesis, Formal Modelling and Formal Methods have conclusively demonstrated their strength as invaluable tools for elucidating and solidifying requirements. However, their application was primarily confined to two critical functions. The comprehensive modelling of the entire suite of functions constitutes an integral component of future work.

9.2 List of contributions

Contribution 1 : Development and Confirmation of the FIST Framework.

Contribution 2 : Discover Trust-Related Challenges in Information Sharing Systems.

Contribution 3 : Establishing Trust Requirements for Information Sharing Systems.

Contribution 4 : Constructing a Template for Modelling Trust in Information-Sharing Systems.

9.3 Research Assumptions (Scope)

This research has explored the Saudi context and the proposed trusted platform, both of which influence education and employment departments on the validation of shared or distributed records. The study sample comprised organisations related to education and employment in Saudi Arabia, excluding special education, gifted education, adult and evening education, curriculum development and special employment. The platform requires internet connectivity and internet access. Finally, this research is about records-sharing on a distributed infrastructure while integrating verified data, not about records-keeping or information analysis.

9.3.1 No specific Technology

This framework is technology agnostic, it is unbiased to a specific technology or dependant on any certain technology. When sharing is requested between two parties or among more than two, this frame comes into place.

The chapter 3 explains all technologies, this FW was built on factors from different technologies and analyses through experts interviews which lead to the confirmed framework

9.3.2 Information Security

Access controls and information Security is provided by Nafath.

9.3.3 Infrastructure Security

This framework is based on an e government system.

9.3.4 Data

The data is available on the ministries, there is no need to create new data.

9.3.5 Attestation

If the data has no source, it will be validated and verified by a representing entity within a ministry, such as Safeer (Mentioned at 2.1.6.1).

9.4 Refelction

Inspiration and Genesis of the Research: My journey into researching the FIST framework began with a blend of personal interest and a keen awareness of societal needs. Working in the education sector, I frequently observed students' challenges in finding suitable employment. This, coupled with my routine reading of the news, sparked the idea to explore a solution that could bridge the gap between educational qualifications and job market requirements in Saudi Arabia.

Challenges and Overcoming Barriers: One of the most significant hurdles I faced was conducting interviews in Arabic. The language barrier often led to miscommunications and misunderstandings, highlighting the importance of clear and effective communication in research. Additionally, finding willing experts to participate in the study was daunting. This experience has underscored the need for dedicated research support within institutions to facilitate such crucial interactions.

Influence of Experts on Research: The contribution of experts was instrumental in shaping the framework of my study. While the initial desk study provided theoretical insights, the real-world experience and knowledge of these experts infused practical relevance into my research. However, the scarcity of experts willing to participate was a constraint, leading me to advocate for more structured research support systems within academic and professional institutions.

Learning and Skill Development: This research journey has been a profound learning experience. It has sharpened my problem-analysis skills, enhanced my critical thinking abilities, and, most importantly, taught me the intricacies of developing a robust framework. These skills have not only been academic achievements but also valuable life lessons.

Surprises Along the Way: A surprising aspect of my research was the need to employ a variety of methodologies, like the Delphi method and Goal Question Metric (GQM). Often, it was necessary to guide the focus of experts back to the core issues at hand, a challenging yet enlightening aspect of the research process.

Future Application of Research Insights: As an academic, my journey does not end with this thesis. The insights and skills I have acquired are assets I plan to carry forward in my career. I am keen on continuing my research endeavours and imparting the knowledge and methodologies I have learned to others in the academic community.

Personal and Academic Growth: Reflecting on my research journey, it has been a period of immense personal and academic growth. Delving deep into this research has honed my learning and teaching skills, and most importantly, it has been a journey of self-improvement. It has taught me resilience, adaptability, and the value of continuous learning, qualities that I will cherish and continue to develop in my academic and personal life.

9.5 Chapter Conclusions

This research has undergone numerous stages, contributing significantly to its evolution and the resultant knowledge body. This thesis successfully identified and addressed the central problem with the expert analysis panel's validation.

The comprehensive examination and systematic approach have culminated in the development of the FIST Framework, which is now complete. Our focus has been on diagnosing the problem accurately and providing a robust and adaptable solution to this complex issue.

Future research endeavours will potentially further validate and refine the FIST Framework and its formal modelling methodology. As research is an iterative process, continually improving these tools, techniques, and frameworks remains critical.

This research has pushed the boundaries of our understanding of trust in information-sharing systems by creating a bridge between theoretical understandings and practical applications. As such, it is a cornerstone for future investigations in this area.

The journey of this research, from its inception to its conclusion, has been a testimony to the dynamic interplay between theoretical concepts and practical applications. This thesis, through its meticulous research and analysis, has not only addressed a central problem but has also paved the way for innovative solutions in the realm of information sharing and validation.

One of the key outcomes of this research is the establishment of the FIST Framework as a pioneering tool in the field of e-governance. It stands as a testament to the potential of bridging technology and administrative processes, thereby enhancing the efficiency and reliability of information exchange between educational and employment sectors. The framework's adaptability and robustness make it a valuable asset in various scenarios, particularly in addressing the unique challenges of the Saudi Arabian context.

Looking ahead, there is immense potential for this research to be expanded and applied in broader contexts. The methodologies and insights garnered from this study could be adapted and applied in other countries or sectors, exploring new horizons in interconnected, trustworthy systems. Thus, this thesis not only resolves specific challenges within Saudi Arabia but also contributes significantly to the global discourse on information systems and technology.

The reflection on this journey underscores the importance of interdisciplinary collaboration and the need for continuous learning and adaptability in research. The challenges encountered and the learning curve experienced have enriched the research, making it a comprehensive and insightful study. The engagement with experts, overcoming language barriers, and the application of various methodologies have all contributed to the depth and breadth of this thesis.

In conclusion, this research marks a significant contribution to the field of information systems, particularly in the context of trust and accuracy in information exchange. The journey from conceptualisation to realisation of the FIST Framework highlights the importance of integrating practical experiences with theoretical knowledge, creating a model that is not only effective but also responsive to the evolving needs of society.

Appendix A

This Appendix illustrates the critical role that news outlets play and their considerable relevance to the research problem at hand. Additionally, it abstracts some of the official procedures deployed within the country for evaluating the credibility of claimed qualifications, thereby underlining their importance in the broader schema for the information-sharing framework.

Please Rewrite the below ideas

This section arranged and organised from older to more recent news.

The below are selected news on well known newspapers. There is an abundance of reports and a significant amount of news articles addressing the challenges and issues within the Ministry of Education and Human Resource Development Sector and how they affect the labour and economic sectors. However, the following selected pieces are taken from well-known newspapers.

This part shows the current issue relating to information verification and employment history checks, it is vital to shedding light on the role of news outlets and their relevance to the research problem.

shedding light on news outlets' role and their relevance to the research problem. Furthermore, it outlines some of the official practices utilised within the country for checking the credibility of qualifications.

This part also shows the news outlet related to the research problem.

This part shows the current practice for information validation and how the employment history is verified.

A.1 News Outlet

The newspapers mentioned in the subsequent section carry official status, and the websites referenced are widely recognised.

A.1.1 News Outlet 1:

This article was published in the Al Watan newspaper and written by Sukina Almeshekhis (2014). The writer raises a question that emerges in the case of graduates: *Do we really not need these graduates?* This question leads us to create more questions: If there is no need for these graduates, why were they accepted into colleges that do not align with the labour market's needs in the first place? Then, what is the need for universities that graduate thousands annually if they are not utilised (unemployed)? Are the concerned ministries responsible for employment and responsible for the workforce? What will these graduates' fate be after five, ten, or fifteen years? These "unemployed" and "ageing" graduates reveal significant shortcomings in the employment process. We cannot expect success with the continuous rise in unemployed individuals and job seekers. Inevitably, the future will bring more difficult repercussions if these issues are not addressed and rectified promptly.

A.1.2 News Outlet 2:

This article was published in Al Eqtisadiyah newspaper and written by Sattam Althagiel (2016). The writer critically examines the predicament students face during high school, highlighting their general need for more awareness of the labour market. A concerning proportion of these students need to engage in strategic academic planning, leading them to unemployment. Unfortunately, this often extends into their university education, leaving many individuals unemployed despite having degrees. Such matters require careful studies and numbers carried out by government bodies and must be based on something other than individual judgments with high error rates.

A.1.3 News Outlet 3:

This article was published in two different news outlets, Makkah newspaper and Argaam website and written By Ahlam Al-Zaim (2016a) & (2016b). The writer elaborates that the Saudi Ministry of Human Resources and Social Development (HRSD) has pinpointed eight fields in the local job market that are experiencing a decrease in the number of graduating students. Most of these areas in demand are science-based, including diverse engineering sectors, education, nursing, computer science and IT, medicine, pharmacy, medical technology, and finance and accounting. However, the Ministry also noted an overabundance of students in four other fields: Sharia law, Islamic studies, Arabic language, and humanities. These oversubscribed specialisations could lead to increased unemployment, necessitating collaborative efforts with other ministries to redirect student interest to areas of demand.

A.1.4 News Outlet 4:

This article was published in the Al Jazirah newspaper and written by Abduilhafiz Mahboob (2017). The writer reported at a 2017 event for directors of Saudi universities that the Minister of Education emphasised the need for fresh ideas and plans to enhance efficiency, sustainability, and responsibility in university education, not through increased spending but by focusing on enhancing the current capabilities. The minister highlighted universities' critical role in preparing the workforce for Saudi Arabia's Vision 2030 economic transformation, which includes careful student selection to serve the economic shift and bridging the gap between higher education outcomes and labour market needs. Fresh graduates with degrees should partner with the training sector to overcome the weak outputs of higher education or the mismatch of their specialities with the labour market requirements. Finally, the government spends enormous amounts of money (on training) to re-educate these graduates and look for jobs for them instead of creating new projects that generate jobs.

A.1.5 News Outlet 5:

This article, published in the Mekkah newspaper and written by Sahar Abushahin (2018), reports a conference recommendation concerning the graduation rates from medical colleges. The conference advised against opening new medical colleges specialising in Dentistry and Pharmacy until 2030 (For 12 years). Furthermore, it recommended a 50% reduction in admissions to Dentistry and Pharmacy programs over the next four years. These measures aim to prevent an overproduction of graduates, which currently leads to unemployment. The conference strongly urged an increase in admissions to General Practitioner (GP) and Nursing programs, particularly in primary care centres, as they form the backbone of the health system and can reduce hospital patient traffic.

A.1.6 News Outlet 6:

This article was published in OKAZ and Saudi Gazette newspapers and written by Abdullah Sadiq Dahlan (2018b) & (2018a). The writer of the article discusses the support that the education and health sectors receive from the Saudi leadership, both benefiting from substantial financial backing. The author points out a significant flaw in the Ministry of Health's employment and training policies for newly graduated doctors. The failure of these policies represents an economic drain, as many medical graduates remain unemployed. The author asserts that the high unemployment rates among doctors are an alarming indicator of the state of the job market. Ignoring these issues could lead to disastrous consequences for the country, thereby suggesting a need for a serious review and amendment of the current employment policies and plans in the health sector.

A.1.7 News Outlet 7:

This article was published on Al Madina and NSHR and written by Ahmed Al-Juhani (2019a) & (2019b). The writer in the article shows that Persistent unemployment rates among medical degree graduates coupled with the cost of studying practical medical specialities are high, which has led some to recently call for a slowdown in the acceptance into medical departments. The article shows that a recent study conducted by SCFHS revealed that the current number of Saudi doctors looking for jobs indicates approximately 6,000 Saudi doctors actively seeking employment.

A.1.8 News Outlet 8:

This article, was published on Al Arabiya and Asharq Al-Awsat and written by Aml Al-Hazani (2022a) & (2022b). This article illustrated when the University Affairs Council decided to "double the acceptance rate in quality colleges," which include health, engineering, technical, applied, and business administration colleges. Conversely, acceptance has been reduced by no less than 50% in majors that do not align with the labour market. This decision sparked controversy on the importance of mentioned "quality colleges" specialisations leading to a divide between two groups. Supporters of the decision see a clear benefit: it addresses the issue of graduates remaining unemployed at home due to a lack of job opportunities in their field. On the other hand, opponents argue that all academic specialities are essential from a knowledge perspective, and the value of an academic speciality should not be measured only in terms of financial gain or job opportunities but also in terms of its inherent intellectual value.

A.1.9 News Outlet 9:

This article was published on AL-HAL NET online news and written by Ramez Al-Homsi (2022). This news article discusses that linking the labour market with universities is a shared responsibility, as it helps preserve young human resources. However, it is agreed that the primary mission of universities and institutes is education and graduation, and employment is outside their priorities. Moreover, the writer ends by saying, "No one wants to confront the painful reality of a huge gap existing between education and work".

A.1.10 News Outlet 10:

This article was published in the Al Jarida newspaper and written by Faisal Al-Sharifi (2022). This article discusses how the quality of education can impact graduates; they suffer from a lack of cognitive abilities and skills. It also addresses the importance of

aligning educational outcomes with the demands of the labour market. Finally, there is an oversupply of certain specialities that the labour market needs to accommodate.

A.1.11 News Outlet 11:

This article was published on Online News: ALANBA online news and written by Jala Mansour (2022). This article suggests an evident need to shift focus on the particular specialities in demand within the labour market. This focus shift is critical for aligning educational outcomes with job market requirements."

A.1.12 News Outlet 12:

This article was published in Al Watan newspaper and written by News: ALWATAN (2023). The Secretary-General of the University Council has announced upcoming modifications to academic programs. These adjustments, responsive to the labour market's needs, lead to the closure of specialisations within universities and colleges that the job market has found unnecessary. Several of these specialisations, deemed "non-quality, " are scheduled for removal from bachelor and diploma programs. These changes will affect roughly 70 colleges throughout the country, reflecting the evolving demands of the job market. Furthermore, he highlighted a new strategy where multiple universities would be tailoring their specialisation to meet regional developmental needs and job opportunities, aiming to bridge the gap between academic outputs and job market demands.

A.2 Validating Examples

This part shows practices on how to ensure the credibility of the data, which is crucial in a range of fields of HR.

Example: GOSI

٢ date: التاريخ pages: صفحة

Certificate Number: رمز الشهادة

شهادة بيان مدد واجور مشترك

المؤسسة العامة للتأمينات الاجتماعية
General Organization for Social Insurance

Nationality الجنسية	NAME لاسم
National ID Number رقم الهوية الوطنية	Birth date تاريخ الميلاد
	GOSI Number رقم المشترك

Company Name اسم المنشأة		Employer Nummer رقم صاحب العمل
Final Day in employment تاريخ الإنقطاع	Start Day تاريخ الإلتحاق	Company Location المكتب
التغطية	الاجر	نهاية الاجر
What covers	Payment	End date
		Begin date

إجمالي أشهر الاشتراك: For how long

Next page has an official certificate stamp and a QR code for validation

SAMPLE ONLY

Example: Service Certificate

Company Logo

شهادة خدمة SERVICE CERTIFICATE

NAME	_____	الإسم
NATIONALITY	_____	الجنسية
LAST POSITION HELD	_____	آخر وظيفة
WORK AREA	_____	الجهة
GRADE	_____	المرتبة
BASIC MONTHLY SALARY SAR	_____	الراتب الأساسي الشهري
TRANSPORT SAR	_____	بدل المواصلات
HOUSING SAR	_____	بدل السكن
JOINING DATE	_____	تاريخ التعيين
LEAVING DATE	_____	تاريخ نهاية الخدمة :

Employee Number: *****

This is to certify that

Mr \ **EMPLOYEE NAME**
Has worked for the **COMPANY NAME** as stated
above and he has been discharged.

Arabic Transcript

This certificate has been given to him upon his own
request without any responsibility on the company part.

Stamped and signed

Appendix B

This part shows how the experts reviews has been carried out. Also, it shows all the documents that were emailed to them. Furthermore, it shows protocols on how the interview was made.

B.1 Interview Portocol

Before the Interview

1. Contacting experts through the phone call or a text message.
2. Experts who agree to participate are requested to provide their email for the invitation letter.
3. Emailing experts an invitation letter with the a request for their availability.
4. Providing experts Participant Information Sheet, Consent Form and the Expert Review Questioner.
5. Then at the day of the interview, a text message sent as a reminder.

During the Interview

1. Experts are greeted and thanked for participation.
2. Introducing myself and remind them about the conversation recording.
3. Give a brief recap of the study. Then provide a scenario that helps to engage the expert thinking.
4. Show the expert the diagram of they system and where the framework sits.
5. Start by explaining what is the category does then ask the expert what topics should considered as a concern or a factor.
6. While experts are talking, factors are being checked manually when the expert mention it.
7. After the expert finishes relating to a category, the remaining undiscussed factors are represented for further discussions.
8. When all factors are discussed, a diagram is provided with all of the factors.
9. Experts are requested if there is something missing.
10. Experts are asked if the main categories covers all the aspects about the problem.

After the Interview

1. Experts are thanked for participating.
2. Experts are asked if they would like to keep in contact for any further clarifications or future re-participation.
3. The researcher expresses thankfulness to the Experts for participating.
4. The researcher is grateful to keep contact information for further clarifications or future re-participation.

B.2 Expert Invitation Letter

Dear **.

I would like to take this opportunity to thank you in advance for the help I will received from you in my research. This research is for an e-Government system relating to information sharing. As an expert in your fields, we would like to invite you for an interview. The interview will take about 30- 45 minutes to be completed.

This research is an academic research towards a Ph.D. degree. I am a lecturer at the College of Business at the University of Jeddah. Currently, I am a Ph.D. at the University of Southampton and my research fields are computer science and security. This research is about investigating factors that proposes a framework for records sharing in education and employment fields. To achieve a secure record sharing, this study proposes a framework with factors that helps in the investigation of a back-end system for records sharing. Consequently, this study identifies what are the important factors then propose a framework and finally a validate this framework.

The interviews are done anonymously. The requested information would be regarding your experience in your field. During the interview, our conversation will be audio recorded. However, no names will be stores or used in the research. By taking a part in this research, you would have the opportunity to help developing a system to help in records sharing between educational institutes and employment organisations. There are no any risks involving you.

Kindly attached is the questioner form, consent form and Participant Information Sheet.

Thanks,

Rayan Ghamri

B.3 Expert Review Questioner

Scenario

Once upon a time, you have given a task of being:

Employer or a recruiter at the Human Resources Department You will be recruiting new prospective employees for a jobs, how would you find the prospective candidates? How would you verify the provided information on their resumes? How about you want to reach to every possible individual before you start overseas outsourcing?

Job Seeker You will be job seeking and you want employers to know your availability? What about if you hold valuable personal information and you want it to be shared in a secure way in a system for employers to access and find you?

Security Developer and Information Sharing You have the task of sharing personal information of individuals represented by your organisation (Awarded Certificate/Employment History). How would you share information outside your organisation while preserving security and privacy? These information would be used to verify individuals in relation with your organisation.

Human Development and Planning You are given the task of planning developing employees skills, how would you know their weaknesses and improve them? How about you are an employer and you want your future employees to have a specific skill, how would you communicate with educational institutes?

The problem would be how would you verify unreliable information through a trusted source of information before sharing them with different parties. The challenge presented here is how to improve information sharing in-between education and employment organisations (education - employment and employment - employment).

Creating a technology to solve this problem of sharing verified and trusted records through a back-end system for e-government. However, the system is not yet well-designed and validated. In terms of sharing the information, do you agree it makes sense? If you do, please help us to develop a system that can be used for records sharing by answering the next few pages and answering the below question:

What do you think about information sharing between educational institutes and employment organisations?

First Part: Background:

1. What is your sector domain?
 - Public
 - Private
2. What is your organisation domain?
 - Education
 - Employment
3. Which of the following best describes you?
 - Security Systems Developer
 - Information Sharing Developer
 - Human Development Researcher
 - Human Resources Advisor
 - Blockchain Expert
4. How long have you been working in the field?
 - Less than 3 Years
 - 3-5 Years
 - 6-10 Years
 - More than 10 Years

Second Part: The Framework:

Before answering the next part, please take few moments looking at the below proposed framework.

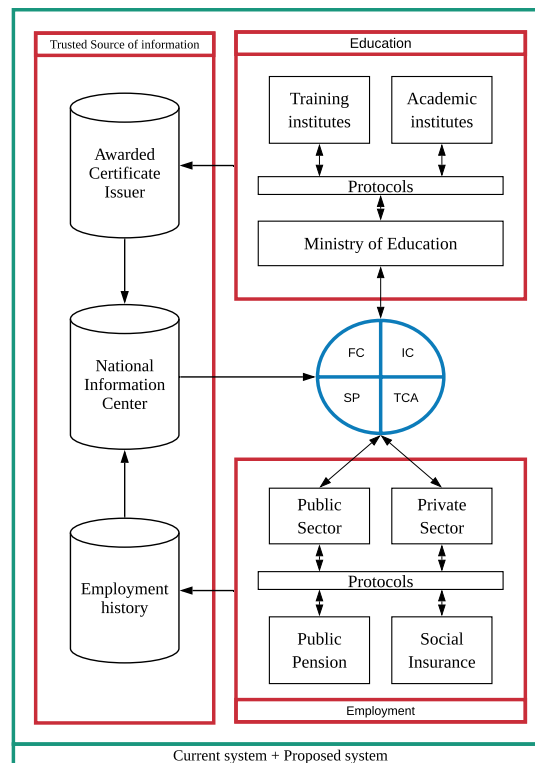


Figure 1: The Proposed Framework for Records Sharing

Framework Questions:

1. Considering the system in blue, would it be theoretically possible to be placed between Employment, Education and trusted source of information to serve record sharing system? if not, what are the barriers and challenges?
2. Looking at the diagram in red for the proposed framework, does it look accurate for education, employment or trusted source of information?
3. All things considered in green, do you think I have explained the full picture? Is there something missing? What do you think about the proposed framework? is this framework applicable?

Third Part: Categories

The following two tables (Table 1 and Table 2) are discussing four main categories that influence records sharing and how could the framework be a back-end system.

To what extent do you think these categories support the framework in its aim to alleviate the information sharing problem. Please give your comments, especially on the required factors for each category

Table 1: Social Context and Administrative Context Categories

Category	Comments
Facilitating Conditions ¹	
Implementing Conditions ²	

¹ Facilitating Conditions: This category can be explained as the factors that are needed to be presented to enable the use of the proposed trusted system. These factors can be organisational and technical infrastructures which needs to be available.

² Implementing Conditions: These issues are major concern for system administrators to implement any new system. Their concerns can be examined in a form of questions that raise issues which needs to be addressed before implementing any new system. The admin requires new systems to be capable of being secure, reliable, scalable, usable, flexible and can be stored without many challenges.

To what extent do you think these categories support the framework in its aim to alleviate the information sharing problem. Please give your comments, especially on the required factors for each category

Table 2: Technical Context Categories

Category	Comments
Security Principles ³	
Trusted Chain Authentication ⁴	

³ Security Principles: Since some factors are mentioned under different categories, which can be inherited and achieved. This category contains the security factors that are not addressed in other categories in the proposed framework. There are three main components of security principle practices. Information Security, Information Authenticity and Information Exchange. Which are needed to be practiced and implemented assure a secure environment for sharing records of citizens.

⁴ Trusted Chain Authentication: This category is a necessary requirement for a system containing records to provide secure records that are trustworthy. This type of citizens record is often required to be recorded for long periods that might extend beyond the life span of a database system or a server. Records should be exchanged in a trusted, secure system. Based on Blockchain, for having an ongoing chain of authorised agreements starting from the issuer of the record. It contains algorithms to confirm the validity and authenticity of information It for a trustworthy system.

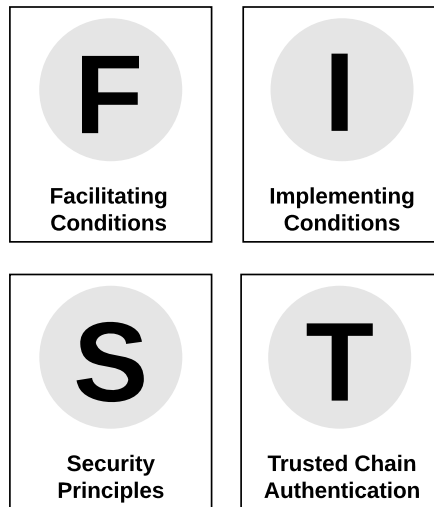


Figure 2: The Proposed Categories

Categories Questions:

1. What other main categories that could be important regarding the technical context and social context to be applied for records sharing?
2. Is there any categories that should be renamed, deleted, changed, renamed or added?
3. Have I overlooked any categories that should be considered in the framework?

Fourth Part: Factors

The following Four tables (Tables 3, 4, 5 and 6) are discussing the factors of the four previous categories that were addressed for records sharing.

Please provide your comments on each of the factors:

Table 3: Facilitating Conditions

Factor	Comments
Financial Barriers	
Top Management Commitment	
Cooperation and Collaboration	
Outdated Infrastructure	
Training and Experience	
Job assignments	

Please provide your comments on each of the factors:

Table 4: Implementing Conditions

Factor	Comments
Security	
Reliability	
Scalability	
Usability	
Flexibility	
Storage	

Please provide your comments on each of the factors:

Table 5: Security Principles

Factor	Comments
Confidentiality	
Authenticity	
Availability	
Encryption	
Integrity	

Please provide your comments on each of the factors:

Table 6: Trusted Chain Authentication

Factor	Comments
Trust	
Privacy	
Smart Contracts	
Consensus Mechanism	
Decentralisation	
Immutability	

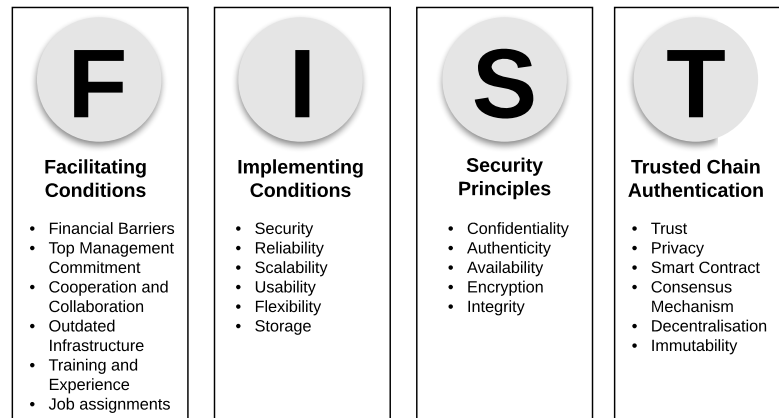


Figure 3: The Proposed Categories and its Factors

Factors Questions:

1. Do you think any of the identified factors needs to be redesigned or regrouped under a different category?
2. Is there any factors that should be renamed, deleted, changed, renamed, added, move or change components

Fifth Part: Overall Framework

The overall framework illustrated below. Please provide feedback if you have any further comments regarding the overall framework.

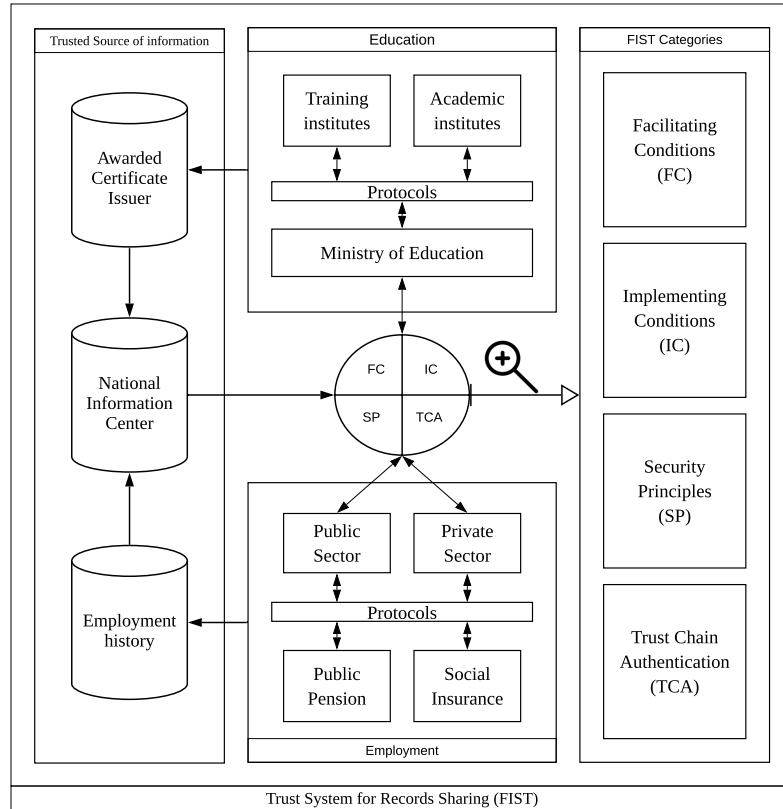


Figure 4: The Proposed Framework for Records Sharing

Comments:

Sixth Part: Explanations:

This part explains the architecture of the proposed framework and explain the components of the factors.

Frame Work Architecture

(Figure 4) Shows the proposed framework. A Trust System for Records Sharing is a backend system that provide Facilitating Conditions, Implementing Conditions, Security Principles and Trust Chain Authentication which is named FIST. The system task is to share records with some limitation on storing information. Government agencies are the main participants with all the required information. The organisation that owns the data, will grant access on the data within the trusted system. The system allows the sharing of information between relevant organisations to employment and education. There will be users of the system, however there will be some protocols and algorithms on handling informant. Users would be individuals, employers, training institutes, academic institutes and human resources.

The protocol will provide different types of users with different types of permissions from administrators to view only users. illustrates The Architecture for the Framework.

Explaining Components (Figure 3) Shows an overview of all the factors and its components.

Authenticity: Authenticity as a security principle is a different practice than having it for trust authentication. In this context, it means validating both parties which are the sender and receiver of the information. Also, verifying claimed identity to ensure communication and information are genuine.

Confidentiality: A property that only allows approved entities, parties or processes to receive information.

Consensus Mechanism: An ongoing algorithm that is aimed to verify information starting from the organisation that issues the record. It tools to ensure the records are valid and confirmand. These kinds of records will provide data consistency, fraud protection, information ownership, and immutable records. To achieve this, records should be securely sealed and recorded in the system; any proof of tampered data should be discarded or rejected.

Cooperation and Collaboration: This is a major issue with public sector, to successfully implement the suggested system, there would be a need of cooperation and collaboration from many departments such as; cooperation and collaboration between the ministries and government sectors, cooperation of financial department for funding, cooperation with researchers to find related issues to implementation and cooperation of top management.

Data Availability: The authenticated records should be available at all times whenever needed. A system that stores records or transactions in different systems would mean a reduction in single points of failure.

Decentralisation: A decentralised structure will allow for historical/related record sharing in a secure environment in different organisations. There is no central ownership of the records, although information is validated by an authority. Once a record has been verified, it is stored .

Encryption: (Cryptography and Digital Signatures) The digital cryptographic signature is used to demonstrate the authenticity of the information which use public-private key pairs. In a digital signature, the recipient encrypts the hash of the message using their private key, which can be sent along with the message to the receiver. The recipient also produces the original message's hash value, and authenticity can be checked against the hash value generated by decrypting the hash values sent by the sender using their public key.

Financial Barriers: At organisational level, top management must be willing to spend money to invest in records sharing. Providing benefits would help favouring a decision of implementing. It is a significant barrier for having it has three obstacles; limited spending on ICT, expensive cost of running ICT and high cost from service telecommunication providers.

- Flexibility:** is the new system flexible enough to be implemented with the current infrastructure without many software and hardware changes? is it flexible enough to work with different operating systems and different users?
- Immutability:** Once the information is recorded, it will stay the same and should not change and should be traceable. Information can be changed, updated, and modified, but never deleted between ministries. Even if a system mentions that a record is not valid, has expired or is hidden, that record is always stored.
- Integrity:** Authenticated records are stored in a sequential order in the form of a trust chain. Said chain includes all of the previous hashed stored transactions that led to the verified record. This helps to verify and track long-term digital transactions.
- Job assignments:** Employees assessment should be practiced during hiring with assigning employees with the right background and training to be in line with the job assignments.
- Learning to Build Skills:** One part is the ability of employees to learn to build new skills. Another part is the employers if they are willing to fund learning and development for their employees.
- Outdated Infrastructure:** There are limitation related to the outdated infrastructure, this be shown as a legacy system which could be outdated computer systems. This is a part hardware and another part is the software. Updated infrastructure enables the government agencies in accelerating daily tasks by using the technology to save time and effort.
- Privacy:** Blockchain has features of decentralisation and encryption while being resistant to change or modification. It strength privacy by allowing citizens to have control over their information to be shown for public access (for employment or sharing records) or private for government records.
- Reliability:** The information is reliable because creating records comes from only authorised personal which in most cases are the organisation who issued the information. This means opening the verification process of records to everyone who has authorisation. In other words, there is no independent isolated verification to complete a record. Moreover, records must be relatively safe and are able to prevent human subjective and artificial records modification. Reliability will answer these questions: Can the user depend on the system achieve its tasks? Can it function under given conditions while maintaining accurate records?
- Scalability:** can the new system function quick enough not to have scalability issues that slows the system?
- Security:** is the new system secure? is there any added value? how can you confirm the system is more secure than the current practice?
- Smart Contract:** Smart contract is a code to perform an algorithm attached at the condition of an operation. This code is stored on the blockchain and it becomes active when it is about to execute an operation. It can be used in education and employment to validate a record and to authorise an update of a record.
- Storage:** where would the shared records stored? where would be the physical related hardware stored?
- Top Management Commitment:** Top management plays an important part by taking responsibility on accelerating or suspending an implementation.
- Trust:** Having a trust in an organisation to handle personal information. Also, an organisation to have trust in a new system to store and practice sharing records.
- Usability:** is the system user friendly? can it be used with different software and hardware? can the new system achieve its objectives?

B.4 Consent Form

CONSENT FORM

Study title: Investigating Trusted Records for Employment and Education

Researcher name: Rayan Mohamed S Ghamri

ERGO number: ERGO/FEPS/55047

Please initial the box(es) if you agree with the statement(s):

I have read and understood the information sheet (2020-03-05 / Version 1.1) and have had the opportunity to ask questions about the study.	
I agree to take part in this research project and agree for my data to be used for the purpose of this study.	
I understand my participation is voluntary and I may withdraw for any reason without my participation rights being affected.	
I understand that I will not be directly identified in any reports of the research.	
I understand that taking part in the study involves audio recording which will be transcribed and then destroyed for the purposes set out in the participation information sheet.	

Name of participant (print name).....

Signature of participant.....

Date.....

Name of researcher (print name)

Signature of researcher

Date.....

.....

B.5 Participant Information Sheet



Participant Information Sheet

Study Title: Investigating Trusted Records for Employment and Education

Researcher: Rayan Mohamed S Ghamri
ERGO number: ERGO/FEPS/55047

You are being invited to take part in the above research study. To help you decide whether you would like to take part or not, it is important that you understand why the research is being done and what it will involve. Please read the information below carefully and ask questions if anything is not clear or you would like more information before you decide to take part in this research. You may like to discuss it with others, but it is up to you to decide whether or not to take part. If you are happy to participate you will be asked to sign a consent form.

What is the research about?

This research is an academic research towards a Ph.D. degree. I am a Ph.D. student from the faculty of Engineering and Physical Science, my research field is computer science security. This research is investigating factors that propose a framework for records sharing in education and employment fields. To achieve a secure record sharing, this study proposes a framework with factors that helps in the investigation of a back-end system for records sharing. Consequently, this study identifies what are the important factors then propose a framework and finally a validate this framework.

Why have I been asked to participate?

This research is for an e-Government system relating to information sharing. Participants from public and private sectors related to employment and education are essentially required to this study. They are being chosen by their expertise in order to help in the developing of the records sharing system.

What will happen to me if I take part?

You are an expert in the fields, and we would be having an open-end discussion on specific questions and the proposed framework. The interview consists of five parts and will take about 30-45 minutes to be completed.

The participants will not be asked to provide any personal information. The requested information would be regarding their experience in the field.

During the interviews, the participants conversations will be audio recorded. The recordings will later be used as findings in the analysis for validating the proposed framework.

For the provided data, all participants will get a unique identified number to enable collected of the data. However, no names will be stores or used in the research.

Are there any benefits in my taking part?

By taking a part in this research, you would have the opportunity to help developing the system to help in records sharing between educational institutes and employment organisations.

Are there any risks involved?

There are no any risks involving the participants. The questionnaires and interviews are done anonymously.

[2020-03-05] [Version 1.1]

[Ethics/IRAS number (if applicable)]

What data will be collected?

The collected data will be audio recorded about the expert's opinion on the framework and how can it be developed based on your expertise in the field.

Once the audio records and notes from the interview have been transcribed and checked for accuracy, the audio files and notes will be destroyed. Only the anonymised transcript will remain. The transcript will be used for data analysis for the duration of the PhD research. After the PhD has been completed it will be kept for research integrity purposes only, for 10 years, as per university policy.

Will my participation be confidential?

Your participation and the information we collect about you during the course of the research will be kept strictly confidential.

- All interview papers will be scanned and kept in a password-secured computer at the University of Southampton. The papers will then be shredded.
- All audio files are kept in the password-secured computer at the University of Southampton.

Only members of the research team and responsible members of the University of Southampton may be given access to data about you for monitoring purposes and/or to carry out an audit of the study to ensure that the research is complying with applicable regulations. Individuals from regulatory authorities (people who check that we are carrying out the study correctly) may require access to your data. All of these people have a duty to keep your information, as a research participant, strictly confidential.

Do I have to take part?

It is entirely up to you to decide whether or not to take part. If you decide you want to take part, you will need to sign a consent form to show you have agreed to take part.

What happens if I change my mind?

During the interview, you have the right to change your mind and withdraw at any time without giving a reason and without your participant rights being affected. All your personal data will be deleted, and your interview data will be anonymized. You may withdraw at any time up to the point where the data analysed has been generated a set of anonymized findings.

What will happen to the results of the research?

Your personal details will remain strictly confidential. Research findings made available in any reports or publications will not include information that can directly identify you without your specific consent.

Where can I get more information?

If you would like to get more information about this study, please feel free to contact Rayan Ghamri (rg1v18@soton.ac.uk)

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Thank you.

Appendix C

The analysis of the transcript was done by themes, then by category. With a Top Down analysis which made each phrase to fall under its correct factor. Table Figure C.1 shows the Duration and location of each of the experts.

TABLE C.1: Expert Locations and Interview’s Durations

Location	Expert	Date	Duration
Face-to-face Interviews in Riyadh	Expert A 01	8th March 2020	01H:08M
	Expert B 02	8th March 2020	01H:00M
	Expert C 03	8th March 2020	00H:41M
	Expert D 04	9th March 2020	00H:38M
	Expert E 05	9th March 2020	00H:31M
Virtual Interviews (Online)	Expert F 06	3rd October 2020	00H:48M
	Expert G 07	7th October 2020	01H:02M
	Expert H 08	12th October 2020	01H:00M
	Expert I 09	12th October 2020	01H:07M
	Expert J 10	12th October 2020	01H:06M
	Expert K 11	13th October 2020	00H:44M
	Expert L 12	19th October 2020	01H:04M
	Expert M 13	20th October 2020	01H:03M
	Expert N 14	25th October 2020	02H:03M
	Expert O 15	25th October 2020	00H:46M

C.1 Facilitating Conditions

A.R1.01, A.R1.02, B.R1.01, B.R1.02, C.R1.01, C.R1.02, C.R1.03, D.R1.01, D.R1.02, D.R1.03, E.R1.01, E.R1.02, E.R1.03, G.R1.01, G.R1.02, H.R1.01, J.R1.01, K.R1.01,

K.R1.02, K.R1.03, L.R1.01, L.R1.02, L.R1.03, L.R1.04, M.R1.01, M.R1.02, M.R1.03, N.R1.01, N.R1.02, O.R1.01.

C.1.1 Added Value

A.R1.03, A.R1.04, A.R1.05, B.R1.03, B.R1.04, B.R1.05, C.R1.04, E.R1.01, E.R1.04, E.R1.05, F.R1.01, G.R1.02, G.R1.03, G.R1.04, G.R1.05, H.R1.01, H.R1.02, K.R1.03, K.R1.04, L.R1.05, L.R1.06.

C.1.2 Top Management Support

E.R1.05, G.R1.05, A.R1.06, A.R1.07, B.R1.01, B.R1.06, B.R1.07, C.R1.02, C.R1.03, C.R1.05, C.R1.06, D.R1.02, D.R1.04, E.R1.02, E.R1.03, E.R1.06, E.R1.07, F.R1.02, G.R1.02, H.R1.03, H.R1.04, I.R1.01, I.R1.02, J.R1.01, J.R1.02, J.R1.03, J.R1.04, K.R1.05, K.R1.06, L.R1.03, L.R1.07, M.R1.03, N.R1.01, N.R1.02, N.R1.03, N.R1.04.

C.1.3 Laws and Regulations

B.R1.07, B.R1.01, B.R1.08, D.R1.05, E.R1.02, F.R1.03, F.R1.04, G.R1.01, G.R1.06, G.R1.07, G.R1.08, G.R1.09, H.R1.05, H.R1.06, H.R1.07, J.R1.05, L.R1.08, M.R1.01, M.R1.03, M.R1.04, N.R1.05, O.R1.02, O.R1.03, O.R1.04.

C.1.4 Clear KPI - Performance Measurement and Achievements

K.R1.06, A.R1.08, A.R1.09, A.R1.10, A.R1.11, A.R1.12, A.R1.13, A.R1.14, B.R1.08, B.R1.09, C.R1.07, D.R1.06, D.R1.07, D.R1.08, F.R1.05, G.R1.05, G.R1.10, H.R1.08, I.R1.03, I.R1.04, I.R1.05, I.R1.06, L.R1.09, L.R1.10, L.R1.11, L.R1.12, M.R1.04, M.R1.05, M.R1.06, M.R1.07, M.R1.08, O.R1.05.

C.1.5 Cooperation and Collaboration

A.R1.07, D.R1.04, C.R1.02, C.R1.03, C.R1.05, C.R1.08, C.R1.09, C.R1.10, D.R1.02, D.R1.03, E.R1.02, H.R1.03, H.R1.09, J.R1.06, J.R1.07, J.R1.08, K.R1.02, L.R1.03, L.R1.13, M.R1.01, M.R1.02, M.R1.03, M.R1.09, N.R1.06, N.R1.07, O.R1.06.

C.1.6 Financial Support or Resource support

B.R1.07, B.R1.10, D.R1.01, D.R1.02, D.R1.09, D.R1.10, D.R1.11, D.R1.12, E.R1.01, E.R1.05, E.R1.08, G.R1.02, H.R1.03, I.R1.07, J.R1.01, J.R1.04, J.R1.09, K.R1.03, L.R1.01, L.R1.03, L.R1.14, M.R1.03, N.R1.08, O.R1.01, O.R1.01, O.R1.07.

C.2 IT Operations

A.R1.15, B.R1.11, D.R1.13, D.R1.14, E.R1.09, E.R1.10, E.R1.11, F.R1.06, G.R1.11, G.R1.12, H.R1.01, H.R1.10, H.R1.11, H.R1.12, H.R1.13, I.R1.08, I.R1.09, J.R1.01, J.R1.03, J.R1.10, J.R1.11, L.R1.13, L.R1.15, M.R1.03.

C.2.1 Adoptive Infrastructure

B.R1.10 B.R1.12 B.R1.13 C.R1.11 D.R1.15 E.R1.10 G.R1.11 G.R1.12 H.R1.01 H.R1.11
H.R1.14 H.R1.15 I.R1.10 J.R1.03 J.R1.12 L.R1.15 L.R1.16 M.R1.10 N.R1.06 N.R1.09
N.R1.10 N.R1.11 N.R1.12

C.2.2 Scalability

A.R1.16 B.R1.14 C.R1.12 D.R1.16 F.R1.07 K.R1.07 N.R1.13 N.R1.14 N.R1.15 E.R1.11
I.R1.09 H.R1.15 N.R1.06

C.2.3 Storage

B.R1.15 C.R1.13 C.R1.14 D.R1.17 E.R1.12 E.R1.13 E.R1.14 E.R1.15 E.R1.16 F.R1.08
F.R1.09 G.R1.13 H.R1.16 I.R1.11 K.R1.08 M.R1.11 M.R1.12 N.R1.16 N.R1.17 N.R1.18
O.R1.08 O.R1.09 N.R1.04 H.R1.07 B.R1.12 B.R1.14 D.R1.16 N.R1.13 B.R1.02 L.R1.15

C.2.4 Usability

F.R1.10 I.R1.12 K.R1.09 L.R1.17 M.R1.13 N.R1.19 N.R1.20 O.R1.10 K.R1.04 D.R1.14
C.R1.12 I.R1.09

C.2.5 Flexibility

K.R1.09 O.R1.10 D.R1.14 E.R1.11 C.R1.12 I.R1.09

C.2.6 Reliability

E.R1.17 I.R1.13 K.R1.10 L.R1.18 N.R1.21 O.R1.11 C.R1.07 J.R1.10 C.R1.14 M.R1.12
B.R1.12 D.R1.16 N.R1.06 D.R1.14 E.R1.11 C.R1.12 I.R1.09

C.3 Security Principles

A.R1.17 B.R1.12 C.R1.15 C.R1.16 D.R1.17 D.R1.18 E.R1.15 E.R1.18 F.R1.06 F.R1.11
G.R1.14 H.R1.01 H.R1.07 H.R1.13 H.R1.17 H.R1.18 H.R1.19 I.R1.09 J.R1.11 J.R1.13
J.R1.14 J.R1.15 K.R1.10 K.R1.11 L.R1.19 L.R1.20 L.R1.21 M.R1.04 M.R1.12 N.R1.06
N.R1.08 N.R1.16 N.R1.17 N.R1.22 O.R1.03 O.R1.09 O.R1.12

C.3.1 Confidentiality

B.R1.16 A.R1.07 B.R1.01 C.R1.17 E.R1.18 E.R1.19 F.R1.12 H.R1.18 H.R1.20 I.R1.14
K.R1.12 K.R1.13 L.R1.22 L.R1.23 M.R1.04 O.R1.13

C.3.2 Authentication

A.R1.18 B.R1.17 C.R1.18 D.R1.19 E.R1.18 E.R1.19 F.R1.13 F.R1.14 F.R1.15 H.R1.18
H.R1.21 I.R1.14 I.R1.15 I.R1.16 I.R1.17 J.R1.16 L.R1.24 L.R1.25 M.R1.14 M.R1.15
N.R1.16 O.R1.14

C.3.3 Authorisation

A.R1.19 B.R1.17 B.R1.18 B.R1.19 C.R1.14 C.R1.18 E.R1.18 H.R1.21 H.R1.22 H.R1.23
H.R1.24 H.R1.25 I.R1.14 I.R1.17 I.R1.18 K.R1.13 K.R1.14 L.R1.24 M.R1.13 M.R1.14
M.R1.15 N.R1.16 O.R1.13

C.3.4 Data Availability

A.R1.20 B.R1.20 E.R1.18 E.R1.19 F.R1.12 F.R1.16 G.R1.15 H.R1.20 H.R1.25 I.R1.14
K.R1.15 L.R1.26 N.R1.16

C.3.5 Encryption

A.R1.21 B.R1.21 H.R1.18 I.R1.19 I.R1.20 J.R1.17 K.R1.16 L.R1.27 M.R1.12 M.R1.15
N.R1.23 N.R1.24 O.R1.15

C.3.6 Integrity

A.R1.22 A.R1.18 B.R1.21 E.R1.18 E.R1.19 F.R1.12 G.R1.16 G.R1.17 H.R1.20 I.R1.14
J.R1.18 K.R1.17 L.R1.22 M.R1.13 M.R1.14 N.R1.16 O.R1.15 O.R1.16

C.4 Trust and Accuracy

(39 By 15) A.R1.23 A.R1.02 A.R1.18 B.R1.19 B.R1.22 C.R1.07 C.R1.14 D.R1.20 D.R1.21
D.R1.22 E.R1.20 F.R1.17 G.R1.18 H.R1.23 H.R1.24 H.R1.25 I.R1.09 I.R1.18 I.R1.21
I.R1.22 J.R1.19 J.R1.20 K.R1.13 K.R1.14 K.R1.16 K.R1.18 L.R1.17 L.R1.28 L.R1.29
M.R1.13 M.R1.16 N.R1.25 N.R1.26 O.R1.17 O.R1.18 O.R1.19 O.R1.20 O.R1.21 O.R1.22

C.4.1 System integration

(49 by 15) A.R1.24 B.R1.07 B.R1.12 B.R1.13 B.R1.15 B.R1.19 C.R1.05 C.R1.11 C.R1.19
C.R1.20 D.R1.02 D.R1.03 D.R1.20 D.R1.22 E.R1.16 E.R1.21 F.R1.18 F.R1.19 G.R1.15
G.R1.19 H.R1.14 H.R1.16 H.R1.21 I.R1.06 I.R1.18 I.R1.23 J.R1.06 J.R1.08 J.R1.21
J.R1.22 K.R1.04 K.R1.09 K.R1.16 K.R1.18 L.R1.16 L.R1.17 M.R1.01 M.R1.03 M.R1.08
M.R1.10 M.R1.11 N.R1.10 N.R1.17 N.R1.27 N.R1.28 N.R1.29 O.R1.10 O.R1.23 O.R1.24

C.4.2 Privacy

(40 by 14) A.R1.25 A.R1.07 B.R1.01 B.R1.02 B.R1.06 B.R1.21 B.R1.23 C.R1.10 C.R1.16
C.R1.17 D.R1.06 E.R1.21 E.R1.22 E.R1.23 F.R1.15 F.R1.20 F.R1.21 G.R1.20 H.R1.13
H.R1.21 J.R1.23 J.R1.24 J.R1.25 J.R1.26 J.R1.27 K.R1.12 K.R1.19 L.R1.10 L.R1.23
L.R1.30 L.R1.31 L.R1.32 M.R1.04 M.R1.05 N.R1.23 O.R1.25 O.R1.26 O.R1.27 O.R1.28
O.R1.29

C.4.3 Data Verification and Validation

(75 by 15) A.R1.26 A.R1.18 A.R1.24 A.R1.27 A.R1.28 A.R1.29 A.R1.30 B.R1.18 B.R1.24
C.R1.07 C.R1.11 C.R1.13 C.R1.14 C.R1.18 C.R1.20 C.R1.21 C.R1.22 D.R1.08 D.R1.21
D.R1.23 E.R1.20 E.R1.24 F.R1.22 F.R1.23 F.R1.24 F.R1.25 F.R1.26 F.R1.27 G.R1.14
G.R1.15 G.R1.16 G.R1.18 H.R1.21 H.R1.22 H.R1.25 I.R1.09 I.R1.21 I.R1.24 I.R1.25
I.R1.26 J.R1.08 J.R1.11 J.R1.20 J.R1.25 J.R1.26 J.R1.28 J.R1.29 J.R1.30 K.R1.14 K.R1.18
L.R1.08 L.R1.17 L.R1.29 L.R1.30 L.R1.33 L.R1.34 L.R1.35 M.R1.13 M.R1.16 M.R1.17
M.R1.18 M.R1.19 N.R1.10 N.R1.14 N.R1.16 N.R1.26 N.R1.30 N.R1.31 N.R1.32 N.R1.33
O.R1.18 O.R1.19 O.R1.21 O.R1.22 O.R1.24

C.4.4 Provenance

(27 By 13) B.R1.19 B.R1.22 B.R1.24 C.R1.07 E.R1.25 F.R1.22 F.R1.27 F.R1.28 F.R1.29
F.R1.30 G.R1.21 H.R1.23 H.R1.24 H.R1.26 I.R1.18 I.R1.27 I.R1.28 J.R1.31 K.R1.13
K.R1.14 L.R1.36 L.R1.37 M.R1.13 M.R1.14 N.R1.26 N.R1.34 O.R1.30

C.4.5 Misrepresented information

(23 By 12) B.R1.18 B.R1.24 C.R1.07 D.R1.06 E.R1.20 E.R1.25 G.R1.10 H.R1.25 I.R1.25
J.R1.32 J.R1.33 J.R1.34 J.R1.35 L.R1.31 L.R1.35 M.R1.16 M.R1.18 M.R1.20 N.R1.16
N.R1.35 O.R1.23 O.R1.31 O.R1.32

C.4.6 Distributed Decentralisation

(15 By 11) A.R1.31 B.R1.13 B.R1.25 C.R1.20 D.R1.16 D.R1.17 D.R1.24 E.R1.26 I.R1.28
J.R1.13 K.R1.20 L.R1.38 M.R1.09 M.R1.17 O.R1.08

Appendix D

This Appendix is dedicated for Delphi and GQM methodologies which is reflected of chapter 6.

There are 4 Rounds where Delphi Methodology Applied and 3 Rounds where GQM got applied as the following describes:

First Delphi Round: This was based on 15 experts on open-ended discussion on the field of the research problem. Which confirmed the domain of FIST Framework. Explained in Chapter 5.

Second Delphi Round: Combining Delphi with GQM on 5 experts by semi-structured questions to confirm dimensions and factors to create a dimensions story.

Third Delphi Round: Combining Delphi with GQM on 5 experts by semi-structured questions identify the key problem.

Fourth Delphi Round: Combining Delphi with GQM on 5 experts by structured questions to reach consensus and ask for scenarios based on the sequence of the factors.

D.1 First Delphi Round

The outcome of the first Delphi round served to confirm the preliminary investigation that shaped the early framework (FITS) aligns seamlessly with the domain of information sharing (later redefined as information exchange) in both employment and education sectors, thereby addressing the research problem. This significant adjustment made the transition from the original acronym FIST to the more suitably fitting FITS.

Please refer to chapter 5 for full discussions and findings. Table D.1 summarises the duration of each expert.

TABLE D.1: First Round of Experts Locations and Interview's Durations

Expert ID	Duration	Location
<i>Expert A</i> 01	01H:08M	In Person
Expert B 02	01H:00M	In Person
Expert C 03	00H:41M	In Person
Expert D 04	00H:38M	In Person
<i>Expert E</i> 05	00H:31M	In Person
Expert G 07	01H:02M	Virtual
<i>Expert H</i> 08	01H:00M	Virtual
<i>Expert I</i> 09	01H:07M	Virtual
<i>Expert J</i> 10	01H:06M	Virtual
Expert K 11	00H:44M	Virtual
Expert L 12	01H:04M	Virtual
Expert M 13	01H:03M	Virtual
Expert N 14	02H:03M	Virtual
Expert O 15	00H:46M	Virtual

D.2 Second Delphi Round

This section has the experts interview analysis on the Figure 6.3 while the moderator (the researcher) is reading (screen share) the Goal, Question and Metric shown on tables D.3, D.4, D.5, D.6 and D.7 with the numbers referencing to the figure 6.3.

The second round of Delphi methodology was approached on three different parts as the following shows:

In each interaction, experts were reminded of the following points:

- Reminded that this session is recorded.
- They were reminded that this was an extension of the original open-ended discussion that had previously taken place.
- A brief recap was provided about the problem that the research is addressing.
- They were asked to confirm the existence of the research problem.
- They were asked to confirm that this Framework could potentially solve the research problem.
- Feedback from other experts about changes to the Framework was discussed.
- When A factor or a dimension is scored 3 or lower, the expert asked to elevate his feedback.
- Ask the experts to tell a story or an example how would the framework be utilised.
- Ask the experts to provide some requirements for the system.

The outcome of this round is to refine the framework, ensuring its coherence, and providing illustrative stories and definitive requirements.

The table D.2 shows the duration for each expert. The experts interactions were:

TABLE D.2: Second Round of Experts Locations and Interview's Durations

Location	Expert ID	Duration
Virtual	Expert A	00:33M
	Expert E	00:32M
	Expert H	00:37M
	Expert I	00:26M
	Expert J	00:42M

TABLE D.3: Round 2: Delphi + GQM for the Main Dimensions

Goal	Purpose	Confirm the relevance and adequacy to
	Issue	Scope and effectiveness of
	Object	The four identified dimensions
	Viewpoint (Stakeholders)	Management and Users
Question	Do the identified FIST Framework dimensions fall within the scope of the research problem?	
Metric	Metric Factor	Measure
	Facilitating Conditions	Classification Score
	IT Operations	Classification Score
	Security Principles	Classification Score
	Trust and Accuracy	Classification Score
Classification Score: (5) Strongly Agree - (4) Agree (3) Neutral - (2) Disagree - (1) Strongly Disagree		
The Classification Score used to indicate dimension quality level in relevance to the research problem		

TABLE D.4: Round 2: Delphi + GQM for the Facilitating Conditions Factors

Goal	Purpose	Convince potential sponsors to
	Issue	Endorse new system by
	Object	Addressing/Assessing relatable factors
	Viewpoint (Stakeholders)	Management and Users
Question	Does the feature of those factors have the potential to align with stakeholder expectations and convince potential sponsors to facilitate a new system?	
Metric	Metric Factor	Measure
	Added Value	Classification Score
	Top Management Support	Classification Score
	Laws and Regulations	Classification Score
	Performance (KPI)	Classification Score
	Cooperation	Classification Score
	Resource Support	Classification Score
Classification Score: (5) Strongly Agree - (4) Agree (3) Neutral - (2) Disagree - (1) Strongly Disagree		
The Classification Score used to indicate factor quality level in relevance to the Purpose and Objective of its dimension		

TABLE D.5: Round 2: Delphi + GQM for the IT Operations Factors

Goal	Purpose	Convince potential software developers to
	Issue	Develop new system by
	Object	Ensure factors meet fundamental prerequisites
	Viewpoint (Stakeholders)	Software Developers and Engineers
Question	When considering the development of a new information sharing and exchange system with a focus on interoperability, do these factors correspond with the expectations of the stakeholders involved in this system's development?	
Metric	Metric Factor	Measure
	Adoptive Infrastructure	Classification Score
	Scalability	Classification Score
	Storage	Classification Score
	Usability	Classification Score
	Flexibility	Classification Score
	Reliability	Classification Score
Classification Score: (5) Strongly Agree - (4) Agree (3) Neutral - (2) Disagree - (1) Strongly Disagree		

TABLE D.6: Round 2: Delphi + GQM for the Security Principles Factors

Goal	Purpose	To ensure security measures applied to shared information for
	Issue	The risk of unauthorised access or comprised data of
	Object	The shared information (allocated information)
	Viewpoint (Stakeholders)	Users who share their Information
Question	When evaluating security protocols implemented for the sharing and exchange of information, with a special emphasis on data access security, do these factors meet the expectations of stakeholders involved in granting access to the information?	
Metric	Metric Factor	Measure
	Confidentiality	Classification Score
	Authentication	Classification Score
	Authorisation	Classification Score
	Availability	Classification Score
	Encryption	Classification Score
	Integrity	Classification Score
Classification Score: (5) Strongly Agree - (4) Agree (3) Neutral - (2) Disagree - (1) Strongly Disagree		

TABLE D.7: Round 2: Delphi + GQM for the Trust and Accuracy Factors

Goal	Purpose	Enhance trust and accuracy in the sharing of information on
	Issue	The potential risk of inaccuracies in the shared data of
	Object	Shared information systems
	Viewpoint (Stakeholders)	Users who request and share information
Question	When requesting information from diverse sources that distribute data, how vital do you view the roles of trust and accuracy in the request and supply of information? To what extent do these factors align with the expectations of stakeholders who are actively engaged in accessing this shared data?	
Metric	Metric Factor	Measure
	System Integrations	Classification Score
	Private Information	Classification Score
	Data Verification and Validation	Classification Score
	Provenance	Classification Score
	Misrepresented Information	Classification Score
	Distributed Records	Classification Score
Classification Score: (5) Strongly Agree - (4) Agree (3) Neutral - (2) Disagree - (1) Strongly Disagree		

D.2.1 Round 2: Applying GQM to the Four Dimensions of FIST Framework

GQM is applied to FIST Framework dimensions as Figure D.1 shows and applied on the goal question metric approach analysis on table D.3.

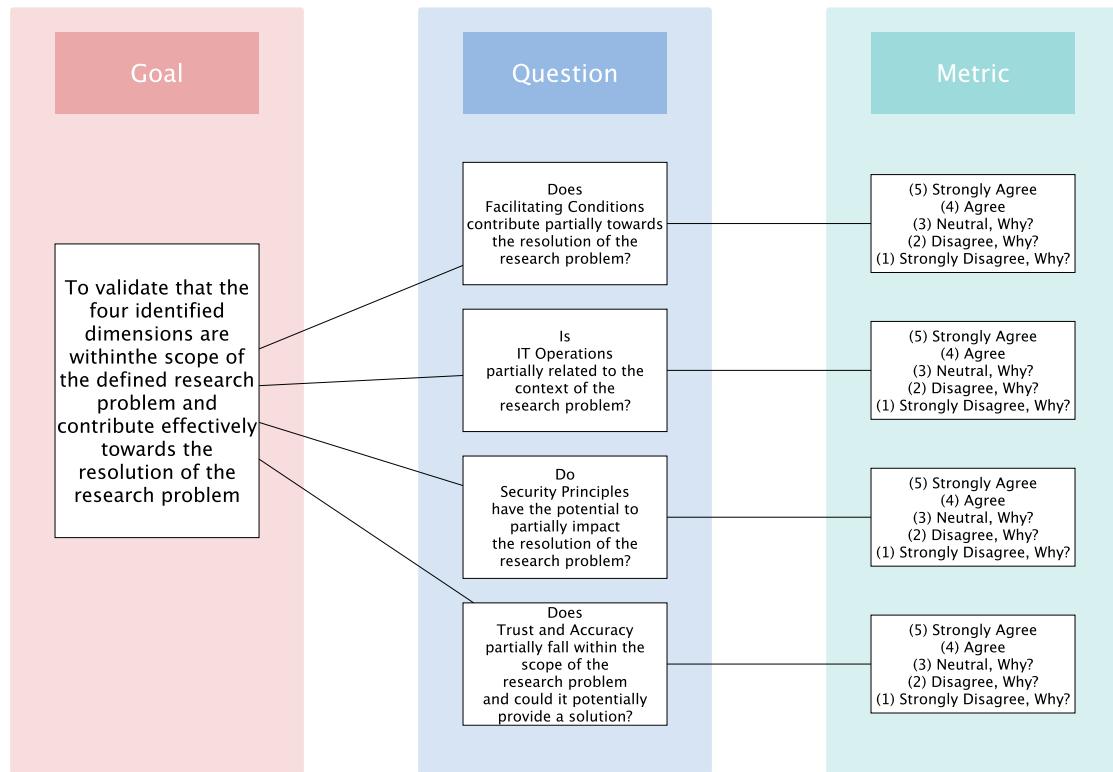


FIGURE D.1: Round 2: GQM applied on FIST Framework Dimensions

Applying GQM to Facilitating Conditions GQM is applied to Facilitating Conditions dimension's factor as Figure D.2 shows and applied on the goal question metric approach analysis on table D.4.

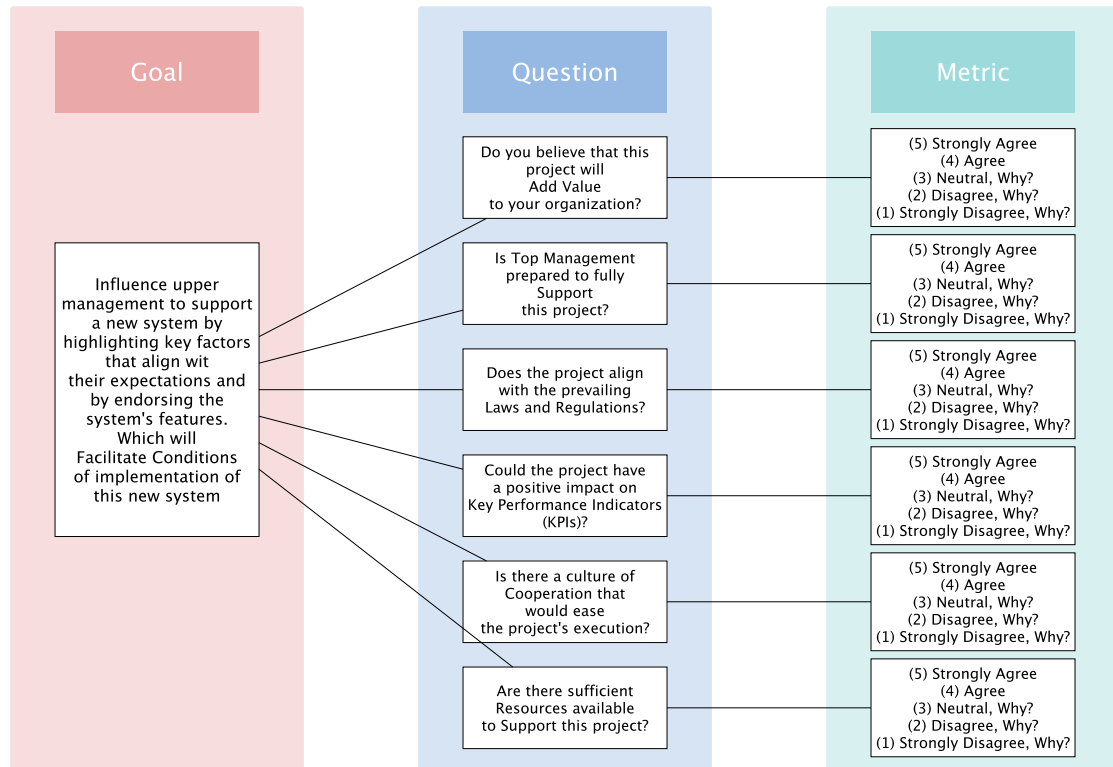


FIGURE D.2: Round 2: Deploying GQM on Facilitating Conditions Factors

Applying GQM to IT Operations GQM is applied to IT Operations dimension's factor as Figure D.3 shows and applied on the goal question metric approach analysis on table D.5.

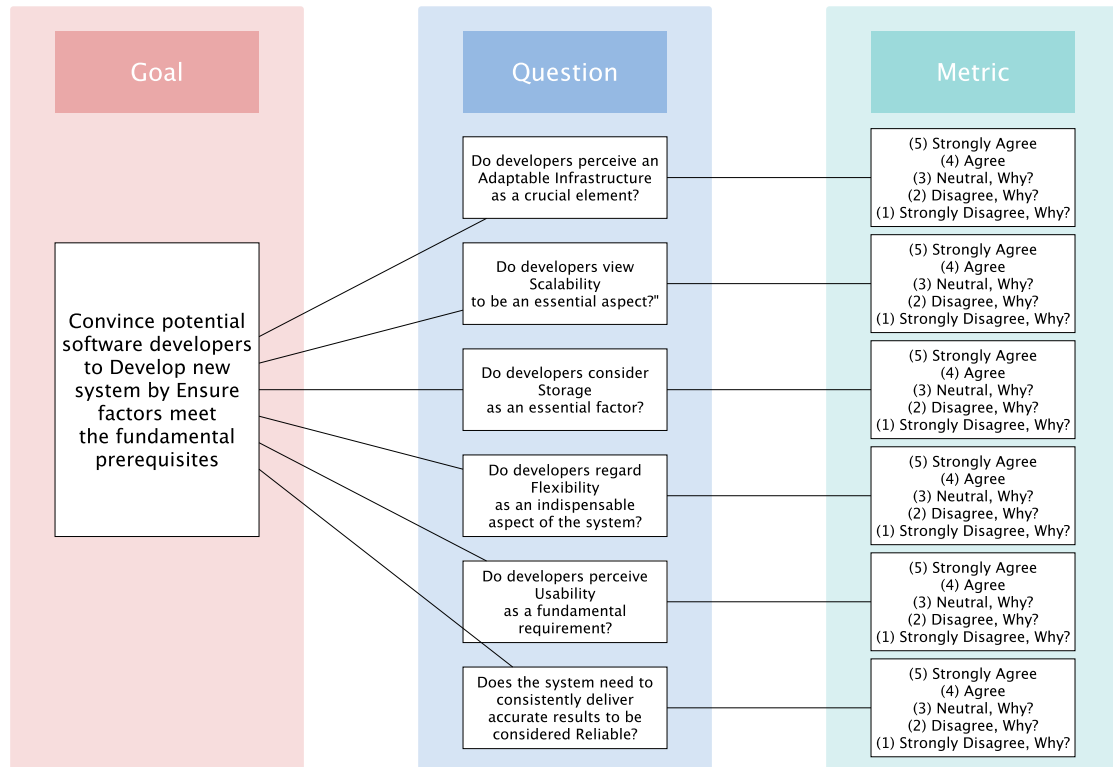


FIGURE D.3: Round 2: Deploying GQM on IT Operations Factors

Applying GQM to Security Principles GQM is applied to Security Principles dimension's factor as Figure D.4 shows and applied on the goal question metric approach analysis on table D.6.

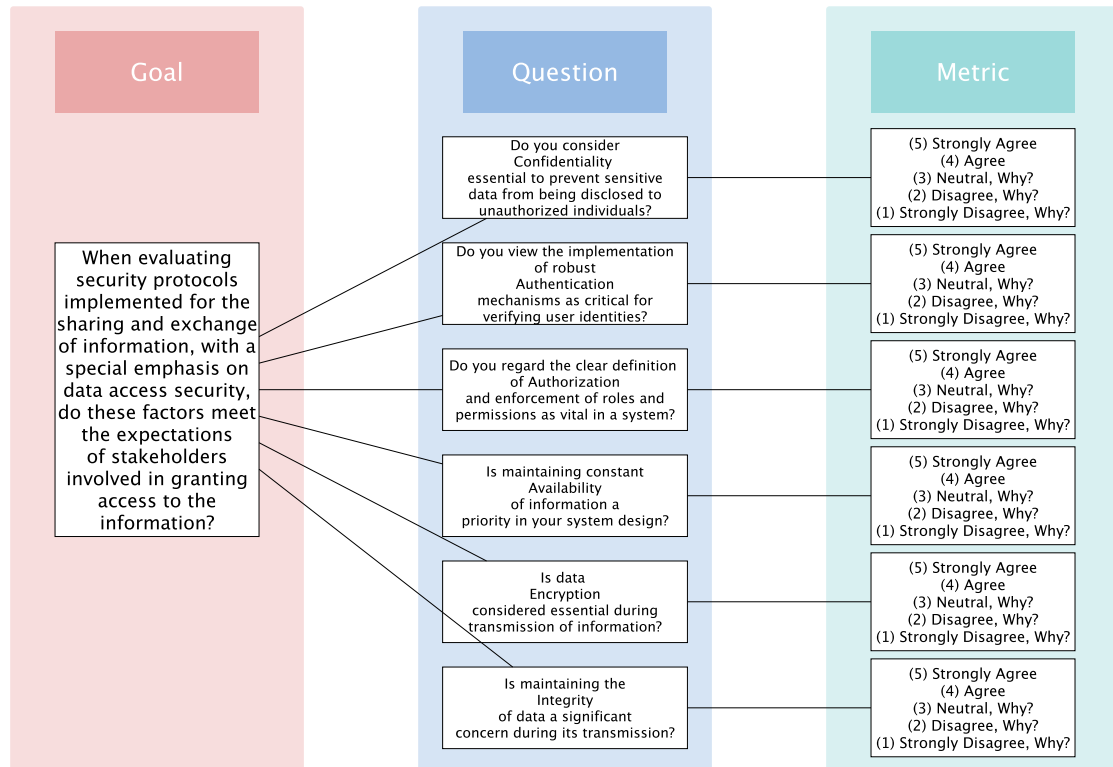


FIGURE D.4: Round 2: Deploying GQM on Security Principles Factors

Applying GQM to Trust and Accuracy GQM is applied to Trust and Accuracy dimension's factor as Figure D.5 shows and applied on the goal question metric approach analysis on table D.7.

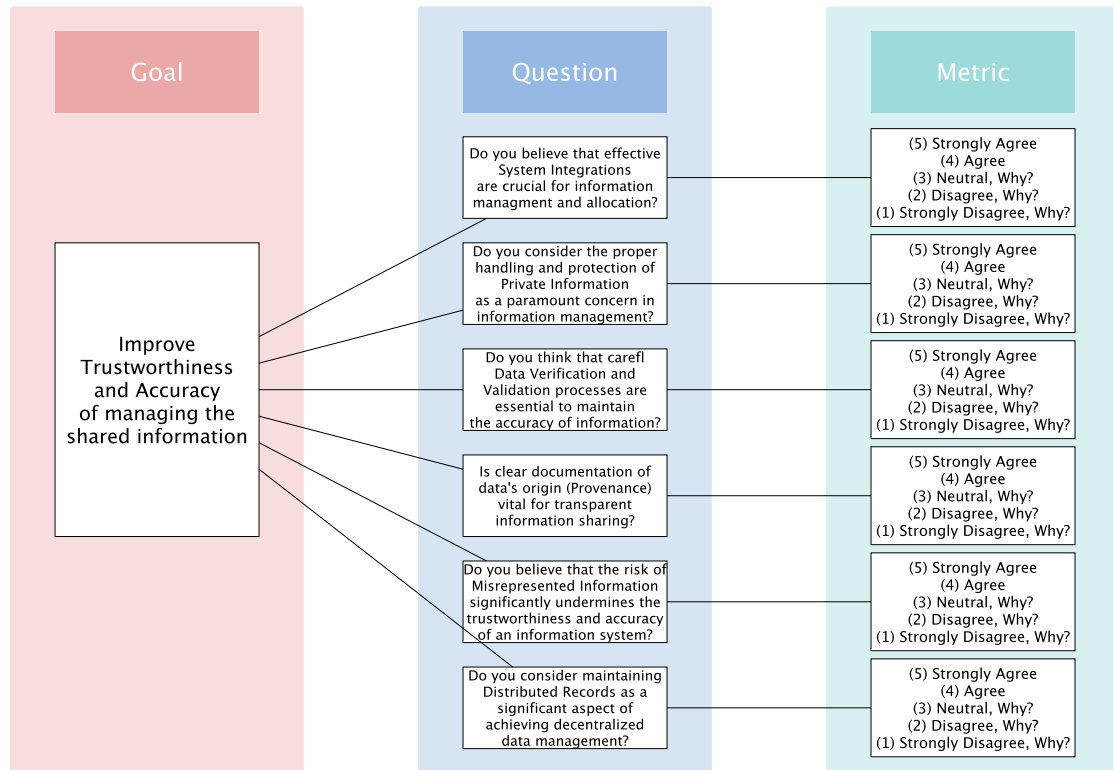


FIGURE D.5: Round 2: Deploying GQM on Trust and Accuracy Factors

D.2.2 Analysis of the of Expert A Interview

TABLE D.8: Second Round of Expert A Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	5	5	5	5	4	5	5
2	1	5	5	5	5	5	5
3	3	5	5	5	5	5	5
4	5	5	5	1	5	1	2

Rejected Dimensions: (2-0) and (3-0)

(2-0): This is about the dimension (*IT Operations*); please Refer to A.R2.02 on Table D.30.

(3-0): This is about the dimension (*Security Principles*); please Refer to A.R2.03 on Table D.30.

Rejected Factors: (4-3), (4-5) and (4-6).

(4-3) & (4-5):

(4-6):

D.2.3 Analysis of the of Expert E Interview

TABLE D.9: Second Round of Expert E Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	5	5	5	5	2	5	5
2	1	5	5	5	5	5	5
3	1	5	4	5	4	5	5
4	5	5	5	1	5	1	3

D.2.4 Analysis of the of Expert H Interview

TABLE D.10: Second Round of Expert H Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	5	5	5	5	1	5	5
2	1	5	5	5	5	5	5
3	1	5	5	5	5	1	5
4	5	5	1	1	5	1	3

D.2.5 Analysis of the of Expert I Interview

TABLE D.11: Second Round of Expert I Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	5	5	5	5	2	5	5
2	3	5	5	5	5	5	5
3	3	5	5	5	5	3	5
4	5	5	3	2	5	2	2

D.2.6 Analysis of the of Expert J Interview

TABLE D.12: Second Round of Expert J Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	4	4	4	4	3	4	4
2	3	4	4	4	4	4	4
3	3	4	4	4	4	2	4
4	5	5	2	2	5	2	2

D.3 Third Delphi Round

This section has the experts interview analysis on the Figure 6.4 while the moderator (the researcher) is reading the Goal, Question and Metric shown on tables D.14, D.15, D.16, D.17 and D.18 with the numbers referencing to the figure 6.4.

This section was approached as the following:

In each interaction, experts practiced following points:

- Reminded that this session is recorded.
- The framework has been revised and updated since our last discussion.
- We revisited the key issue that the research aims to address.
- An overview of the topics from our previous meeting was provided.
- Participants were invited to suggest potential solutions within the framework that could effectively address the research problem.
- Experts were encouraged to articulate the primary problem in their own terms.
- Evaluations were categorised as either 'adequate' or 'inadequate'. In case of an 'inadequate' classification, experts were requested to provide more in-depth feedback for improvement.

The objective of this round is to pinpoint the main key problem within information exchange. The table D.13 shows the duration for each expert.

TABLE D.13: Third Round of Experts Locations and Interview's Durations

Location	Expert ID	Duration
Virtual	Expert A	00:29M
	Expert E	00:33M
	Expert H	01:02M
	Expert I	00:29M
	Expert J	00:32M

TABLE D.14: Round 3: Delphi + GQM for the Main Dimensions

Goal	Purpose	Confirm the relevance and adequacy to
	Issue	Scope and effectiveness of
	Object	The four identified dimensions
	Viewpoint (Stakeholders)	Management and Users
Question	Do the identified FIST Framework dimensions fall within the scope of the research problem?	
Metric	Metric Factor	Measure
	Facilitating Conditions	Rating Score
	IT Services	Rating Score
	Secure Access	Rating Score
	Trust and Accuracy	Rating Score
Classification Score: (✓) Adequate - (X) Inadequate, Why?		

TABLE D.15: Round 3: Delphi + GQM for the Facilitating Conditions Factors

Goal	Purpose	Convince potential sponsors to
	Issue	Endorse new system by
	Object	Addressing/Assessing relatable factors
	Viewpoint (Stakeholders)	Management and Users
Question	Does the feature of those factors have the potential to align with stakeholder expectations and convince potential sponsors to facilitate an new system?	
Metric	Metric Factor	Measure
	Added Value	Rating Score
	Top Management Support	Rating Score
	Laws and Regulations	Rating Score
	Service Level Agreement (SLA)	Rating Score
	Cooperation	Rating Score
	Resource Support	Rating Score
Classification Score: (✓) Adequate - (X) Inadequate, Why?		

TABLE D.16: Round 3: Delphi + GQM for the IT Services Factors

Goal	Purpose	Convince potential software developers to
	Issue	Service a new system by
	Object	Ensure factors meet fundamental prerequisites
	Viewpoint (Stakeholders)	Software Developers and Engineers
Question	When considering the development of a new information sharing and exchange system with a focus on interoperability, do these factors correspond with the expectations of the stakeholders involved in this system's development?	
Metric	Metric Factor	Measure
	Adoptive Infrastructure	Rating Score
	Scalability	Rating Score
	Storage	Rating Score
	Usability	Rating Score
	Flexibility	Rating Score
	Reliability	Rating Score
Classification Score: (✓) Adequate - (X) Inadequate, Why?		

TABLE D.17: Round 3: Delphi + GQM for the Secure Access Factors

Goal	Purpose	To ensure security measures applied to shared information for
	Issue	The risk of unauthorised access or comprised data of
	Object	The shared information (allocated information)
	Viewpoint (Stakeholders)	Users who share their Information
Question	When evaluating security protocols implemented for the sharing and exchange of information, with a special emphasis on data access security, do these factors meet the expectations of stakeholders involved in granting access to the information?	
Metric	Metric Factor	Measure
	Confidentiality	Rating Score
	Authentication	Rating Score
	Authorisation	Rating Score
	Availability	Rating Score
	Privacy (Rating to Share)	Rating Score
	Integrity	Rating Score
Classification Score: (✓) Adequate - (X) Inadequate, Why?		

TABLE D.18: Round 3: Delphi + GQM for the Trust and Accuracy Factors

Goal	Purpose	Enhance trust and accuracy in the sharing of information on
	Issue	The potential risk of inaccuracies in the shared data of
	Object	Shared information systems
	Viewpoint (Stakeholders)	Users who request and share information
Question	When requesting information from diverse sources that distribute data, how vital do you view the roles of trust and accuracy in the request and supply of information? To what extent do these factors align with the expectations of stakeholders who are actively engaged in accessing this shared data?	
Metric	Metric Factor	Measure
	System Integrations	Rating Score
	Data Encryption	Rating Score
	Data Verification	Rating Score
	Provenance	Rating Score
	Data Validation	Rating Score
	Information Exchange	Rating Score
Classification Score: (✓) Adequate - (X) Inadequate, Why?		

D.3.1 Round 3: Applying GQM

Applying GQM to the Four Dimensions of FIST Framework GQM is applied to FIST Framework dimensions as Figure D.6 shows and applied on the goal question metric approach analysis on table D.14.

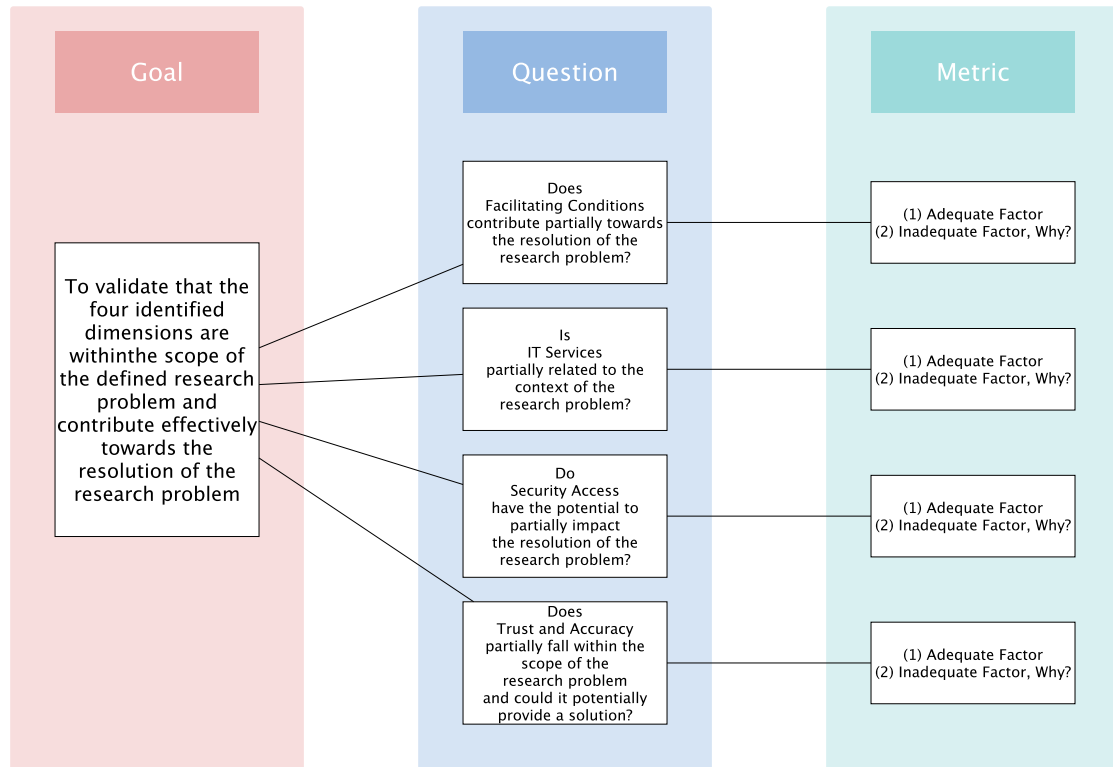


FIGURE D.6: Round 3: Deploying GQM to FIST Framework Dimensions

Applying GQM to Facilitating Conditions GQM is applied to Facilitating Conditions dimension’s factor as Figure D.7 shows and applied on the goal question metric approach analysis on table D.15.

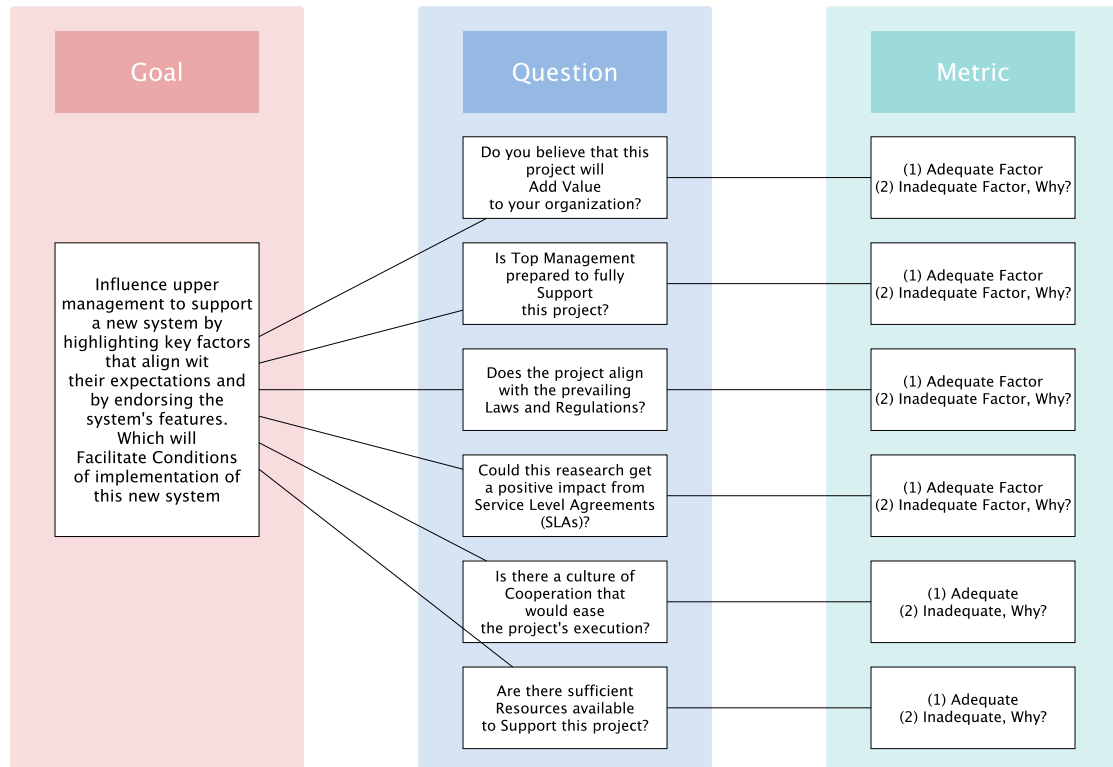


FIGURE D.7: Round 3: Deploying GQM on Facilitating Conditions Factors

Applying GQM to IT Services GQM is applied to IT Operations dimension's factor as Figure D.8 shows and applied on the goal question metric approach analysis on table D.16.

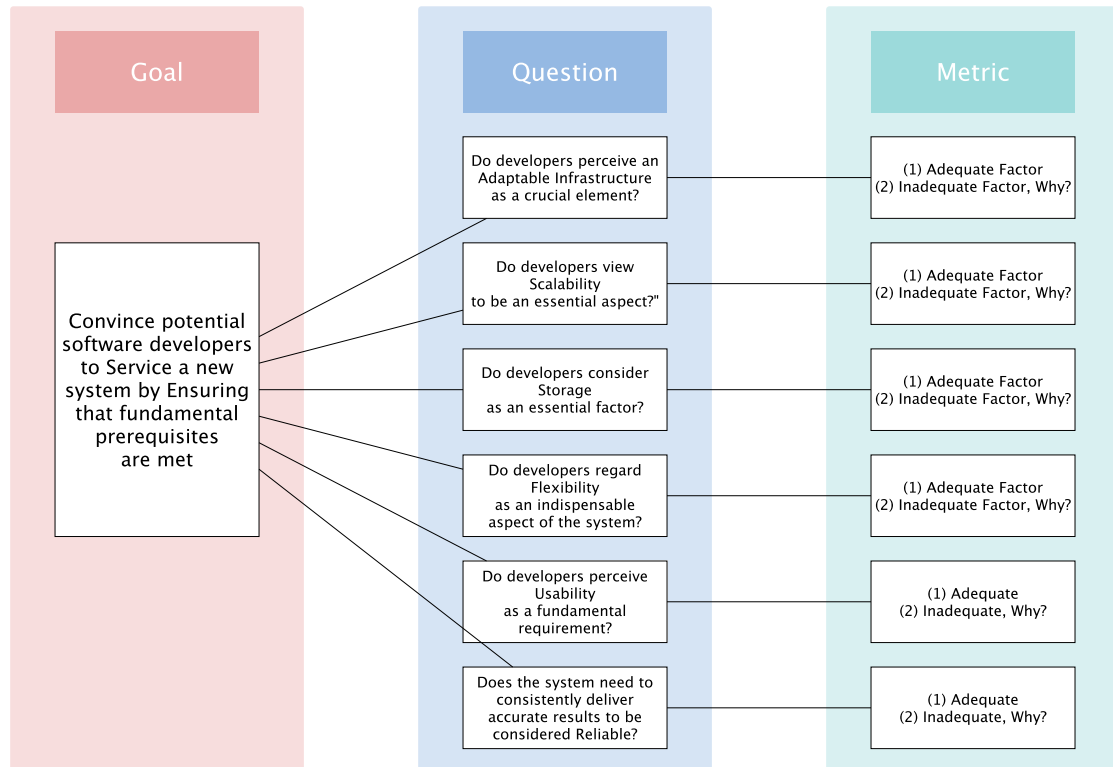


FIGURE D.8: Round 3: Deploying GQM on IT Services Factors

Applying GQM to Secure Access GQM is applied to Security Principles dimension's factor as Figure D.9 shows and applied on the goal question metric approach analysis on table D.17.

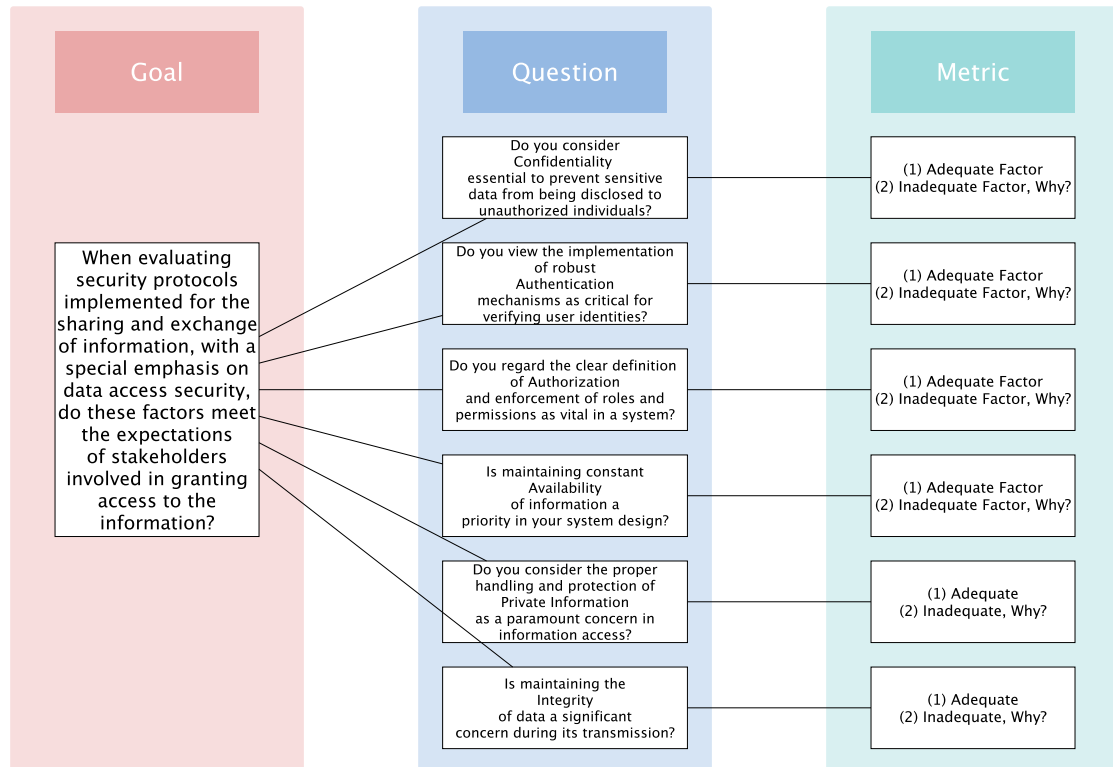


FIGURE D.9: Round 3: Deploying GQM on Secure Access Factors

Applying GQM to Trust and Accuracy GQM is applied to Trust and Accuracy dimension’s factor as Figure D.10 shows and applied on the goal question metric approach analysis on table D.18.

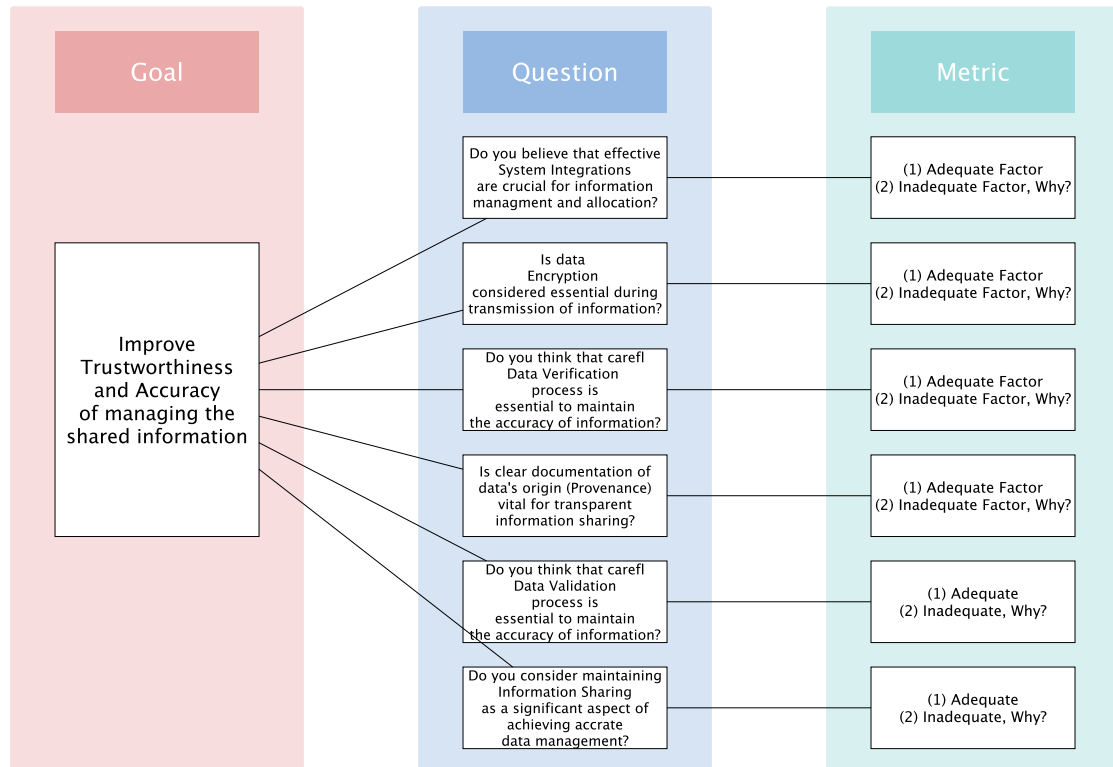


FIGURE D.10: Round 3: Deploying GQM on Trust and Accuracy Factors

D.3.2 Findings of Expert A Interview

TABLE D.19: Third Round of Expert A Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓

D.3.3 Findings of Expert E Interview

TABLE D.20: Third Round of Expert E Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓

D.3.4 Findings of Expert H Interview

TABLE D.21: Third Round of Expert H Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓

D.3.5 Findings of Expert I Interview

TABLE D.22: Third Round of Expert I Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓

D.3.6 Findings of Expert J Interview

TABLE D.23: Third Round of Expert J Classifications Score

Dimensions	Factors						
	0	1	2	3	4	5	6
1	✓	✓	✓	✓	✓	✓	✓
2	✓	✓	✓	✓	✓	✓	✓
3	✓	✓	✓	✓	✓	✓	✓
4	✓	✓	✓	✓	✓	✓	✓

D.4 Fourth Delphi Round

This section has the experts interview analysis on the Figure 6.4 while the moderator (the researcher) is reading the Goal, Question and Metric shown on tables D.14, D.15, D.16, D.17 and D.18 with the numbers referencing to the figure 6.4. This section was approached as the following:

In each interaction, experts practiced following points:

- Reminded that this session is recorded.
- The framework has been revised and updated since our last discussion (Nothing Changed).
- We revisited the key issue that the research aims to address.
- An overview of the topics from our previous meeting was provided.
- The experts requested to provide a sequential order of the factors.
- The experts were asked to confirm if the Key problem is Trust and Accuracy.
- The experts were asked to provide scenarios of how the framework could be beneficial.

The objective of this round is to create the factors in a sequential order which create the scenarios. The table D.13 shows the duration for each expert.

TABLE D.24: Fourth Round of Experts Locations and Interview's Durations

Location	Expert ID	Duration
Virtual	Expert A	00:19M
	Expert E	00:22M
	Expert H	00:36M
	Expert I	00:19M
	Expert J	00:28M

To effectively arrange various factors in a sequential manner to create scenarios and organise dimensions that construct a cohesive and meaningful narrative. putting factors in sequential order This allows visualising the framework and in create a representative scenario.

TABLE D.25: GQM Main R3 Dimensions

Goal	Purpose	To organise in a sequential order and
	Issue	The arrangement of dimensions to
	Object	Create a compelling story
	Viewpoint (Stakeholders)	Management and Users
Question	Could you please arrange these factors in sequential order to illustrate a plausible scenario? Start with the initial dimension and progress towards factors sequentially to be linked with the next dimension, ensuring a logical flow between factors	
Metric	Metric Factor	Measure
	Facilitating Conditions	Rating Score
	IT Services	Rating Score
	Secure Access	Rating Score
	Trust and Accuracy	Rating Score
Rating Score: (1) First - (2) Second - (3) Third - (4) Fourth - (5) Fifth - (6) Sixth 1 Represents the initial starting factor and 6 signifies the final factor in the sequence		

TABLE D.26: Round 4: Delphi + GQM for the Facilitating Conditions Factors

Goal	Purpose	To organise in a sequential order and
	Issue	The arrangement of factors to
	Object	Create a coherent scenarios
	Viewpoint (Stakeholders)	Management and Users
Question	Could you please arrange these factors in sequential order to illustrate a plausible scenario? Start with the initial dimension and progress towards factors sequentially to be linked with the next dimension, ensuring a logical flow between factors	
Metric	Metric Factor	Measure
	Added Value	Rating Score
	Top Management Support	Rating Score
	Laws and Regulations	Rating Score
	Service Level Agreement (SLA)	Rating Score
	Cooperation	Rating Score
	Resource Support	Rating Score
Rating Score: (1) First - (2) Second - (3) Third - (4) Fourth - (5) Fifth - (6) Sixth 1 Represents the initial starting factor and 6 signifies the final factor in the sequence		

TABLE D.27: Round 4: Delphi + GQM for the IT Operations Factors

Goal	Purpose	To organise in a sequential order and
	Issue	The arrangement of factors to
	Object	Create a coherent scenarios
	Viewpoint (Stakeholders)	Software Developers and Engineers
Question	Could you please arrange these factors in sequential order to illustrate a plausible scenario? Start with the initial dimension and progress towards factors sequentially to be linked with the next dimension, ensuring a logical flow between factors	
Metric	Metric Factor	Measure
	Adoptive Infrastructure	Rating Score
	Scalability	Rating Score
	Storage	Rating Score
	Usability	Rating Score
	Flexibility	Rating Score
	Reliability	Rating Score
Rating Score: (1) First - (2) Second - (3) Third - (4) Fourth - (5) Fifth - (6) Sixth 1 Represents the initial starting factor and 6 signifies the final factor in the sequence		

TABLE D.28: Round 4: Delphi + GQM for the Secure Access Factors

Goal	Purpose	To organise in a sequential order and
	Issue	The arrangement of factors to
	Object	Create a coherent scenarios
	Viewpoint (Stakeholders)	Users who share their Information
Question	Could you please arrange these factors in sequential order to illustrate a plausible scenario? Start with the initial dimension and progress towards factors sequentially to be linked with the next dimension, ensuring a logical flow between factors	
Metric	Metric Factor	Measure
	Confidentiality	Rating Score
	Authentication	Rating Score
	Authorisation	Rating Score
	Availability	Rating Score
	Privacy (Rating to Share)	Rating Score
	Integrity	Rating Score
Rating Score: (1) First - (2) Second - (3) Third - (4) Fourth - (5) Fifth - (6) Sixth 1 Represents the initial starting factor and 6 signifies the final factor in the sequence		

TABLE D.29: Round 4: Delphi + GQM for the Trust and Accuracy Factors

Goal	Purpose	To organise in a sequential order and
	Issue	The arrangement of factors to
	Object	Create a coherent scenarios
	Viewpoint (Stakeholders)	Users who request and share information
Question	Could you please arrange these factors in sequential order to illustrate a plausible scenario? Start with the initial dimension and progress towards factors sequentially to be linked with the next dimension, ensuring a logical flow between factors	
Metric	Metric Factor	Measure
	System Integrations	Rating Score
	Data Encryption	Rating Score
	Data Verification	Rating Score
	Provenance	Rating Score
	Data Validation	Rating Score
	Information Exchange	Rating Score
Rating Score: (1) First - (2) Second - (3) Third - (4) Fourth - (5) Fifth - (6) Sixth 1 Represents the initial starting factor and 6 signifies the final factor in the sequence		

D.4.0.1 Analysis of the of Expert E Interview

Accepted Dimensions: (1-0) and (4-0).

Accepted Factors: (1-1), (1-2), (1-3), (1-5), (1-6), (2-1), (2-2), (2-3), (2-4), (2-5), (2-6), (3-1), (3-2), (3-3), (3-4), (3-5), (3-6), (4-1), (4-2) and (4-4).

Rejected Dimensions: (2-0) and (3-0)

(2-0): This is about the dimension (*IT Operations*); Expert E said: "*This is about the development team and what is important on their scope of work*". The moderator suggested "IT development" based on a previous expert's feedback (Expert A). Then, Expert E said: "*Yes, Information Technology Services does sound about right*".

(3-0): This is about the dimension (*Security Principles*); Expert E said: "*This dimension shows a secure access to a systems or source of data. Naming it (Security Principles) is not clear because security has many principles, which could raise questions on which aspects of security should be under this dimension. I mean if I read the dimension's name or what you called parent, I will not understand the factors are inherited from (Security Principles)*".

Rejected Factors: (1-4), (4-3), (4-5) and (4-6).

(1-4): This is about the dimension (*KPI Performance*); Expert E said: "*Each company has its own unique way on measuring performance of their employee. KPI on your scope is not sensible for information sharing*". Also, as a replacement; Expert E said: "*Did you think about including Service Level Agreement (SLA) with different stakeholders?; it is like a commitment made by a service provider. Read about it, it is like a formal commitment giving detailed responsibilities accompanying with the service that is being provided*".

(4-3) & (4-5): These include both factors; (*Misrepresented Information*) and (*Data Verification and Validation*); Expert E Said: "*Data validation is a tricky one... Validation is important but not like you described, separate Data Verification and Validation for clearer purpose. Also, Misrepresented Information sounds like; was it accidental or intentional?*"

(4-6): This is about the dimension (*Distributed Records*); The moderator asked if this factor is vague and based on specific technologies. Expert E said: "*I agree with the other expert, it does look like it is vague. Information Sharing is more clear*".

D.4.0.2 Analysis of the of Expert H Interview

Accepted Dimensions: (1-0) and (4-0).

Accepted Factors: (1-1), (1-2), (1-3), (1-5), (1-6), (2-1), (2-2), (2-3), (2-4), (2-5), (2-6), (3-1), (3-2), (3-3), (3-4), (3-6), (4-1) and (4-4).

Rejected Dimensions: (2-0) and (3-0).

(2-0): This is about the dimension (x); Expert H said: *"It is not the operation only prospective, it is both development and operation perspectives, I would suggest naming it "DevOps", which is a practice of combining software development (Dev) and IT operations (Ops)"*.

(3-0): This is about the dimension (x); Expert H said: *"Secure Access is a very ambiguous term. All other factors hint what they are. Maybe to call it secure access controls. It is about the access controls on the information before sharing."*

Rejected Factors: (1-4), (3-5), (4-2), (4-3), (4-5) and (4-6).

(1-4): This is about the factor (KPI); Expert H said: *"KPI is irrelevant. Moreover, the way you are tackling the problem, makes the KPI drops and becomes unnecessarily. Especially, when now you are focused on solving over-saturation and undersaturation issues and NOT unemployed, that means most users are newly graduates and fresh for new markets"* Then the moderator mentioned a feedback from another expert; Expert H said: *"Yes, SLA instead makes more sense"*. Then later in the meeting, Expert H said: *"I see what other experts meant by SLA, however, generally speaking; SLAs are contracts constructed with agreement between a service provider and a client. It specify in measurable terms. Also, it has the responsibility aspect, which is critical when the stake holders are providing information. I guess you can look at it both ways, as even the data recipient should have clear responsibilities on how they will use the information"*.

(3-5) & (4-2): This is about both factors dimension (*Encryption & Private Information*); Expert H said: *" Why you have encryption here? encryption is needed if you are not using e-gov systems, it about cipher the information and make it unreadable. Also, Secure Access control uses security checks (authentication) on users and confirms who they claim to be. This guarantees that the right level of access for particular user. This makes the data you need only accessible by authorised users. Also, to check for private information and at what consent, should be with the secure access controls"*.

(4-3) & (4-5): This is about both factors dimension (*Data Verification and Validation & Misrepresented Information*); Expert H said: *"Misrepresentation with only two sectors (EMP and EDU) will allow people who has the same*

names to claim, like the name Mohamed Ali, many has that name, but which Mohamed Ali we are talking about, hence, data verification".

(4-6): This is about the dimension (*Distributed Records*); Expert H said: *"I agree with other experts, it is not a decentralised systems, it is well known that government systems must be centralised"*.

D.4.0.3 Analysis of the of Expert I Interview

The Moderator Explained to the Expert that a previous Expert mentioned it should be named IT Development.

(2-0): This is about the dimension (*IT Operations*); Expert I said: "*The Expert suggested Name it IT Services*" or "*Information Technology Services*" because it can be used to include both *IT operations* and *IT development*".

yes, it means more actions the theory, i mean when i read it, i can understand it ensure security of the data.

D.4.0.4 Analysis of the of Expert J Interview

The Moderator Explained to the Expert that a previous Expert mentioned it should be named IT Development, or IT Services.

(2-0): This is about the dimension (*Renamed Dimensions*); Expert J said: " *IT Services describes the domain of both technological support and development processes. This involve not limited to; the design, development, implementation and maintenance*".

Secure Access is more user friendly, easier for technical and non-technical users to understand.

(2-0): This is about the dimension (*IT Operations*); Expert H said: " ".

Secure access seems to better "YA9OB" feeding the scope.

Yes, SLA can can be provided data as part of stakeholder service. SLA could be relevant in the context of data services, where a stakeholder is providing access to certain database or information.

Yes, SLA can define supplying which date to be expected from the stakeholder. This ensure data compliance, i mean getting relevant data with relevance between the data provider and the data recipient.

There were few change on the on of the factors that we did not discuss.

EXA R3: SLA? of course, it's important, the IT Service provider and the Data access are both SLAs.

Secure access control uses policies that verify users are who they claim to be and ensures appropriate control access levels are granted to users. Implementing access control is a crucial component of web application security, ensuring only the right users have the right level of access to the right resources."

Regarding KPI, right now it is not valid. You should disregard it

TABLE D.30: Round Two: Expert A Spoken Sentences and Their affected Components

Expert A Round Two		
Sentence ID	“Spoken Sentence”	Affected Components
A.R2.01:	“A direction in the labour market indicates an urgent need for certain types of graduates and an oversupply of graduates in fields with little to no demand. To inspire more comprehensive research and studies accomplished through information sharing and consolidation (information in one place), having all relevant information in one place enables a more practical understanding of potential improvements. This issue has led to increased outsourcing and an inflow of foreign workers in the labour market. An earlier study showed that over 70% of the workforce was non-Saudis. Therefore, Saudization could help reduce dependence on foreign labour. Finally, government programs, “Sanid” and “Hafiz”, support citizens; a system to solve the research problem will optimise the government programs to their full potential”.	The Thesis Research Problem.
A.R2.02:	“Based on the problem and the factors, we are discussing system development, not IT Operations. I would suggest simplifying it and referring to it as “IT Development”, which offers both aspects”.	(2-0).
A.R2.03:	“Upon examining the factors, they explain that accessing the system to retrieve data involves user rights and credentials, essentially logging into a system or accessing data. However, the dimension’s name expresses a general field or discipline”.	(3-0).
A.R2.04:	“Naming a factor “Misrepresentation” refers to false information, deceptive behaviour, or dishonesty about something. It appears to be relevant to your research as it falls within the scope of your framework. However, to amplify its relevance, the factor’s focus should eliminate undesirable activities through the involvement of verification and validation”.	(4-3)
A.R2.05:	“Keeping vacancy information “up to date” is critical. Data validation doesn’t solely concern expired certificates but also any expired or unavailable vacancies. For example, if a vacancy is inaccessible, it should be removed from all systems. Therefore, if someone applies for a vacancy, it should be available (“Now” or Future) and forthcoming to candidates. This factor highlights the importance of up-to-date vacancy information”.	(4-5).
A.R2.06:	“Regarding “Distributed Records”: If your framework doesn’t involve the use of blockchain or distributed information due to its decentralised nature, I suggest renaming this factor to something like “Information Exchange” or “Information Distribution” to be more specific”	(4-6).
A.R2.07:	“Despite applying to many job postings on various platforms (e.g., LinkedIn), I’ve received no responses, leaving my personal information exposed. There are instances where I’ve applied for jobs and reached the “Personal Interview” stage, only to find out that the job didn’t exist, which wastes the applicant’s time; this instance seems only data collection exercises to study salary ranges and market conditions.”.	TEDW
A.R2.08:	“For example, during the job application process, I reached the personal interview stage, only to find out that the job didn’t exist and appeared only interested in collecting data to understand salary ranges and market conditions. I’ve applied to numerous offers and links, including on LinkedIn, but have not received any responses. As a result, my personal information is now publicly available. I insist that my information only be shared when there’s a likely chance of a compelling offer or opportunity in return. I also expect privacy, meaning my data should only be accessed when necessary, when it offers something in return or for development purposes. Lastly, I require a system that maintains accurate information about the candidate and the job description. As a vacancy holder, I want a system that allows me to publish my vacancies and attract candidates that align with the vacancy description.”	TEDW

... Continued on next page

Expert A

A.R2.09: *“Like any powerful software system implemented in the government sector, there’s a critical journey from conception to realisation. First, the inception of such a system calls for a sponsor, someone with the vision and resources to facilitate its cause. Once the sponsor is onboard, it’s time to assemble a team. This team of dedicated and skilled developers will transform what was once an “Added Value” into tangible software. The developers will require data, the lifeblood of any data system. Service Level Agreements (SLAs) are set up with stakeholders to ensure a steady and reliable supply. These contracts guarantee the delivery of data that is both timely and relevant. Finally, at the foundation of this software system lie Trust and Accuracy. Verification then validation mechanisms must be implemented to ensure that the information gets thorough checks, is processed and then exchanged and is as accurate as possible”.* **Story Problem.**

A.R2.10: *“Certainly, trust, particularly regarding information availability and accuracy regarding creating the information, represents a keystone for the advantage of the FIST framework-based system. Addressing it can substantially improve system implementation.”* **Key Problem.**

The Expert spoke these sentences while asking about the research problem and if the problem exists:

D.4.0.5 Applying TEDW

The moderator deployed the TEDW methodology on the experts to ensure an understanding of the delivery of the issue and the FIST framework. This model inspires more insightful questions to enhance their knowledge of the problem. It observed an essential step in understanding the story problem, requirements and usage through a collective intellectual journey, enabling clarity and precision in the FIST framework quest.

The Story:

This expert requirements are:

1. I require the system to show the descriptions of the salary range included in the job profile.
2. I require a system that delivers results, either in terms of candidates or vacancies.
3. My information must only be shared when there’s a compelling offer or opportunity in return.
4. My data should only be viewed when necessary, either when it offers something in return or facilitates development.
5. The system could facilitate profile matching by aligning candidates to vacancies.
6. The system could promote communication between the vacancy holder and the applying candidate.
7. I require over my privacy, deciding when to share my information and when to remove it.
8. The system must be impartial, showing no favouritism.

9. I require accurate information about both; the candidate and the job description is essential.
10. The system should store the origin of certificates, even if it's not shown and kept hidden.
11. As a vacancy holder, I want to publish my vacancy and attract matching candidates.
12. The system must maintain accurate information about vacancy availability and description, including salary range.
13. The system should provide feedback, even in unsuccessful applications, indicating how the candidate can improve or explaining the reason for rejection.

The Key Problem:

The moderator mentioned that based on your feedback and other experts (From Round Two and Round One), discovering a fundamental problem is a central focus that captures the critical task of the FIST framework-based system. Then the moderator highlighted the significant issue derived directly from your feedback and other experts' insights. The fundamental problem that emerged is Trust in the sense of availability for information exchange and accuracy, as the creator of the information must have the authorisation for creating the data.

Sanrios

Scenario 1: A labour market analyst notices a trend where certain types of graduates are in high demand while other fields oversaturate with graduates. They publish this insight using this system, unfolding discussions among educational institutions to realign their curriculums accordingly, thus creating a more balanced labour market.

Scenario 2: A recruitment manager has a vacant role with a specific salary range. They use the system to post the job description, including the salary range, ensuring transparency and attracting candidates who align with the compensation offered.

Scenario 3: A job seeker has encountered cases of misrepresentation, such as non-existent job openings used for data collection purposes. They turn to the system which promises authenticity in job postings, with all vacancies validated for their existence and availability.

Appendix E

This appendix provides the diagrams, tables, figures that were used to mover from the FIST framework to Requirements.

E.1 Tables

E.1.1 Experts Reactions to "Facilitating Conditions"

This subsection shows the experts reactions

TABLE E.1: Experts Reactions to "Facilitating Conditions"

Factor	Emphasis	Expert														
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
1-0	SE	✓	✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	✓	✓
	ME							✓			✓					
	LE															
	NE															
1-1	SE	✓	✓	✓		✓	✓	✓	✓			✓	✓			
	ME															
	LE				✓					✓	✓			✓	✓	✓
	NE															
1-2	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME															
	LE															✓
	NE															
1-3	SE		✓		✓	✓	✓	✓	✓		✓		✓	✓	✓	✓
	ME															
	LE	✓		✓						✓		✓				
	NE															
1-4	SE	✓	✓				✓		✓	✓		✓	✓	✓		✓
	ME															
	LE					✓					✓				✓	
	NE			✓	✓			✓								
1-5	SE	✓		✓	✓	✓					✓	✓	✓	✓		✓
	ME															
	LE		✓				✓	✓	✓	✓					✓	
	NE															
1-6	SE		✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME															
	LE	✓		✓			✓									
	NE															

E.1.4 Experts Reactions to "Trust Chain"

TABLE E.4: Experts Reactions to "Trust Chain"

Factor	Emphasis	Expert														
		01	02	03	04	05	06	07	08	09	10	11	12	13	14	15
4-0	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME						✓									
	LE															
	NE															
4-1	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME															
	LE															
	NE															
4-2	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME									✓						
	LE															
	NE															
4-3	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME															
	LE															
	NE															
4-4	SE		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
	ME							✓								
	LE	✓			✓											
	NE															
4-5	SE		✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	✓	✓
	ME															
	LE	✓						✓				✓				
	NE															
4-6	SE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
	ME															
	LE															
	NE															

E.2 Personas

Building persona from actor and actions.

E.2.1 Expert A

Expert A is acutely aware of the challenges and opportunities in creating a new, comprehensive system for sharing information. They see the need for a strong sponsor and identify government entities as potential beneficiaries and trustworthy system overseers. They are interested in the business implications and added value such a system could offer organisations and government agencies. Also, Expert A insists on controlling personal information and has reservations about sharing employees' achievements without governmental intervention. They suggest that the system will be accepted more readily if it focuses on eliminating inequities in hiring and personnel evaluations, which they have observed in their personal experience. This expert underscores the importance of creating a system that can accurately allocate achievements and circumvent favouritism. They acknowledge the need for a unified authority to validate personal evaluations and

propose using KPIs to ensure fairness. This expert emphasises the necessity of data authenticity and security, especially in sensitive jobs, and stresses the need for accurate and consistent information. They are also mindful of the system's scalability and the inclusion of business intelligence to aid in decisions like salary predictions and certificate expiration dates. They urge an encrypted, reliable trust structure that eliminates the need to verify information constantly. His primary concerns include verifying overseas and online information and ensuring the accuracy of personal, non-credited information. Overall, Expert A wants the system to respect the rights of the information owners, allowing them to control what to share publicly. They believe the system must be hierarchical, with multiple levels of data authentication before the information is published.

E.2.2 Expert B

Meet Expert B: A practical yet forward-thinking individual who understands the complexities of developing a new system, especially regarding data privacy and the various regulations of different industries. While recognising the potential challenges, Expert B supports a government-controlled system to maximise cooperation and privacy. Expert B emphasises the importance of adding value to individuals and corporations and highlights the criticality of aligning degree holders with job market needs. They perceive the proposed system as invaluable for determining training focus areas, allocating talent, and guiding the job market direction. While considering the system's implementation, Expert B underscores the need for top management support, financial backing, a platform for data integration, a quality manager for system accuracy and performance monitoring, and necessary permits for inter-organisational integration. Having firsthand experience with internal KPI measurements, Expert B advises caution while incorporating such performance indicators due to their varied and often confidential nature within organisations. Expert B foresees the need for robust project infrastructure to ensure accuracy, including hardware and software requirements and bringing attention to the operational team and associated costs. Finally, they advocate for the system's constructive purpose, facilitating connections between candidates and employment opportunities. They see this framework as a potential platform dedicated to educational and employment agencies. With a proof of concept focused on academic certificates and employment achievements, Expert B is optimistic that the system would pique the interest of new parties and grow over time.

E.2.3 Expert C

An experienced technocrat acutely aware of the challenges inherent in garnering support and cooperation for new system implementation. Expert C emphasises the importance of financial backing, suggesting that developers should be allocated to the project. They

advocate for gaining cooperation through influential power, believing that administrative decisions provide the best leverage. Expert C foresees the primary challenge as convincing the beneficiaries to adopt the system rather than any technological hurdles. From Expert C's perspective, the added value of the proposed system should be tangible for both private and public sectors, and it must involve numerous Service-level Agreements (SLAs) to be successful. Top management support is deemed critical to ensure resource allocation. Concerns are raised about the credibility of data when it comes to the involvement of authorising individuals in validating or verifying records, suggesting that the system should focus on issued certificates from reliable sources rather than employee performance. The system's success, as per Expert C, is contingent upon its support by the government sector. They believe that a system operating on a Government Secure Network (GSN) would alleviate security concerns and bypass data privacy issues that come with information ownership and isolation. Expert C advises the system to be a back-end-focused web service, gathering data from distributed systems into a unified platform for validation and accuracy assurance. They emphasise that information verification is critical, and the system should only show authenticated and authorised records. The end goal, as Expert C envisions, is a system that efficiently validates and provides accurate information.

E.2.4 Expert D

A strategic decision-maker who strongly emphasises the economic feasibility of a system from a private sector perspective. They are particularly interested in revenue generation, suggesting that private entities will likely adopt the proposed system with a significant financial benefit. Expert D recognises the complexities of cooperation between public and private sectors, having witnessed the cancellation of numerous projects due to a lack of collaborative spirit. They stress the need for a transparent organisational vision that withstands management changes. While they envision a successful system involving universities, training institutes, and both public and private sector organisations, they question the practicality of gaining their cooperation. They express concerns about management changes, suggesting that such transitions hinder cooperation. Expert D proposes privacy controls on what individuals can share on their profiles, and they are aware of the social and personal complexities involved in employee evaluations. They also suggest methods for verifying and validating achievements, such as a peer-review voting system and including neutral parties like HR. From a business standpoint, Expert D seeks a solid business model that justifies financial investment and generates substantial revenue. They propose innovative ideas for additional income, such as employee loaning and freelancing, to limit outsourcing. Concerning system infrastructure, Expert D advises on the importance of support for patches and updates, security, and storage while ensuring ease of use for an average-experienced operations team. The system should provide an endpoint for information sharing, validate certificates, and ensure high security,

possibly through government cloud services. They maintain that face-to-face interviews are still necessary, even with a system verifying resume data.

E.2.5 Expert E

A pragmatist who focuses on the strategic and operational aspects of system implementation within the intersection of private and governmental sectors. They perceive financial income as challenging if the private sector adopts the system, but they see significant potential for governmental adoption based on social benefits. Expert E understands the inherent difficulties of introducing a new e-government system and believes that solid support from higher management is critical to driving collaboration and endorsement. They underscore the importance of demonstrating added value to public and private sectors to spark interest and investment. The expert emphasises the need for financial and top management support to drive projects, and once stability and required access are attained, the focus shifts towards revenue generation. They see the project as more than just administrative but as impactful for IT Operation Management. Expert E stresses that any new infrastructure must be prepared for system development and that every project should be reliable, scalable, and flexible. They also advocate for a minimalist approach to data storage, suggesting that the system should primarily facilitate data sharing rather than storage. The data stored, if any, should be kept minimal to reduce risks. They are acutely aware of the critical nature of security, especially given the sensitive data the system would handle. They call for stringent data classification and access measures, focusing on authenticity, authorisation, confidentiality, availability, and integrity. Expert E considers the validation of information and trust-building as crucial issues. They suggest employing machine learning techniques or cognitive automation capabilities for ongoing validation and anomaly detection. Lastly, they propose the careful decentralisation of information, depending on data sensitivity within respective sectors.

E.2.6 Expert F

A highly user-centric, detail-oriented professional with a keen eye on the broad socio-economic implications of a new system. They approach system design from the user's perspective, focusing on added value and advantages to all stakeholders involved. Expert F recognises the paramount role of the government sector as an influencer in decision-making processes and system changes. They emphasise the necessity of government support to amplify system reach and regulatory compliance. The expert underscores the need for information control to abide by established laws and protocols. They see job matching as beneficial, saving time and effort while ensuring compatibility with job descriptions. Expert F sees controllability, accountability, and authentication as the fundamental implementation conditions, emphasising the importance of determining the

entity responsible for the system's information. The system should be scalable, capable of extended storage, and primarily as a link or gateway without storing or controlling any information. They advocate for an easy-to-use system with special user permissions, emphasising that security, confidentiality, integrity, and availability are non-negotiable. They highlight the importance of precise data control protocols, data access management, and identity theft prevention. They propose a framework for confirming and validating data, leveraging existing data sources via APIs and integrating with other on-line systems. Expert F is conscious of potential conflict of interest issues and urges clear data classifications. They perceive technologies such as blockchain as a solution to track changes and maintain the authenticity and credibility of data, especially given the high turnover in specific job sectors. They also highlight the system's potential to safeguard users against loss of credentials by facilitating the re-issue of misplaced certificates.

E.2.7 Expert G

A pragmatic, results-oriented professional focusing on the practicality, value, and feasibility of system implementation. They see the significance of sponsorship and support from critical stakeholders in launching a successful system. They advocate for the system to leverage existing data from primary beneficiaries instead of starting from scratch, avoiding unnecessary legal and regulatory difficulties. Expert G believes stakeholders' power comes from their investment, bringing the dual authority of data ownership and command influence to make things happen. They emphasise the necessity of understanding the added value and mapping the needs of stakeholders. They question why stakeholders would invest time in system configuration and operation, especially considering the extensive time investment required to record and authenticate achievements. They express concern about the source of information, foreseeing challenges in data compatibility and suggesting the need for data sharing and insertion standards. They propose enforcing a unified way of measuring performance across different sectors and the necessity of legal regulations for sharing private employee information. Expert G suggests focusing on professional certifications and exams, excluding irrelevant achievements. They stress the importance of stakeholder meetings to consolidate concerns and infrastructure requirements. They dismiss concerns about outdated infrastructure and highlight the importance of security, especially during the employment hiring process. According to Expert G, availability is secondary to security and integrity and may not always be essential. Their primary focus is reaching and validating the requested information while ensuring its integrity. They strongly emphasise data integrity and trust as paramount factors for the system. They advise against starting from scratch and encourage the usage of existing data resources from different organisations and institutes. They deem privacy and immutability necessary, depending on their specific use cases.

E.2.8 Expert H

An authoritative individual who values the role of e-government in hosting and developing systems. This individual perceives physical hosting of the system by e-government as more secure and efficient, as it guarantees governance, control, and monitoring. Expert H believes new systems developed in the private sector often get overlooked and considers the public sector more robust. They stress the value of this system in the hiring process across both public and private sectors. They underscore the role of top management in providing budgets, workforce, and cooperation. Expert H also highlights the need to follow regulations provided by the National Cyber Security Authority and the Ministry of Interior. This expert acknowledges the challenges that come with achievements and work history. They emphasise social connections and networking as crucial for a project's success. They are also conscious of server specifications and technical details like user numbers and endpoints, advising that these details are necessary for system requirements and design. Expert H acknowledges the potential for conflicts of interest and the necessity of privacy. They suggest the inclusion of privacy fields during system development. They downplay the importance of infrastructure, stressing the need for inter-organisational integration and future scalability. They value security from a technical and procedural perspective, emphasising policies, controls, governance, processes, and training. They believe authenticity, encryption, and data leakage prevention are paramount and depend on data classification. They further stress their framework's importance of confidentiality, availability, and integrity. Finally, Expert H values the approval process and trust chain verification for information and suggests a transparent audit and trace for each information transaction.

E.2.9 Expert I

An advocate for freelancers and educational development. "Expert I" see the value in a system that enhances the experience of freelancers and builds robust, compelling resumes. They stress the importance of securing the cooperation of educational institutes, primarily through the Ministry of Education. They note the necessity of top management commitment and the relevance of international standardisation to graduate preparedness. "Expert I" believes in the power of intelligent systems, especially those that facilitate freelancing. They envisage a system that minimises favouritism and maximises opportunities for all based on criteria rather than candidate type. They call for the system to fetch or build resumes by looking at a candidate's background, acknowledging the willingness of non-government sectors to invest in such a system if it offers validated and accurate resumes. Expert I values user-friendly, reliable systems that support updates and patches with minimal administrative interference. They emphasise the need for a modern and secure infrastructure, endorsing systems that facilitate configuration and integration. They champion data integrity, authenticity, availability, confidentiality and

validation and propose a centralised system that can interact with others. Expert I supports automatic updating and authenticating services, viewing data acknowledgement as crucial. They advocate for encryption and trust procedures to validate information, optimising current issues and problems. Expert I recognises the need for robust methodologies to validate the information from multiple sides or interfaces. The system will significantly benefit students, job seekers, and headhunters, emphasising the importance of validating and verifying various credentials and achievements. Lastly, "Expert I" underscores the importance of data survivability even after an institute's closure, suggesting decentralisation as a solution.

E.2.10 Expert J

A firm believer in integrating governmental organisations into data systems. Expert J asserts that such integration lends authority, support, and supervision to these systems and believes that investment in technological development, particularly with top management support, is crucial for a country's vision and economy. Expert J highlights the role of administrators and developers in running and developing the system, emphasising the importance of cooperation and collaboration between information holders. They see a well-managed system as a boon to HR departments, functioning as a headhunter recruiting service and yielding significant benefits. Expert J underlines the financial implications of investing in these systems and the potential return on investment. They acknowledge the importance of security but argue that it should not overshadow other system aspects. They recommend a balanced approach to data decentralisation, noting that while it improves quality, it may limit quantity. They advocate for updated infrastructures, stressing the cost of outdated systems. Expert J believes that data integrity is paramount and that an up-to-date system ensures accuracy, even when the original data source is unavailable. They acknowledge the existing issues with resume credibility, suggesting an add-on system to ensure accuracy. Expert J proposes a system that can act as an impartial validation to counter favouritism and conflicts of interest. They underscore the importance of privacy, suggesting the system should only verify what the candidate permits. Expert J imagines a more streamlined hiring process, made possible by a system that verifies education and employment documents, effectively speeding up the process. They foresee a future in which such a system can even catch misrepresented information and detect false credentials and potentially fraudulent activities, thereby enhancing overall trustworthiness.

E.2.11 Expert K

is a strategic thinker who values the integration of government sectors into a proposed data system. They see governmental involvement as the key to spreading and supporting

this system, given its ability to officially endorse and deploy it in other organisations. For Expert K, the top management's support is crucial. Their endorsement ensures the system's successful deployment and that organisations recruit highly qualified employees. They acknowledge the financial strengths of large companies in providing training sessions for new employees. However, they also recognise that not all companies, particularly those with less financial power, can do this. Expert K sees scalability and storage as critical components, suggesting that the system should be able to accommodate increasing traffic and store essential documents. They believe that cross-platform compatibility, user-friendly design, and reliability are crucial for the system's success. In terms of security, Expert K emphasises the importance of confidentiality and integrity. They suggest using SSL to establish a chain of trust certificates, contributing to data validation, provenance, authorisation, and trust. They argue for the importance of data encryption during transmission and recognise the credibility issue in resumes. They suggest a solution in the form of a validated resume containing information that has undergone various checks and verifications. While Expert K views privacy as not a significant concern for those actively job-seeking, they understand its importance when companies issue achievement certificates for their employees. They also support the idea of data replication and decentralisation to prevent data loss.

E.2.12 Expert L

s an experienced IT professional who prioritises the role of a sponsor or adopter in the success of any system. They believe that the top support, financial backing, and cooperation from different departments that a sponsor can provide are fundamental. They underline the need to identify the system's beneficiaries, insisting that official directives and action decisions are mandatory if it is a governmental entity. Expert L highlights the need for a responsible and funded party with an administrative decision to assist in documenting professional certificates. In their experience, planning needs to align with market needs, and they suggest identifying added values for different stakeholders. They highlight the importance of web-based systems to reduce the workload on organisations and maintain standardisation. Expert L proposes preserving privacy for companies to avoid conflicts of interest, noting that performance measurements like KPIs are often unfavourable within organisations. They emphasise the need for a secure, reliable system with disaster recovery provisions. They talk about the system's potential privacy concerns, especially around personal information in resumes, and call for stringent measures around authorisation, authentication, and data accuracy. They see the validity and accuracy of provided certificates and resumes as a significant issue the system should address. Finally, they highlight the importance of provenance and support a system that promotes transparency and discourages favouritism.

E.2.13 Expert M

is a seasoned professional in the field of Human Resources and Information Systems, demonstrating a deep understanding of the recruitment process, e-Governance, and data management. He is a forward-thinker, identifying the challenges in the current employment system and envisioning a technology-driven solution to streamline the process. Highly attentive to the importance of government support, Expert M stresses the need for a government-backed initiative that connects education, employment and National Identification Centres (NIC) to ensure data accuracy and system efficiency. He respects the significance of confidentiality and privacy yet acknowledges the necessity of transparency for validating qualifications and experiences. Expert M suggests a regulated approach to information sharing, focusing on certificates, job descriptions, and performance evaluations rather than sensitive personal details. From his experiences as an employer, he recognises the discrepancy between the information presented in resumes and the reality, often leading to time-consuming hiring procedures. Expert M sees the potential of integrating a performance measurement system and background checks to overcome this problem. Expert M believes in decentralisation, advocating for cross-organisational cooperation to provide more extensive and reliable data. Understanding the technical aspects, he emphasises the crucial role of robust infrastructure, secure data exchange, user-friendly interfaces, and efficient auditing mechanisms. Furthermore, he underlines the necessity of a reputation-based validation system that establishes trust and accountability. His comprehensive view of the employment system makes Expert M a reliable guide for implementing an innovative, technology-driven solution to recruitment challenges.

E.2.14 Expert N

a blockchain evangelist with a deep understanding of the technology and a vision for its future role in data management. He emphasises the significance of top management's support for successfully implementing a blockchain system, underscoring the necessity of financial and moral backing. He believes in the potential of blockchain to reduce infrastructure costs by eliminating the need for servers and data centres, despite the technology's tarnished reputation by its association with Bitcoin. Expert N sees a vital role for blockchain in enhancing data security and safeguarding against cyberattacks due to its decentralised nature. Despite seeing potential obstacles in data digitisation and integrating various entities into the blockchain system, Expert N proposes beginning with small, specific sample sets. He believes the technology's integrity, availability, and authenticity can elevate its data management and security position. Expert N advocates for an increased focus on the user-friendly interfaces for blockchain and acknowledges the challenges in storing multimedia content on the blockchain. He understands the role of blockchain in data validation rather than storage. They see the potential for technology

in employment and education, particularly for resume and certificate verification. He considers the blockchain's immutability a significant strength, as it ensures the accuracy and authenticity of information, thereby increasing trust and reliability. He sees the future of blockchain as a tool to enhance the veracity of information provided by individuals and institutions.

E.2.15 Expert O

is a seasoned professional with a deep understanding of systems management and data security. He recognises the importance of top management support and appropriate financing for successful system implementation. Expert O understands that various laws and regulations can pose challenges due to differences across institutions and organisations. A significant concern for Expert O is data security, particularly concerning sensitive government data. He advocates for standardisation and compliance with given standards as a security measure. Aware of the potential conflicts between decentralisation and managerial control, he acknowledges the valuable role of direct managers in building employee experiences. Expert O sees cooperation between the public and private sectors as key to system activation and proposes cloud-based solutions for secure data storage within the country. He stresses the need for system flexibility, usability, and accessibility across multiple platforms and devices, along with guaranteed data confidentiality. Expert O emphasises the importance of authentication, encryption, and integrity in maintaining user trust in the system. He recognises the challenges of resume verification in hiring processes and proposes a unique code confirmation system for certificates. Lastly, he insists on privacy and conflict of interest considerations in sharing information, advocating for transparency in system operations.

E.2.16 User Story

Using template (7.1) as a base for all User Types identified in 7.2.2 the below is the output:

AS A < User Type 1 > **I WANT TO** < View all available vacancies by reciters > **SO THAT I CAN** < Get Reports to provide economy planning and future development >

AS A < User Type 1 > **I WANT TO** < View all available Seekers for a vacancy > **SO THAT I CAN** < Get Reports to provide economy planning and future development >

AS A < User Type 1 > *I WANT TO* < View all available educational qualifications > *SO THAT I CAN* < Get Reports to provide economy planning and future development >

AS A < User Type 1 > *I WANT TO* < View all available employment qualifications > *SO THAT I CAN* < Get Reports to provide economy planning and future development >

AS A < User Type 2 > *I WANT TO* < Provide employment qualifications > *SO THAT I CAN* < Provide assurance and provenance for Recruiters >

AS A < User Type 2 > *I WANT TO* < Provide employment organisation information > *SO THAT I CAN* < Provide assurance and provenance for Seekers >

AS A < User Type 3 > *I WANT TO* < Provide educational certificates qualifications > *SO THAT I CAN* < Provide assurance and provenance for Recruiters >

AS A < User Type 3 > *I WANT TO* < Provide educational organisation information > *SO THAT I CAN* < Provide assurance and provenance for Seekers >

AS A < User Type 4 > *I WANT TO* < Provide Credentials Security Checks > *SO THAT I CAN* < Authenticate Users and Authorise Access For Integrity and Privacy >

AS A < User Type 4 > *I WANT TO* < Assign User Identity to Employment Organisation > *SO THAT I CAN* < Confirm the Identity of an Employment Organisation >

AS A < User Type 4 > *I WANT TO* < Assign User Identity to Educational Institutes > *SO THAT I CAN* < Confirm the Identity of an Educational Institutes >

AS A < User Type 4 > *I WANT TO* < Assign User Identity to SEEKER > *SO THAT I CAN* < Confirm the Identity of Seeker User >

AS A < User Type 4 > *I WANT TO* < Assign User Identity to Reciter > *SO THAT I CAN* < Confirm the Identity of Reciter User >

AS A < User Type 5 > *I WANT TO* < Allocate employment record from USER-TYPE 2 > *SO THAT I CAN* < Provide Information Provenance >

AS A < User Type 5 > *I WANT TO* < Allocate educational certificates from User-Type 3 > *SO THAT I CAN* < Provide Information Provenance >

AS A < User Type 5 > *I WANT TO* < Allocate Available Seekers from UserType 6 > *SO THAT I CAN* < Provide Information Availability >

AS A < User Type 5 > *I WANT TO* < Allocate Available Vacancies by Recruiters from UserType 7 > *SO THAT I CAN* < Provide Information Availability >

AS A < User Type 5 > *I WANT TO* < Allocate USER Identification from UserType 4 > *SO THAT I CAN* < Assure Validity of a USER >

AS A < User Type 5 > *I WANT TO* < Assign Allocated records to an Allocated USER > *SO THAT I CAN* < Assure Ownership of the information to Provide Information Provenance >

AS A < User Type 5 > *I WANT TO* < Combine Allocated information and Encapsulate Allocated Information > *SO THAT I CAN* < To Assure The Integrity of the information >

AS A < User Type 5 > *I WANT TO* < Distribute the Encapsulated information > *SO THAT I CAN* < Provide Information Sharing >

AS A < User Type 6 > *I WANT TO* < Allocate Avilable Vacancies > *SO THAT I CAN* < Get information for the Vacancy >

AS A < User Type 6 > *I WANT TO* < Provide Credentials > *SO THAT I CAN* < Provide to recruiters to become a candidate >

AS A < User Type 6 > *I WANT TO* < Promote my availability as a seeker > *SO THAT I CAN* < Attract recruiters to become a candidate for a vacancy >

AS A < User Type 7 > **I WANT TO** < Allocate Available Vacancy Seekers > **SO THAT I CAN** < Get information about seekers availability >

AS A < User Type 7 > **I WANT TO** < Provide my Organisation information > **SO THAT I CAN** < Provide to Seekers to promote a vacancy >

AS A < User Type 7 > **I WANT TO** < Promote Vacancy availability > **SO THAT I CAN** < Attract Vacancy Seekers to become a candidate and fill a vacancy >

E.3 Interactions Diagrams - Sequences

The below explains figures E.1, E.2, E.3, E.4, E.5, E.6, E.7 and E.8.

UC1-1 :

The **USER** interacts with the **AppClint** interface
 The **USER** provide their access credentials
 The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations)
 The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**
 The **AppFIST** Allocate information from **ServerUser**
 The **ServerUser** Provide the requested information to **AppFIST**
 The **AppFIST** Allocate information from **ServerEdu**
 The **ServerEdu** Provide the requested information to **AppFIST**
 The **AppFIST** Combine the provided information from **ServerEdu**
 The **AppFIST** Provide the requested information to **AppClint**

UC1-2 :

The **USER** interacts with the **AppClint** interface
 The **USER** provide their access credentials
 The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations)
 The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**
 The **AppFIST** Allocate information from **ServerEmp**
 The **ServerEmp** Provide the requested information to **AppFIST**
 The **AppFIST** Combine the provided information from **ServerEmp**

The **AppFIST** Provide the requested information to **AppClint**

UC1-3 :

The **USER** interacts with the **AppClint** interface

The **USER** provide their access credentials

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations)

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**

The **AppFIST** Allocate information from **ServerSeeker**

The **ServerSeeker** Provide the requested information to **AppFIST**

The **AppFIST** Combine the provided information from **ServerSeeker**

The **AppFIST** Provide the requested information to **AppClint**

UC1-4 :

The **USER** interacts with the **AppClint** interface

The **USER** provide their access credentials

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations)

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**

The **AppFIST** Allocate information from **ServerRec**

The **ServerRec** Provide the requested information to **AppFIST**

The **AppFIST** Combine the provided information from **ServerRec**

The **AppFIST** Provide the requested information to **AppClint**

UC2-1 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerSeeker** Update as “Available” on **AppFIST**.

The **AppFIST** Promote **ServerSeeker** Availability to **ServerRec**.

UC2-2 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerRec** Update as “Available” on **AppFIST**.

The **AppFIST** Promote **ServerRec** Availability to **ServerSeeker**.

UC3-1 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerSeeker** Provide Availability information to **AppFIST**.

The **AppFIST** Allocate information from **ServerEdu**.

The **ServerEdu** Provide the requested information to **AppFIST**.

The **AppFIST** Allocate information from **ServerEmp**.

The **ServerEmp** Provide the requested information to **AppFIST**.

The **AppFIST** Combine the provided information from **ServerUser** and **ServerSeeker** and **ServerEdu** and **ServerEmp**

The **AppFIST** Provide the requested information to **AppClint**.

UC3-2 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerRec** Provide Availability information to **AppFIST**.

The **AppFIST** Allocate information from **ServerRec**.

The **ServerRec** Provide the requested information to **AppFIST**.

The **AppFIST** Combine the provided information from **ServerUser** and **Server-Rec**

The **AppFIST** Provide the requested information to **AppClint**.

UC4-1 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerSeeker** Update as “Un-Available” on **AppFIST**.

The **AppFIST** Delete Availability **ServerSeeker** to **ServerRec**.

UC4-2 :

The **USER** interacts with the **AppClint** interface.

The **USER** provide their access credentials.

The **ServerSec** Provide security Checks for entered credentials (such as identity and authorisations).

The **AppFIST** Checks the requested records according to USER Authorisation based on **ServerSec**.

The **AppFIST** Allocate information from **ServerUser**.

The **ServerUser** Provide the requested information to **AppFIST**.

The **ServerRec** Update as “Un-Available” on **AppFIST**.

The **AppFIST** Delete Availability **ServerRec** to **ServerSeeker**.

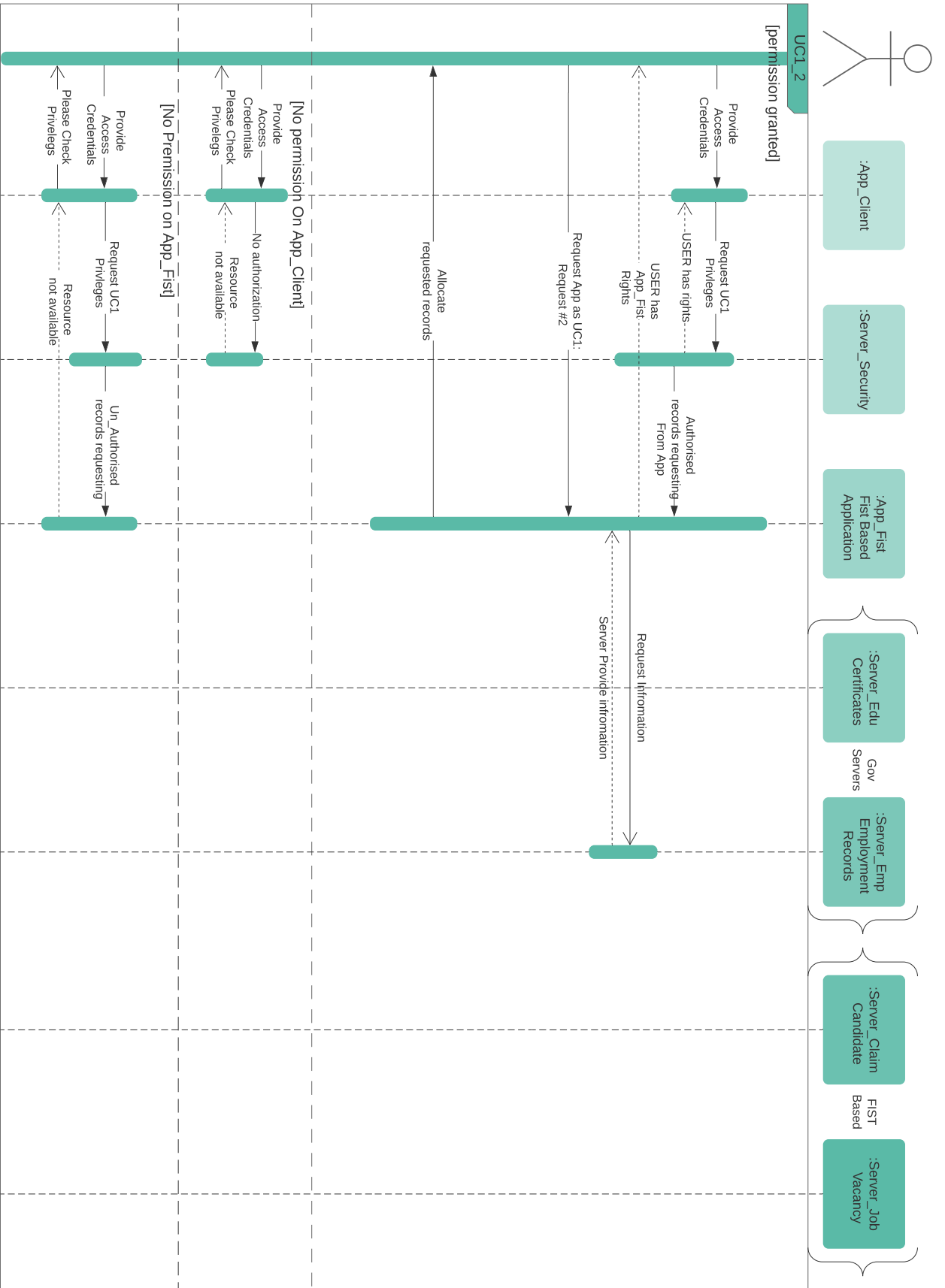


FIGURE E.2: Allocate Employment Records

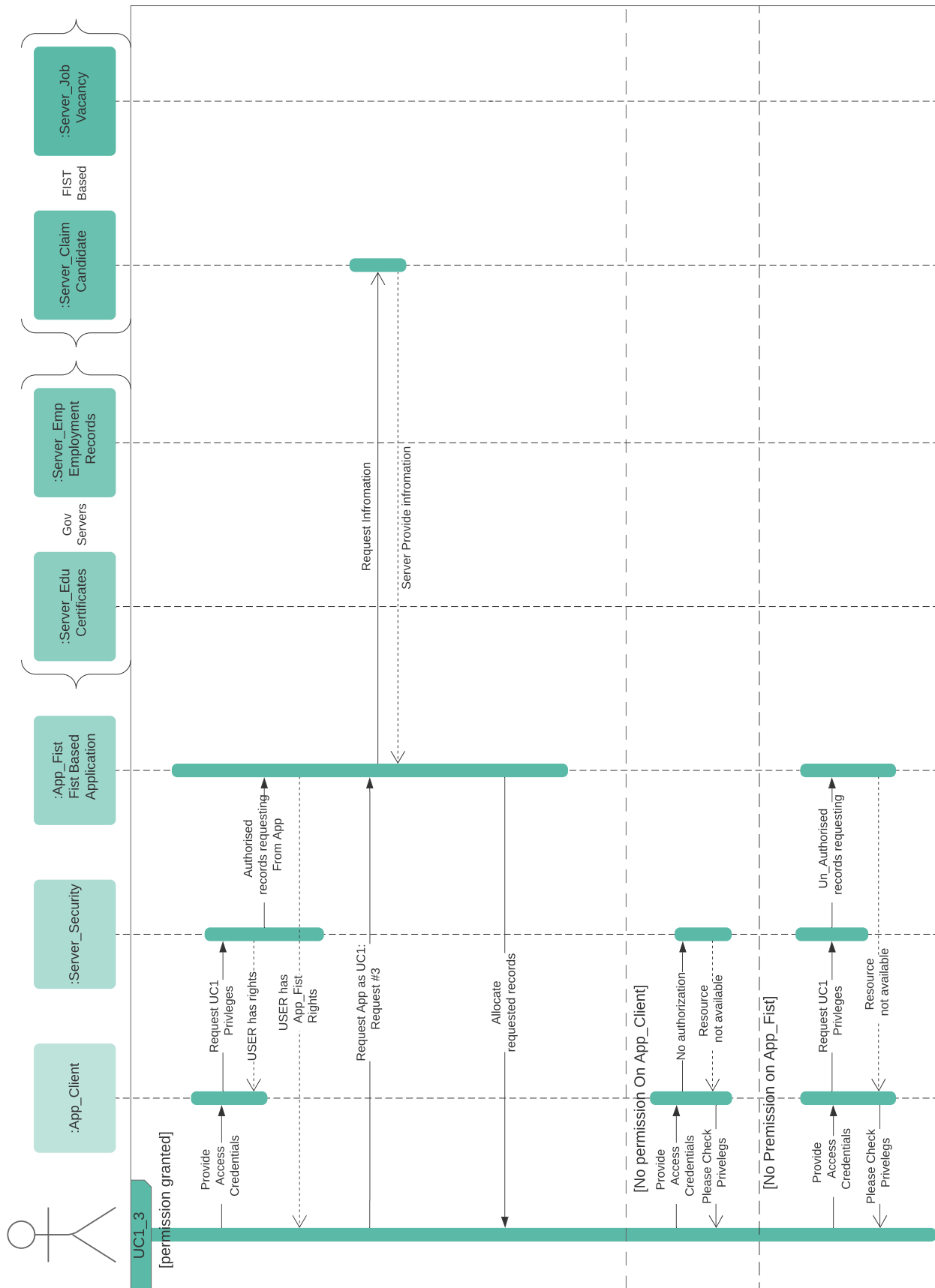


FIGURE E.3: Allocate Available Applicants

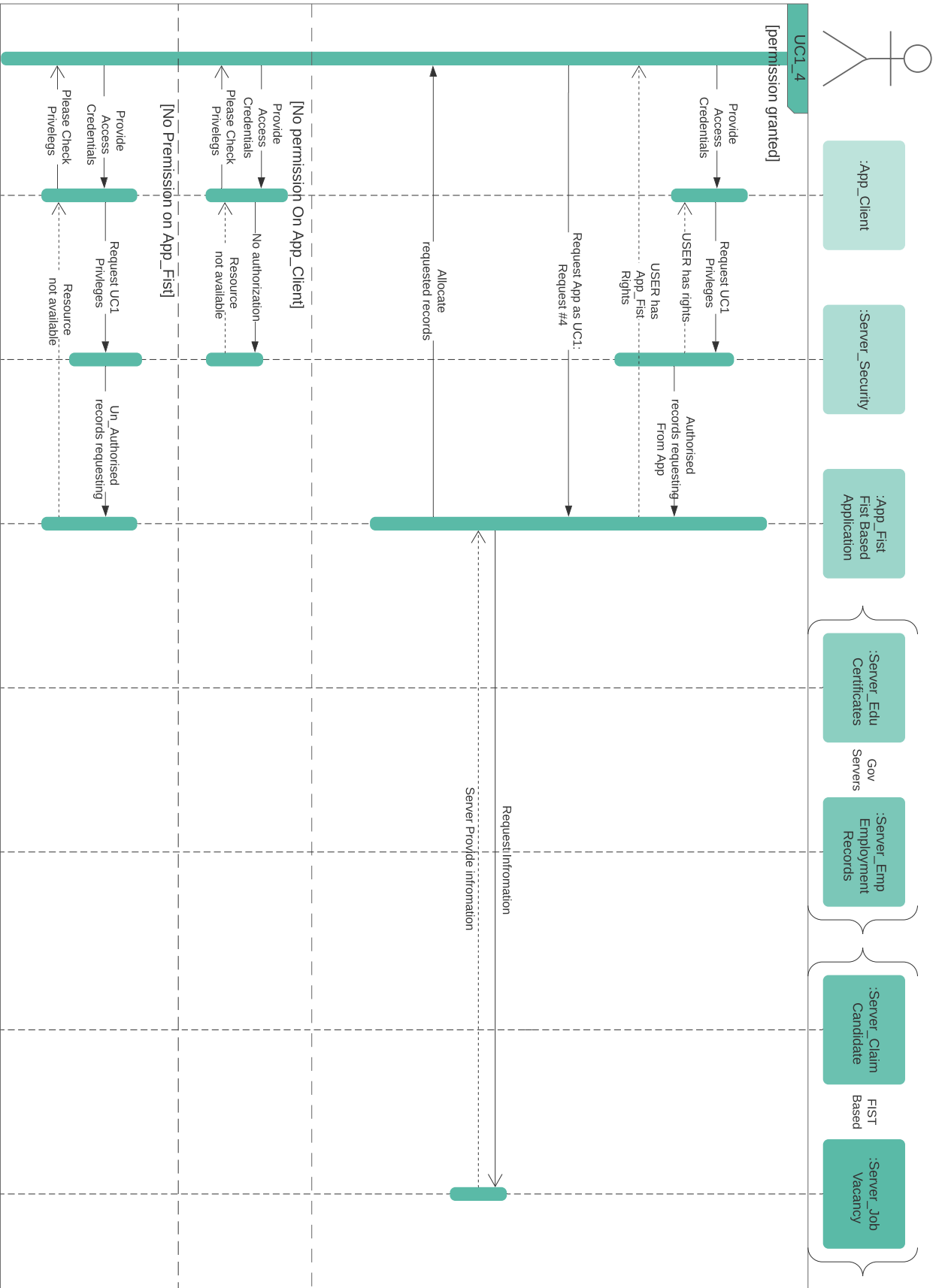


FIGURE E.4: Allocate Available Openings

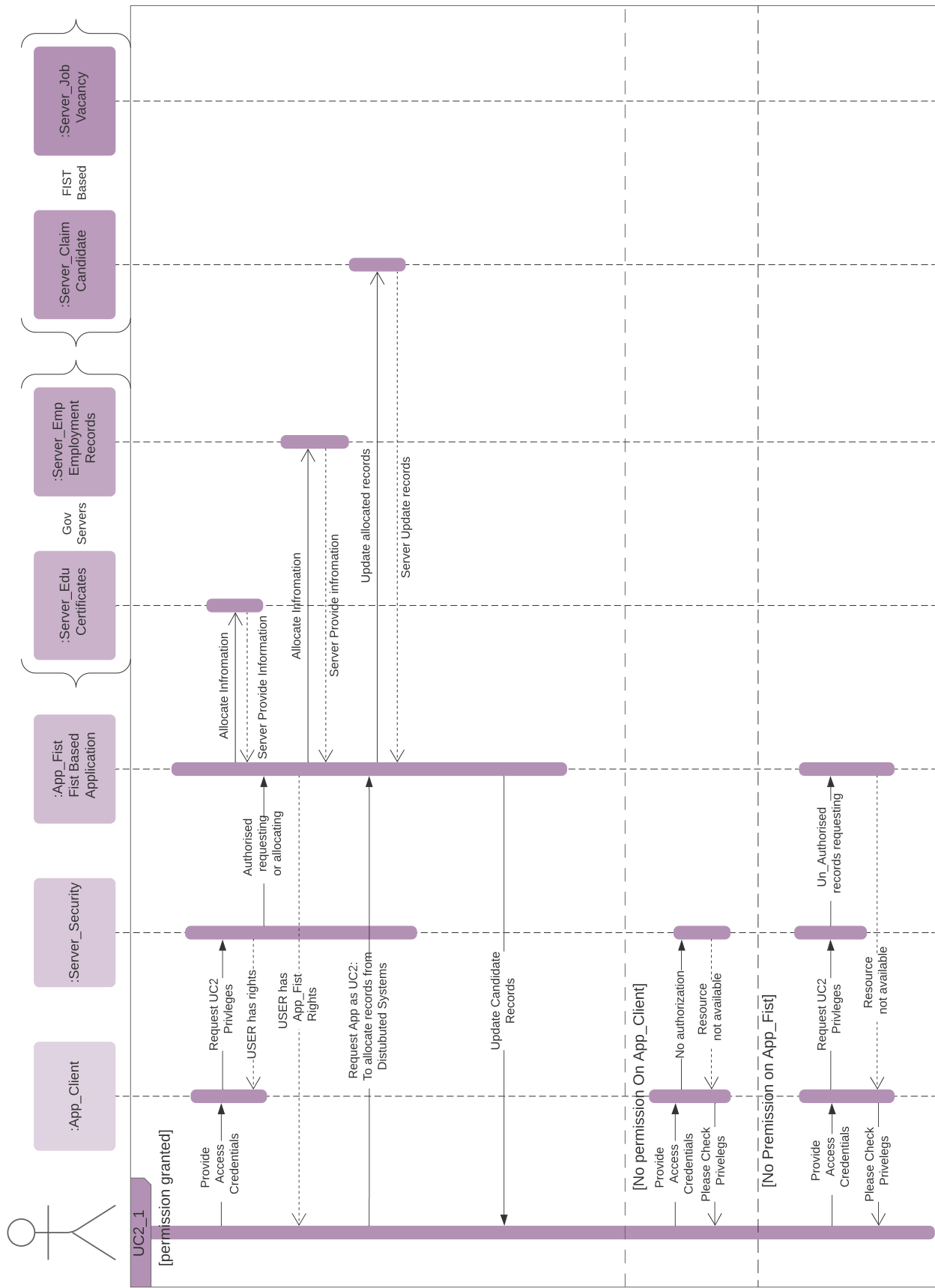


FIGURE E.5: Include / advertise Information for a Candidate

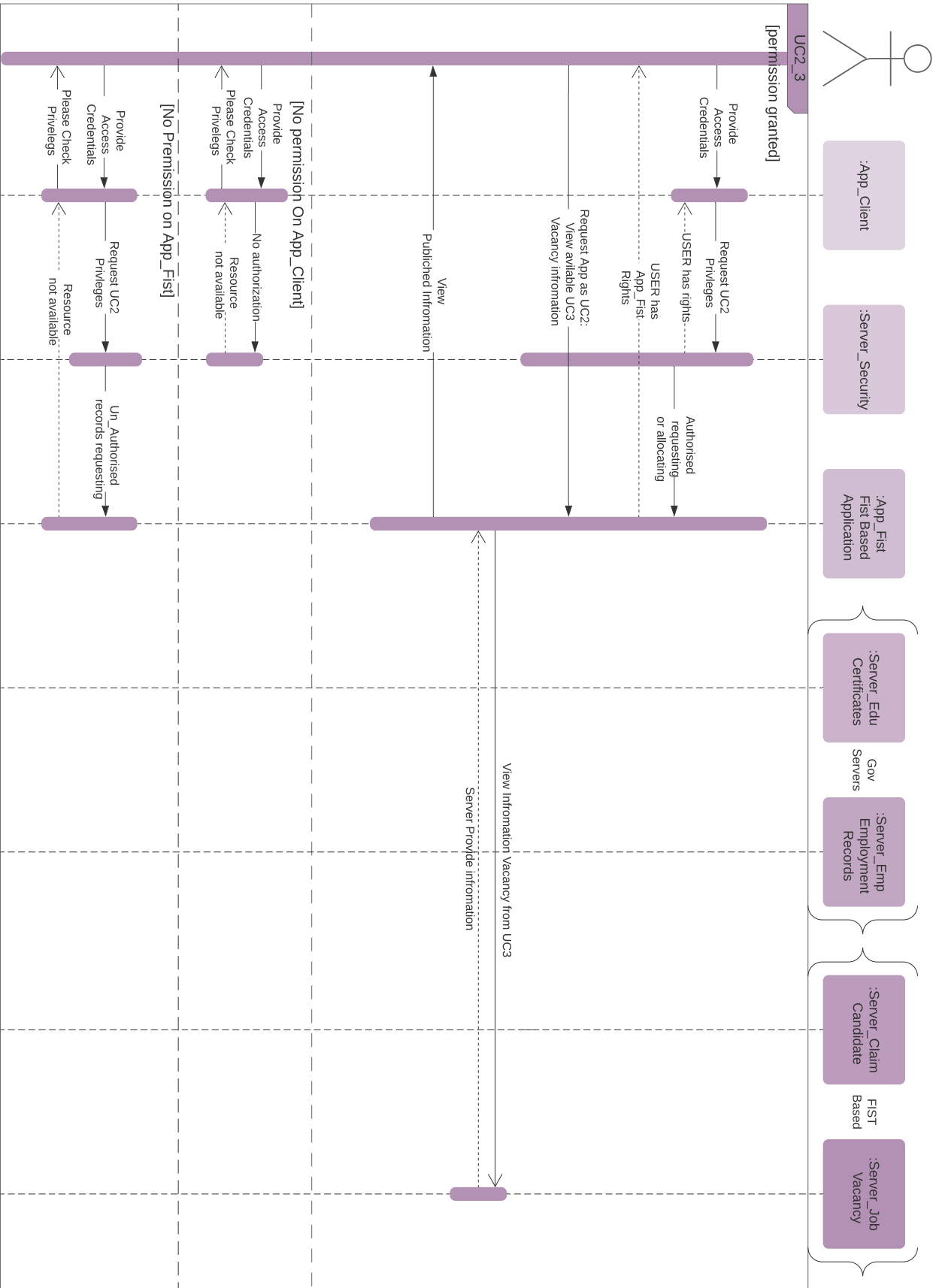


FIGURE E.6: Include / advertise Information for a Vacancy

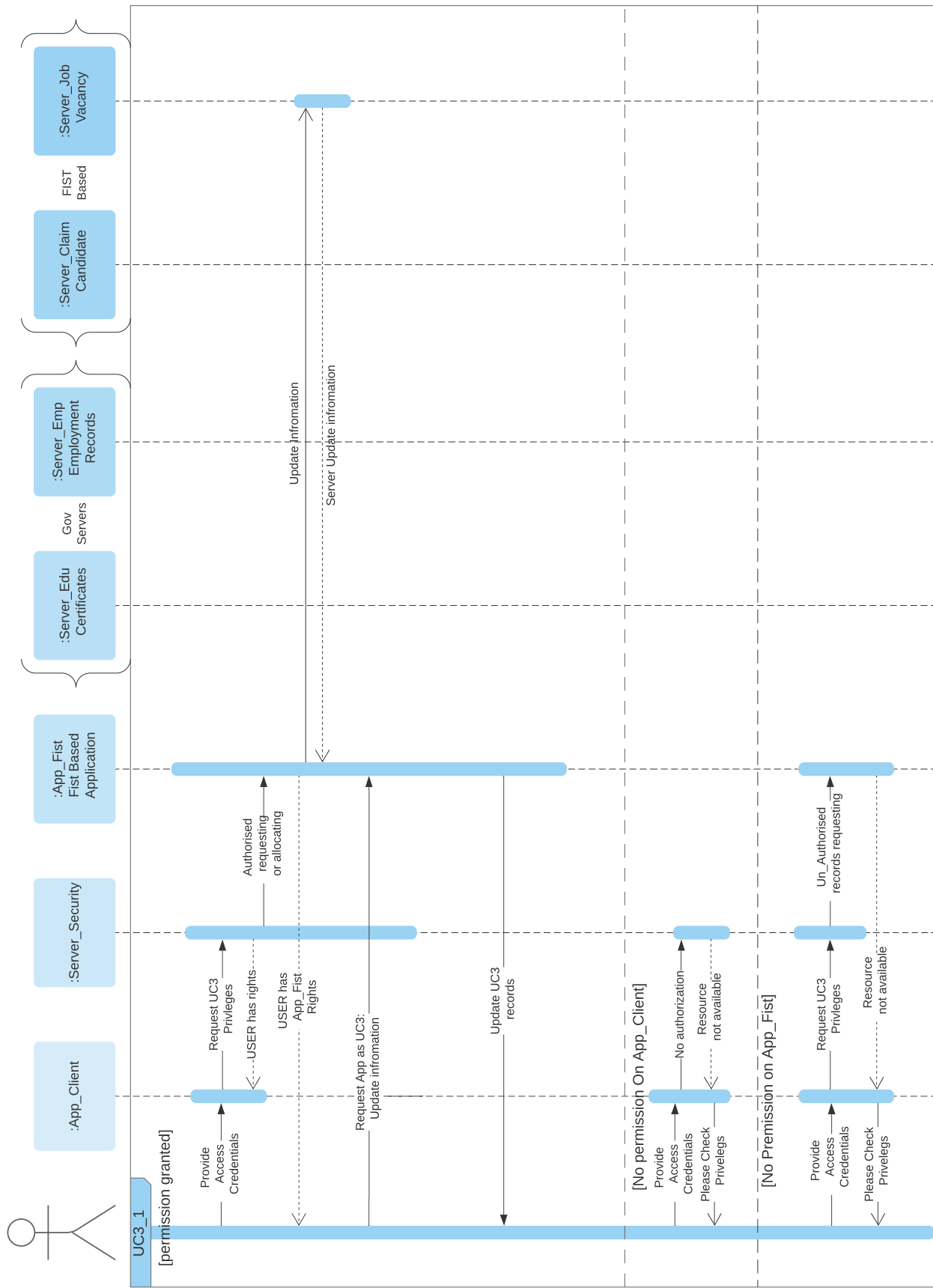


FIGURE E.7: Allocate a Candidate Information

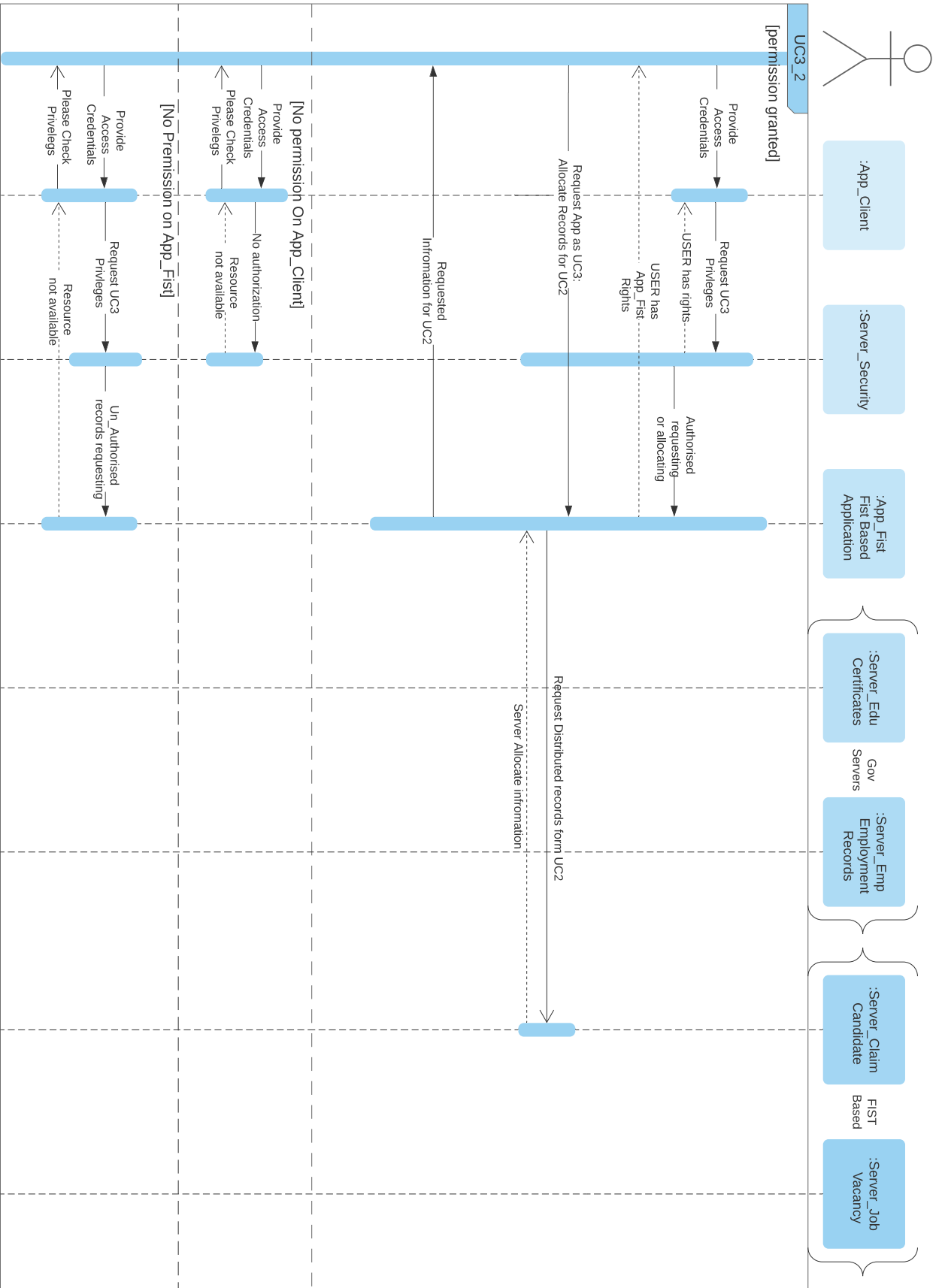


FIGURE E.8: Allocate a Vacancy information

Appendix F

This Appendix contains the complete Formal Modelling and its proof obligations.

Abstract

Refinement

Appendix G

Within the covers of this chapter lies the portal to an invaluable resource - the comprehensive Appendix. This repository manifests the Delphi method meticulously applied across four distinct phases. Every phase represents a diverse array of insights and observations made by experts in the field. This comprehensive Spoken Sentence contains all viewpoints in its representation of the subject matter.

The four phases of the Delphi method involve a consistent five experts throughout the process. Each phase added a new layer of understanding for building and confirming the insights for the FIST Framework. Phase **one** sets the foundational understanding, establishing the base of the FIST Framework with contributions from an expanded discussion of fifteen experts. Concepts and core ideas are introduced and dissected from diverse perspectives, providing a broad and in-depth understanding of the domain of the FIST Framework. The **second** phase sharpens the thoughts of the five consistent experts. Their collective expertise creates a refined FIST Framework and enriched understanding by providing requirements and stories. The **third** phase presents a genuine dissection of the research problem, as the same five experts lend their profound insights and exploration of the discourse and enlighten on the subject matter's depth which identified the Key Problem. Finally, the **fourth** phase represents the scenarios and clarifies the order of factors. Once again, the persistent insights of the five experts helped to spotlight critical insights and conclusions.

This Appendix, therefore, unfolds in four thoughtful phases, encapsulating the collective wisdom of industry experts in a streamlined progression. This orchestration of the Delphi method with persistent experts through all the stages stands as a testament to their expertise.

This Appendix contains all the sentences of the spoken sentences during the experts meetings.

TABLE G.1: Expert A Spoken Sentences and Their affected Components

Expert A		
Sentence ID	“Spoken Sentence”	Affected Components
A.R1.01	“One of the main issues is finding a sponsor for this new system and finding a beneficiary.”(1-0)	
A.R1.02	“Sharing personal information is accepted as long as there is control over it and a trusted, preferably government organisation manages it.”(1-0)(4-0)	
A.R1.03	“Consider the business side.”(1-1)	
A.R1.04	“Focus on the added value for organisations and government agencies.”(1-1)	
A.R1.05	“Why would I Invest or accept this framework, give me the added value?... Focus on the added value for organisations and government agencies”.(1-1)	
A.R1.06	“In my personal experience, no employment institute would share their employees’ achievements unless forced by the government sector concerning human capital development.”(1-2)	
A.R1.07	“It would be best to consider who would view the information, whether it is a third party or a government agency. Companies will cooperate if it is government. Otherwise, you will find significant challenges, such as the added value.”(1-2)(1-5)(3-1)(4-2)	
A.R1.08	“Bottom line: Your system is essential because it will show both; the actual job of the employee and the candidates’ accomplishments, which will lower inequity and allow the exact allocation of achievements.”(1-4)	
A.R1.09	“Consider favouritism and how you would work around it.”(1-4)	
A.R1.10	“Personal evaluation to ensure the right fit for the candidate.”(1-4)	
A.R1.11	“There are many issues with favouritism in personal evaluation, which makes it a vital factor.”(1-4)	
A.R1.12	“There is no single point of authority, procedure or organisation to validate personal evaluation (KPI). The performance is measured and done internally.”(1-4)	
A.R1.13	“We might achieve employment evaluation and expertise if the government or a specific evaluation system made it.”(1-4)	
A.R1.14	“We use KPIs to avoid assessment or evaluation based on personal experience. For Example, my previous employer was a friend and gave me perfect feedback and vice versa; another previous employer gave me lower feedback.”(1-4)	
A.R1.15	“These conditions are already given and inherited by default. Implementing all these dimensions and factors will allow organisations to accept a new system. The system will be noticeable when the framework conditions or requirements are available.”(2-0)	
A.R1.16	“This system is extensive; consider scalability.”(2-2)	
A.R1.17	“Security is an issue, primarily when someone works on sensitive jobs.”(3-0)	
A.R1.18	“The authenticity of the information (Expert means data verification) is vital for hiring someone with the correct information by accumulating qualifications from authorised entities (Expert means Accuracy and Integrity).”(3-2)(3-6)(4-0)(4-3)	
A.R1.19	“Having some business intelligence is vital to predicting the right salary and giving expiration dates for contractors (contracts) or certificates. Also, to ensure the person giving the information has the correct power.”(3-3)	

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Expert A	
A.R1.20	<i>“Data availability is essential but not a significant concern because this is not time-sensitive.”(3-4)</i>
A.R1.21	<i>“Encryption is essential if there is a third party handling the information. If it were a government system, it would be inherited.”(3-5)</i>
A.R1.22	<i>“The information must stay the same after leaving the organisation.”(3-6)</i>
A.R1.23	<i>“The trust structure is vital as there will be no need to return to each information issuer every time to verify the information.”(4-0)</i>
A.R1.24	<i>“The challenge is presented in two ways. Getting the correct information and combining them to build something and being accurate, especially within the employment sector since the educational institutes are already valid and precise.”(4-1)(4-3)</i>
A.R1.25	<i>“Information owners such as the employee, employer or student must have the right to choose what to show publicly. ”(4-2)</i>
A.R1.26	<i>“During the hiring procedure: personal interviews are required to validate the experience and accuracy of resumes.”(4-3)</i>
A.R1.27	<i>“If overseas. How can you verify the information?”(4-3)</i>
A.R1.28	<i>“If an online course existed, would it be demonstrated in the record?”(4-3)</i>
A.R1.29	<i>“In employment and education: validating personal non-credited information is based on personal interactions and preferences, which makes it less accurate to base it on individuals rather than systems. That is one of the reasons for up to 6 months of Co-op to bring prospective candidates to analyse them at the workplace before hiring.”(4-3)</i>
A.R1.30	<i>“The person with the correct power can give or issue the correct information.”(4-3)</i>
A.R1.31	<i>“There is no central or single authenticator; a system that verifies employment information should be on a hierarchical system. Also, you should include how many people should authenticate the data before the information is published.”(4-6)</i>

TABLE G.2: Expert B Spoken Sentences and Their affected Components

Expert B	
Sentence ID	“Spoken Sentence” Affected Components
B.R1.01:	<i>“The development of the system is plausible and can be developed and created; it would raise some challenges when you find your beneficiaries; each one will have its regulations. The beneficiary will provide you with the needed support and endorse collaboration. At an organisational level, one of the challenges is that there will be a form of rejection because each industry will have laws and regulations to warehouse their data, nevertheless, to share private and sensitive data. So, a government-controlled system will gain stronger support and cooperation.”(1-0)(1-2)(1-3)(3-1)(4-2)</i>
B.R1.02:	<i>“To ensure privacy and higher acceptance. The system must not store data but only analyse mass data without indicating the detailed data.”(1-0)(2-3)(4-2)</i>
B.R1.03:	<i>“This would be a very beneficial tool to increase the market value on both levels, individuals and cooperates. ”(1-1)</i>

... Continued on next page

Expert B

B.R1.04: *“There is a need for this framework, and I agree with its importance. There should be a consistency of degree holders with the availability of the job market (Expert means filling the gap in the job market). I wish there had been a system like this before. The system would be very beneficial to find which areas to focus training. Also, allocating talent and assistance predicates the job market direction. This talent allocation would be a very beneficial tool to increase the market value on both individual and cooperative levels.”*⁽¹⁻¹⁾

B.R1.05: *“What is the added value? Why is this important?”*⁽¹⁻¹⁾

B.R1.06: *“Individuals and companies like their privacy. They would cooperate and provide information as long as a government agency and a part of e-gov services manage this system.”*⁽¹⁻²⁾⁽⁴⁻²⁾

B.R1.07: *“Top management support because you will go nowhere without their interest. Top management will lead to the cooperation of everyone. Then you will need the following; (1) Head capital (expert means financial support) to invest and allocate talent to work on this project. A (2) platform works as an integration portal to resource required data. (3) Quality manager to monitor the system’s accuracy and performance. You will also need some (4) permits for the organisations to integrate with other organisations.”*⁽¹⁻²⁾⁽¹⁻³⁾⁽¹⁻⁶⁾⁽⁴⁻¹⁾

B.R1.08: *“There are systems that are used inside our organisation that measures KPI. Are you planning to include performance indicators? That could not be easy because it differs from one organisation to another without a unified way. Also, no one wants to open the door to how KPI is measured, and that’s why it is kept internally (experts mean questionable methods for measuring the performance of employees). On the other hand, KPI might help find what the employee needs to get training or skill improvement. Companies do not admit they have weaknesses and underachievement, so they keep that data internally. KPI has a social part; it is not always about the KPI.”*⁽¹⁻³⁾⁽¹⁻⁴⁾

B.R1.09: *“Your system’s goal must be useful (constructive) by connecting candidates with employment, not (destructive) to confirm scandals (we were talking about KPI).”*⁽¹⁻⁴⁾

B.R1.10: *“The infrastructure has two techniques: to be considered from the planning phase a new infrastructure under the financial support or using the current infrastructure and request the outdated organisations to have some changes. For example, if they use hard copies for records, they ask they use soft digital copies.”*⁽¹⁻⁶⁾⁽²⁻¹⁾

B.R1.11: *“You will need an operation team; did you assign who are the operational team? There will be operational costs; whose responsibility is that?”*⁽²⁻⁰⁾

B.R1.12: *“The project infrastructure comes with software requirements; the system must run accurately. The project infrastructure covers both hardware and software. Such an example and not limited to; Storage, Security, Stability, Database Servers, Special Nodes, Data Clustering and Data Availability.”*⁽²⁻¹⁾⁽²⁻³⁾⁽²⁻⁶⁾⁽³⁻⁰⁾⁽⁴⁻¹⁾

B.R1.13: *“I agree with all as essential (IT operation). However, some factors are added based on the system’s operating environment. There will be a need for infrastructure other than the application because the application becomes distributed on multiple servers and databases. There will be synchronisation between all servers while having clustering on the database and application. Reliability and Scalability.”*⁽²⁻¹⁾⁽⁴⁻¹⁾⁽⁴⁻⁶⁾

B.R1.14: *“This could likely be done as a new platform dedicated to educational and employment agencies. Starting with a proof of concept for academic certificates and employment achievements, new parties will become interested and involved. Suddenly, the system and data will become grown in volume.”*⁽²⁻²⁾⁽²⁻³⁾

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Expert B

B.R1.15: *“Storage is not a big issue. Most of what we are discussing is about integrating with other systems. There will be a lot of challenges that come with storing data; in the short term, it is not allowed. Again, you do not have the data; you are getting it from different organisations, so your job is to create a system with integrations. The design or framework only collects data from various sources for validation and showing it to the end-user. This data collection uses integration methods, which collect data from multiple sources.”*⁽²⁻³⁾⁽⁴⁻¹⁾

B.R1.16: *“Confidentiality is essential because it pours into (teams up with) security.”*⁽³⁻¹⁾

B.R1.17: *“Authentication with authorisation is a pair, to make sure of identity to access then if they have the correct permission to change or update a record.”*⁽³⁻²⁾⁽³⁻³⁾

B.R1.18: *“Also, twisted (misrepresented) information comes from users when there is no authorisation to add a record or another example being exaggerated to the extent that it became inaccurate information.”*⁽³⁻³⁾⁽⁴⁻³⁾⁽⁴⁻⁵⁾

B.R1.19: *“Data with a clear connection of inheritance (Expert means provenance) is a must! to build trust from the first step. Also, trust has two meanings in your framework: belief in the system to correctly make functional tasks (decisions). Also, it means to trust that the data is accurate from the source who enclosed (added) the record.”*⁽³⁻³⁾⁽⁴⁻⁰⁾⁽⁴⁻¹⁾⁽⁴⁻⁴⁾

B.R1.20: *“Availability is both Security (hacker deleted) and “IT Development” (being available at request).”*⁽³⁻⁴⁾

B.R1.21: *“Privacy to have complete control of your data, for when to publish a record, who is allowed to see the document. Encryption is crucial if it is outside the e-gov services. Data Integrity is an essential factor; it is the main reason for the system. ”*⁽³⁻⁵⁾⁽³⁻⁶⁾⁽⁴⁻²⁾

B.R1.22: *“Immutability is a nice feature to know who changed what and when. Which will help in trust building.”*⁽⁴⁻⁰⁾⁽⁴⁻⁴⁾

B.R1.23: *“Privacy for the company and individual is important. Each entity controls its data and what information can be published and shown. This control is a concern for conflict of interest.”*⁽⁴⁻²⁾

B.R1.24: *“There are two directions for your framework. Is it any certificate or certificate within governmentally recognised platforms? Any source of valuable/important information must have a procedure to validate information to assure its accuracy. Any given information should have an origin to validate a particular certificate from the main source of information, such as an institute or organisation. Otherwise, it isn't very worthy.”*⁽⁴⁻³⁾⁽⁴⁻⁴⁾⁽⁴⁻⁵⁾

B.R1.25: *“Decentralisation in terms of date means it can be in more than one place. Decentralisation is rejected and creates a challenge because organisations want their information to stay with them. However, it is an excellent factor when the organisation gets shut down and becomes out of business.”*⁽⁴⁻⁶⁾

TABLE G.3: Expert C Spoken Sentences and Their affected Components

Expert C		
Sentence ID	“Spoken Sentence”	Affected Components
C.R1.01:	<i>“Financial support is required. This comes in form of allocating developers.”</i> ⁽¹⁻⁰⁾	

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Expert C

C.R1.02: *“Getting organisations to cooperate with you and work with you, would be enormously and extremely challenging. The only way thinking about, to get everyone cooperation is by finding a strong influencer to power the system through an administrative decision.”*(1-0)(1-2)(1-5)

C.R1.03: *“The main issue at hand, is not the system or the idea, technologically speaking; actually, it is very straight forward to be executed. The problem is the cooperation and convincing a beneficiary to adopt the system.”*(1-0)(1-2)(1-5)

C.R1.04: *“What is the added value? It must be beneficial to both private and public sectors. ”*(1-1)

C.R1.05: *“This system requires endless SLA (Service-level agreement) from numerous entities.”*(1-2)(1-5)(4-1)

C.R1.06: *“Top management support is compulsory so the system can have the enforced resources findings. ”*(1-2)

C.R1.07: *“Relating to employer assessment, the involvement of authorising individuals (expert means work supervisors) on validating or verifying records, will cause credibility (expert means accuracy) issues. Giving control to someone to alter or add information would have some kind of social pressure, which will lower the accuracy and falsify represent information. The system should only work on issued certificates that has a source not employee performance.”*(1-4)(2-6)(4-0)(4-3)(4-4)(4-5)

C.R1.08: *“Cooperation between government agencies is critical. ”*(1-5)

C.R1.09: *“I see no cooperation for your system or even your system would move forward if and only if it was supported by a government sector. No one would cooperate with private developing companies to build such system.”*(1-5)

C.R1.10: *“Implementation will be very challenging and hard. The problem, each entity has their data privacy and they like ownership and isolation, the presented challenge is cooperation. If you have access to the data, yes, it is possible. ”*(1-5)(4-2)

C.R1.11: *“Infrastructure that is based on online web application should be ready to receive services from intranet that has access on the GSN network.”*(2-1)(4-1)(4-3)

C.R1.12: *“Reliably in terms of being fast and responsive, scalability, flexibility, usability on the web application.”*(2-2)(2-4)(2-5)(2-6)

C.R1.13: *“Storage is not important because you are not storing information, you are verifying shared records to validate a resume or build a resume. ”*(2-3)(4-3)

C.R1.14: *“To assure the reliability and accuracy of the information, this system has to only share records and does not allow any information change. Therefore, no storage is needed and no users. This means no capabilities to change any information after being exported from the record issuer. Consequently, no user to input data. Once the user is able to alter or add information, it becomes like linked-in which will lead to loss in trust of the system.”*(2-3)(2-6)(3-3)(4-0)(4-3)

C.R1.15: *“If and only if you work on the GSN (Government Secure Network), security is not important because they have their own procedures and practices security. Again, security as a concept is important, but if it was within the e-gov, you will not need to think about security because they have their own procedures. So, no comments on factors assuming this is an e-gov system. ”*(3-0)

C.R1.16: *“The information is private and sensitive, security will be a major concern and a great challenge. ”*(3-0)(4-2)

C.R1.17: *“Privacy and confidentiality is important when you there is a concept of any shared records.”*(3-1)(4-2)

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Expert C
C.R1.18: <i>“One of the most important factors, is information verification, and it is what you are trying to achieve. It would happen when the issuer of the information is authenticated and authorised to issue the certificate or the work record. When the authorisation is correct, it gives high assurance with validity and accuracy of the records that will be shared.”</i> ⁽³⁻²⁾⁽³⁻³⁾⁽⁴⁻³⁾
C.R1.19: <i>“All you need is a back-end integration from related entities. This will collect information to show it as being valid and accurate. It does not even need front end development; it should be an add-on on current e-gov systems. The system focus should be back-end and web services.”</i> ⁽⁴⁻¹⁾
C.R1.20: <i>“The system should gather data from distributed systems and bring them together in one integrated platform to validate and guarantees (assures) its accuracy.”</i> ⁽⁴⁻¹⁾⁽⁴⁻³⁾⁽⁴⁻⁶⁾
C.R1.21: <i>“The information should be validated to be accurate, if the system cannot show validated data, what is it used for? .”</i> ⁽⁴⁻³⁾
C.R1.22: <i>“The system should be a web service to validate given/provided information. At the back end gathers data and shows it to the end-user.”</i> ⁽⁴⁻³⁾

TABLE G.4: Expert D Spoken Sentences and Their affected Components

Expert D		
Sentence ID	“Spoken Sentence”	Affected Components
D.R1.01:	<i>“If there is no high revenue from this system, the private sector will not (sponsor) adopt this system. ”</i> ⁽¹⁻⁰⁾⁽¹⁻⁶⁾	
D.R1.02:	<i>“There must be cooperation between private and public sectors. They are always fighting and clashing, and collaboration between them is complex. We have many projects that got cancelled because there was no cooperation. Top management with a transparent organisation vision because management changes, but the organisation vision stays. However, full government sector support is more vigorous and will enforce resources and cooperation. ”</i> ⁽¹⁻⁰⁾⁽¹⁻²⁾⁽¹⁻⁵⁾⁽¹⁻⁶⁾⁽⁴⁻¹⁾	
D.R1.03:	<i>“This will be a successful system involving all universities, training institutes, public sector organisations and private sector corporations. From where would you get this power to enforce their cooperation? ”</i> ⁽¹⁻⁰⁾⁽¹⁻⁵⁾⁽⁴⁻¹⁾	
D.R1.04:	<i>“Cooperation is a significant issue. Especially When there is a change in management.”</i> ⁽¹⁻²⁾⁽¹⁻⁵⁾	
D.R1.05:	<i>“Yesser provides services and the infrastructure for e-gov systems. There is an internal physical network, intranet only for the government sectors usage. Again, they provide services. You will find many regulations regarding sharing information. To be a part of the e-gov network, you must have DMZ, which the government provides. This backend system will be challenging to install in non-governmental sectors. ”</i> ⁽¹⁻³⁾	
D.R1.06:	<i>“Giving the ability to control what to share in profiles could be very beneficial. This control will assure privacy on what someone wants to show on their profiles. Again, the direct supervisor could give an inaccurate evaluation based on personal reasons. Sometimes that erroneous information could be harmful, which job seekers do not want to reveal. ”</i> ⁽¹⁻⁴⁾⁽⁴⁻²⁾⁽⁴⁻⁵⁾	
D.R1.07:	<i>“peer-reviewed achievements to measure achievements.”</i> ⁽¹⁻⁴⁾	

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Expert D

D.R1.08: *"There is a social perspective and personal issues involved when managers evaluate their employees. Some managers will only validate or approve their employees' achievements for being horrible bosses. How would you overcome that? You might involve Blockchain technology if the direct supervisor does not authorise an achievement; if more than half the workers in that Blockchain approve it, the immediate supervisor can overwrite it. However, I strongly do not recommend Blockchain. Another way that could be more beneficial for validation would be to have a Pyramidal Arrangement based on the levels system, so another boss on the same level or higher can validate the information. Another way is peer review with a voting system also to validate. Must involve HR as a part of HR's responsibility because they are a neutral party and not directly involved with employees. The reason for that is to imagine a high influencer manager had an issue with an employee; if that person said something negative, it would impact the employee in their permanent record. So, the involvement of a neutral party is very significant."*(1-4)(4-3)

D.R1.09: *"Again, the most important is the income; cooperation and commitment are secondary."*(1-6)

D.R1.10: *"As a part of the private sector, what is the estimated income? What is the business model? Business development plan? You will require money, show me why?"*(1-6)

D.R1.11: *"Speaking about business and finance, consider improving income and limiting outsourcing. Two suggestions: Freelancing enables employees to work on small projects outside their work environment, and organisations could benefit from employee loaning to limit outsourcing. Also, employees are cycling employees between ministries within the related government sectors."*(1-6)

D.R1.12: *"What is the business model? The government sector will require more work to achieve anything. It is more likely to be developed by the private sector. What is the business model? As a company, do I need to invest in this? Is there an actual need for this system? Can we make it a tangible product that generates revenue? So, stop what you are doing, and think about the business model and the expected revenue per year. Is this something that replaces Linked In? Is everyone would be a part of it and enforce it?"*(1-6)

D.R1.13: *"Did you consider the system would have support for patches and updates?"*(2-0)

D.R1.14: *"From the operational point of view, flexibility is not an issue; this is a web-based system that grants access from a computer and not from a tablet, smartphone or a specific operating system. The operations team require a system that supports patches and updates. The system design should be usable and easy to use without heavy experience or training. A system deployed and managed with average experienced employees would be significant. So, operations must have a strategy with support and only request a little experience for their team."*(2-0)(2-4)(2-5)(2-6)

D.R1.15: *"The infrastructure for the system to is essential for a successfully implemented."*(2-1)

D.R1.16: *"Storage is essential, and government cloud services would ensure scalability and reliability."*(2-2)(2-3)(2-6)(4-6)

D.R1.17: *"The system should be secure, and you should consider only the government cloud."*(2-3)(3-0)(4-6)

D.R1.18: *"For this type of data, the system should be secure."*(3-0)

D.R1.19: *"There is s social part when a manager evaluates their employee. Then the interview mentioned the importance of the Pyramid authenticator."*(3-2)

D.R1.20: *"As a company that develops e-gov services, we have no access to any data. We could share information and what you say as a service, but Yesser will be the back end."*(4-0)(4-1)

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Expert D

D.R1.21: *“Even if you validated the accuracy of the information on the resume, more is needed. A face-to-face interview is mandatory. In my company, you need at least eight years of experience to be considered an expert. So, during the interview, if someone claims to be an expert, it will be easily detected if they are telling the truth. Inaccurate information on resumes is acceptable because it is easily discoverable during the interview.”*⁽⁴⁻⁰⁾⁽⁴⁻³⁾

D.R1.22: *“This system should be an endpoint because there will be many communications back and forth for information sharing. This endpoint will provide the information.”*⁽⁴⁻⁰⁾⁽⁴⁻¹⁾

D.R1.23: *“Inside my organisation, we get a Certificate of Appreciation for achieving something. Unfortunately, not every achievement grants a certificate. How can you verify something that does not have any credentials? Also, if you talk about educational institutes, they have already proven their information. Why do you want to validate a proven certificate?”*⁽⁴⁻³⁾

D.R1.24: *“The system should be secure, and you should consider the cloud.”*⁽⁴⁻⁶⁾

TABLE G.5: Expert E Spoken Sentences and Their affected Components

Expert E		
Sentence ID	<i>“Spoken Sentence”</i>	Affected Components
E.R1.01:	<i>“Financial income will be a concern if the private sector adopts the system. However, if the government sector got involved, it would adopt the approach based on the social benefits.”</i>	⁽¹⁻⁰⁾⁽¹⁻¹⁾⁽¹⁻⁶⁾
E.R1.02:	<i>“Adding a new system related to e-government will the company’s challenges and difficulties in convincing government agencies. There must be government organisation support. Someone in higher management must enforce a system for other sectors to collaborate.”</i>	⁽¹⁻⁰⁾⁽¹⁻³⁾⁽¹⁻²⁾⁽¹⁻⁵⁾
E.R1.03:	<i>“Collaboration is vital, and it raises a lot of issues. In reality, everyone tries not to do something new and throws their tasks at others. Hence, an authority from higher management to enforce Collaboration.”</i>	⁽¹⁻⁰⁾⁽¹⁻²⁾
E.R1.04:	<i>“What is the added value, and what is the private sector’s outcome and benefit? Without added value, you will get no interest from both domains.”</i>	⁽¹⁻¹⁾
E.R1.05:	<i>“Financial support is vital alongside support from top management. If the stakeholder is convinced and acknowledges the importance of such a system positively affecting society, it will be supported and provided with the required resources.”</i>	⁽¹⁻¹⁾⁽¹⁻²⁾⁽¹⁻⁶⁾
E.R1.06:	<i>“I agree with all four main categories. Again, any new system or implementation must come from top management for endorsement.”</i>	⁽¹⁻²⁾
E.R1.07:	<i>“There must be government organisation support. Someone in higher management must enforce a system for other sectors to collaborate.”</i>	⁽¹⁻²⁾
E.R1.08:	<i>“(The expert gave an example of a project they are working on and then said) we have a system, and after getting all the required access to the needed information and reaching stability, we stopped developing it. Then we care about earning revenue.”</i>	⁽¹⁻⁶⁾
E.R1.09:	<i>“What you described is not related to administrators only; it is more about the influential factors for IT Operation Management.”</i>	⁽²⁻⁰⁾
E.R1.10:	<i>“Infrastructure will be refurbished and prepared for any new system. It is a part of the system development.”</i>	⁽²⁻⁰⁾⁽²⁻¹⁾

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Expert E

E.R1.11: *“By default, every project we work on is reliable, scalable, and flexible. Requirements depend on what the system needs.”*⁽²⁻⁰⁾⁽²⁻²⁾⁽²⁻⁵⁾⁽²⁻⁶⁾

E.R1.12: *“Stakeholders must make long A long decision must be made regarding storing data. If the answer is yes, new servers will be required. It is strongly recommended not to store data since this is a back-end/middle system which services data sharing.”*⁽²⁻³⁾

E.R1.13: *“Storage is not a concern since it will be for sharing and not holding actual data. Most of the stored data would be pointers. Storage is optional.”*⁽²⁻³⁾

E.R1.14: *“Storage is optional. Revenue is about the system and what services it can provide, not storing the data. Parties can share what information they require for a service. (Uber Example)”*⁽²⁻³⁾

E.R1.15: *“Security is a big concern since the system handles sensitive data, which comes to attention how to classify information and what kind of data should be stored. ”*⁽²⁻³⁾⁽³⁻⁰⁾

E.R1.16: *“There is no need for any sensitive data storage. Storage is not necessary for information sharing. The best scenario is not storing data. Reduce unnecessary data for sharing and access. Unnecessary data storage will increase the risk. Data access should be “on demand” and “at request” for and available only when needed by an authorised requester. You must store some data, but the system should keep it minimal. The new system’s location guarantees success, which should be an intermediary interface between other platforms. (expert means Back-end API to provide system integration).”*⁽²⁻³⁾⁽⁴⁻¹⁾

E.R1.17: *“We have multiple million systems, and after getting all the required access to the needed information and reaching stability, we stopped developing it and earning revenue.”*⁽²⁻⁶⁾

E.R1.18: *“Suppose there is any interaction with information, either information access or information retrieval. The system must be secure and assure authenticity, authorisation, confidentiality, availability and integrity. ”*⁽³⁻⁰⁾⁽³⁻¹⁾⁽³⁻²⁾⁽³⁻³⁾⁽³⁻⁴⁾⁽³⁻⁶⁾

E.R1.19: *“If there is any stored data, it should assure authenticity, confidentiality, availability and integrity.”*⁽³⁻¹⁾⁽³⁻²⁾⁽³⁻⁴⁾⁽³⁻⁶⁾

E.R1.20: *“A couple of the main issues; raising trust and information accuracy. It must be correct and not fake or wrong. ”*⁽⁴⁻⁰⁾⁽⁴⁻³⁾⁽⁴⁻⁵⁾

E.R1.21: *“How to gain access to different data providers, and at what cost? Even more, figuring out the data you need and who has it.”*⁽⁴⁻¹⁾⁽⁴⁻²⁾

E.R1.22: *“Data classification to ensure what information can and cannot be shared.”*⁽⁴⁻²⁾

E.R1.23: *“Privacy is embedded in all governmental services, which is essential, especially for sensitive data.”*⁽⁴⁻²⁾

E.R1.24: *“The main issues are raising trust and validating the information. That must be correct! Not fake, wrong or exaggerated.”*⁽⁴⁻³⁾

E.R1.25: *“The notion of deploying machine learning techniques or cognitive automation capabilities to ensure the integrity and reliability of all provided information assure. An extreme benefit is if the system could find anomalies or inconsistencies in data. An ongoing validation from the system to check credentials and then the authority to update information while having strong audibility.”*⁽⁴⁻⁴⁾⁽⁴⁻⁵⁾

E.R1.26: *“Decentralisation of information would be beneficial only in the educational institutes, not in the governmental sectors since it holds private information. Employment sectors would need it but less than education. ”*⁽⁴⁻⁶⁾

TABLE G.6: Expert F Spoken Sentences and Their affected Components

Expert F		
Sentence ID	“Spoken Sentence”	Affected Components
F.R1.01:	<i>“As a typical user and person, what is the gained and added value? It seems you have managed to consider employers more than individuals. I could imagine as a user, the employer could recognise me and request to hire me. Rethink your stakeholder’s advantages.”</i>	<i>(1-1)</i>
F.R1.02:	<i>“Around here, the highest and strongest influencer on any major change or decision; is always the government sector.”</i>	<i>(1-2)</i>
F.R1.03:	<i>“Make a system available while maintaining regulations that allow users to use the system; when the government supports the system, it will gain a more significant echo which comes with approval.”</i>	<i>(1-3)</i>
F.R1.04:	<i>“The information issuer should control with protocols and follow laws and regulations.”</i>	<i>(1-3)</i>
F.R1.05:	<i>“Job description matters. Job matching and finding would be beneficial; I imagine it saves time and effort and ensures the best match with job descriptions.”</i>	<i>(1-4)</i>
F.R1.06:	<i>“Relating to implementation conditions (Now IT Operation), controllability is essential; who will control this system? Another factor is accountability because who will be accountable for the information in the system? Having authorisation and authentication by someone that is the responsible entity for this information.”</i>	<i>(2-0)(3-0)</i>
F.R1.07:	<i>“the system you suggest is enormous; the scalability is a given by default which will also have extensive capabilities of any extended storage.”</i>	<i>(2-2)</i>
F.R1.08:	<i>“Any usage for NIC only to manage and link, never to store to avoid redundant duplicated information, finalise what data will be required.”</i>	<i>(2-3)</i>
F.R1.09:	<i>“National information Centre involvement could be as a gateway or a link between related ministries to gain access concerning educational and employment information; they will not store or control any information (means to support systems integration).”</i>	<i>(2-3)</i>
F.R1.10:	<i>“An easy-to-use and usable system for different types of users with special user permissions.”</i>	<i>(2-4)</i>
F.R1.11:	<i>“First, Security is a given, and it is the first and most crucial factor for the data it handles.”</i>	<i>(3-0)</i>
F.R1.12:	<i>“Confidentiality, Integrity and Availability are the basic requirements for any security practices.”</i>	<i>(3-1)(3-4)(3-6)</i>
F.R1.13:	<i>“A system that is a platform for information sharing is valuable, and it may have a persistent need because the process of authenticating information shared between different information holders (schools, workplace, ministries), and some information holders cannot be specific (overseas, freelancers).”</i>	<i>(3-2)</i>
F.R1.14:	<i>“Earlier, I raised a concern or topic about controllability; I assume there is no central point of control or a single control of the information since there is no central control; who will control the data? Who will manage what to access, who access the information, and who will add new information? Who will check the data? Who would authorise changes? How can you prevent identity theft? Who could control this system?”</i>	<i>(3-2)</i>

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Expert F

F.R1.15: “Who is eligible to know (Means who has the right authorisation with the correct clearance to access) what kind of data? What about hiring companies? Do they have access to private data? How to ensure who can see which data?” What information will publish, and to whom?”(3-2)(4-2)

F.R1.16: “The information is already available within the ministries; such employment information (not history or achievements) is available in the Ministry of Human Resource and Social Development, and educational records are obtainable from the Ministry of Education.”(3-4)

F.R1.17: “Yes, Trust is essential.”(4-0)

F.R1.18: “Keep your framework as generic as you can; too early to specify the interested or required parties for your system. Divide responsibilities as much as you can. Dividing responsibilities between different organisations is beneficial. (expert means there is no need to start from scratch because the information is already alliable, and the system needs API to access them).”(4-1)

F.R1.19: “This system will include only trusted parties within the e-government zone (expert means integrating with other online systems).”(4-1)

F.R1.20: “Conflict of interest is a significant issue with your system; some companies require their retired or released employee not to work with a competitor for a certain number of years. Companies will not publish their employee information; that is a dead-end; avoid it.”(4-2)

F.R1.21: “publicly available information about a company’s employee information could lead to a conflict of interest; this information must have clear classifications.”(4-2)

F.R1.22: “(After some discussion to reduce wrong information and strengthen data validation) Consider some hierarchical system which starts from peers’ confirmation. When someone is at the same hierarchical level, they can endorse/validate what each person achieved before climbing into the next hierarchical level. The endorsement continues until it reaches human resources to be in a permeant record and ready to be exported.”(4-3)(4-4)

F.R1.23: “let’s not forget that there are many discovered cases of forgeries or inaccurate information provided by applicants to secure a job because it lacks a proper procedure for data validation.”(4-3)

F.R1.24: “Ministry of Education has launched an electronic system to enquire about an issued certificate. Soon, they aim to have all certificates issued under their ministry’s umbrella; each certificate would have a barcode to ensure being verified by the institute and valid.”(4-3)

F.R1.25: “reliability (the expert means accuracy), because this type of information may affect the person’s life, especially if the information is wrong, he could miss the opportunity to find a job. ”(4-3)

F.R1.26: “some professional training certificates do not have any form of accuracy. The reason for needed accuracy is a type of training has limited time validity. ”(4-3)

F.R1.27: “The issuer owns the information, and a system should use information-sharing techniques to authenticate individual requests.”(4-3)(4-4)

F.R1.28: “One of the crucial factors that I consider to be very important in this system, and technologies such as blockchain can solve, is track all changes because, and this is regarding millennials, they tend to change work and do much training. They have a high turnover (staff renewal rate), especially in information technology jobs.”(4-4)

F.R1.29: “such a system would be helpful because it protects its users; for example, if a person loses their certificate, the system has already authenticated it. This system will allow the ease of re-issuing misplaced certificates. The system could be the new issuer after verifying the integrity and credibility of the certificate owner.”(4-4)

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Expert F

F.R1.30: “You might need this. At the beginning of authentication, the first authenticator will be the first time to record the information. How to provide identity theft and authorise me as a person?”(4-4)

TABLE G.7: Expert G Spoken Sentences and Their affected Components

Expert G		
Sentence ID	“Spoken Sentence”	Affected Components
G.R1.01:	“Who is the sponsor of such a project? It would help if you went to your main stakeholders to get them on board to find the correct provision. Starting from your primary beneficiaries (stakeholders) means not starting from point (step) zero, only providing a system and what needs to change for their usage. Like GOSI, they already have some data that the API platform can use for input; look at their approach, add to it and not start from scratch. Starting from scratch means difficulties with laws and regulations.”(1-0)(1-3)	
G.R1.02:	“Main point is who are the investors, who are going to sponsor, who are the actual beneficiaries that will adopt this system. As long as the stakeholder invests, they invest out of their knowledge of their added value. These kinds of investors will have power, power to enforce regulations, power in the market, and connections to get the cooperation they need. The authority mentioned earlier comes in two forms, the first is having/owning the data, and the second is being in command and can influence (as a top manager) for something to happen.”(1-0)(1-1)(1-2)(1-6)	
G.R1.03:	“Again, what is the added value? Address customers (stakeholders) and what are their needs. Each customer has their value. In other words, they are mapping the needs of stakeholders. For example, finding the job market needs and mapping them with candidates to fill the job market.”(1-1)	
G.R1.04:	“What is the return value, and why should people invest time in things such as configurations and headaches on your system? ”(1-1)	
G.R1.05:	“Why would anyone in the employment sector spend time recording and authenticating achievements? Think about how many employees in a company. It is very time-consuming. This system would practise and deployed if there were a direct informant from the higher management on each employee to their direct manager, which has many key factors, such as whether there is a KPI for performance. How large is the company? How many employees? ”(1-1)(1-2)(1-4)	
G.R1.06:	“I care about the source of information. You will find challenges in compatibilities. It means a standard or regulation for sharing data and inserting new data. Resumes mostly have a divided responsibility requiring information from employment and educational institutes.”(1-3)	
G.R1.07:	“This could happen if there was an enforcement of regulation from the government to practice a consolidation of systems (a unified way which the experts mean standardisation) to measure performance, understanding consolidation of system standers and system communications that are the inforced to share data. Do some research on success factor validation. ”(1-3)	
G.R1.08:	“Why would a company give you its private information on their employees and themselves as a company? Such a system that contains employment history will require regulations from the Ministry of Employment HRSD (Ministry of Human Resources and Social Development). ”(1-3)	
G.R1.09:	“You will face a regulation problem, the formulation and method of presenting achievements differ from company to company, and there is no unified way to measure performance. The KPI is not the same across different companies. ”(1-3)	

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Expert G

G.R1.10: *“Focus on professional certifications and exams. This direction will allow silly or irrelevant achievements to fill the resume. For example, no one cares about backing classes if applying to be a bank teller (Validation). Only focus on what makes it a professional certificate, only certificates with international standards. (Data analysis).”*(1-4)(4-5)

G.R1.11: *“A meeting with the stakeholders is required to write concerns and infrastructure requirement list. Each stakeholder has a different point of view.”*(2-0)(2-1)

G.R1.12: *“Outdated infrastructure is not a concern. The concern is how to run a system and make it a business model applicable in the market. Infrastructure is the easiest part to make and is not a concern.”*(2-0)(2-1)

G.R1.13: *“There is a fine line between reading and sharing the information. Reading means a central database that everyone can read from. Sharing means giving you access to take data, which means you need storage.”*(2-3)

G.R1.14: *“Security is vital during the employment hiring process, which happens during the validation phase for certificates, references and experience. Otherwise, it is not needed at all or used again. This system is a service.”*(3-0)(4-3)

G.R1.15: *“Availability has two concerns; one is with security and another with being available for access at any time. It is not essential to be accessible at any time. Once validating the information from a system or a source is provided as correct and validated based on validating the data from certificate issuers (the primary source of the issued information). This type of information is not critical, so availability is not crucial to me. Again, it depends on your stakeholders and what is their business line. To me, it is a support service, not a mandatory service.”*(3-4)(4-1)(4-3)

G.R1.16: *“All I need is to reach the requested information and validate it while assuring its integrity. Other factors you mentioned (by moderator) are irrelevant since I will not provide any information from my side; as a user, I’m requesting only the validity of the data.”*(3-6)(4-3)

G.R1.17: *“The most important and by far for this type of data is integrity. I cannot emphasise this enough. This level is where the API system should play with (experts mean improvement).”*(3-6)

G.R1.18: *“Trust is important as a feature for data validation.”*(4-0)(4-3)

G.R1.19: *“Do not start from scratch; you will need only two to three parameters to create this system. Government agencies such as GOSI (General Organisation for Social Insurance) already jumped a distance on doing what you are looking for. GOSI already made it mandatory to have some information about employees, which can help to find the employment history. Then it is just combining data from different organisations and institutes.”*(4-1)

G.R1.20: *“Privacy is a valid factor depending on how being used. It is important while finding how and on what is critical,”*(4-2)

G.R1.21: *“Immutability, is important.”*(4-4)

TABLE G.8: Expert H Spoken Sentences and Their affected Components

Expert H		
Sentence ID	“Spoken Sentence”	Affected Components
H.R1.01:	<i>“Is the host physically or a leasing host? Who will be the host for this system? I believe this system needs to be physically hosted by e-government (developers and providers), and it would be the best of the best physical data centre host (expert means the infrastructure). The e-government developers can design and build the system, platform and everything. Based on my knowledge, no one would develop a new strategy other than e-government service providers, which fortunately will be an added value and more secure because it is under the government sector. Based on my knowledge, new systems developed in the private sector get overlooked. However, under the e-government umbrella, it will gain more power through governance, control and monitoring improvements. (Expert gave an example of a project under the public and private sectors and how the public sector made it successful).”</i>	<i>(1-0)(1-1)(2-0)(2-1)(3-0)</i>
H.R1.02:	<i>“There is a need for such a system, and it will have an immense added value for everyone. The added value is for the hiring system in any organisation in both the public and private sectors.”</i>	<i>(1-1)</i>
H.R1.03:	<i>“If top management is convinced, they would provide the budget and workforce. Also, they would provide agreement and cooperation. Who will give the enforcement? The answer is top management.”</i>	<i>(1-2)(1-5)(1-6)</i>
H.R1.04:	<i>“Support in factors other than money, time, and aspect of skilled workforce.”</i>	<i>(1-2)</i>
H.R1.05:	<i>“A clear Job description should be standardised.”</i>	<i>(1-3)</i>
H.R1.06:	<i>“Firstly, and most importantly, follow regulations provided by NCA (National Cyber Security Authority which is a government sector that provides policies, rules and guidelines). Consider NCA at the beginning of building a system. Any government organisation that works in the public sector has to follow directions provided by the NCA and the Ministry of Interior. NCA check compliance and auditing.”</i>	<i>(1-3)</i>
H.R1.07:	<i>“What you suggest would be a huge benefit in sharing the information just to validate it. Storing data means difficulties, regulations, data storage and protection. It means less pressure on security teams.”</i>	<i>(1-3)(2-3)(3-0)</i>
H.R1.08:	<i>“The challenges would appear when you consider achievements, experience, place of work and employment history because it is not in any transparent system. However, few organisations have employment records and accomplishments related to not many specialities and are currently limited only to engineers and healthcare majors.”</i>	<i>(1-4)</i>
H.R1.09:	<i>“People with social relations and connections are better than those without social activities. So, people with social communications and relationships with the decision-makers will help your project walk (Expert means going somewhere as a social factor to convince people to cooperate).”</i>	<i>(1-5)</i>
H.R1.10:	<i>“the government sector monitors e-government system development companies, and they provide auditing and reviews.”</i>	<i>(2-0)</i>
H.R1.11:	<i>“Server specs based on the number of users and the database. Because the database is different depending on the system, so, when the input is available, it will find what the requirements are. Infrastructure requirement”</i>	<i>(2-0)(2-1)</i>

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Expert H

H.R1.12: *“To find the technical, operational details, you’ll need some input. Some input can be in the form of the number of users, the location of the users, and what kind of endpoint (laptop, tablet, phone app, website) the user would use. Getting the input would find system requirements. Finding feedback would determine what you need to build an appropriate system design.”(2-0)*

H.R1.13: *“Conflict of interest is an issue with your system. Some of our staff work in cyber security with different companies; we cannot mention the organisation’s name when we say what projects we managed and made. So, we say only the project without saying who we made it. Also, this system needs privacy. Privacy on hidden files and classified data; however, when it is a must to find, the employer should get a special request for hidden fields. This privacy file can be built into the database while developing the system. 2.0”(2-0)(3-0)(4-2)*

H.R1.14: *“Infrastructure is not a critical factor because you are getting information from different organisations using the e-government platforms; you are looking for a unified system for interactions between each other (experts means integration). Organisations, such as training institutes, must have the popper infrastructure. Educational institutes such as universities for sure have a good infrastructure. ”(2-1)(4-1)*

H.R1.15: *“The most substantial factor is to determine (define) and know today’s requirements and predict how to make an expansion for the future. Prediction of the matrix for the number of users, data size, and how to expand the scalability for new features and more workload in years. (expert means scalability). You cannot find what you need for system scalability until you find the size of data and users, an input to get an output and show the system requirements in, data capacity, network capacity, network design for network, server design, and database design. Infrastructure”(2-1)(2-2)*

H.R1.16: *“Consider this point, NCSC and NCA will stop you and request input on the requested data and how it would travel between different organisations and institutes; they will ask in detail each entity what they will view and read. A suggested practice is not to store or process anything and only use a system to validate the accuracy of a given information or build something based on verified information. Integration and no storage. ”(2-3)(4-1)*

H.R1.17: *“Everything should be secure, such as endpoint, server, database and network. Security is not only technical but also another perspective, such as policies, controls, governance, process and procedures, which comes in the form of standards like ISO, which must follow. Also, a part of security is awareness and training.”(3-0)*

H.R1.18: *“The most important thing for data from the technical part, Authenticity, encryption, and data leakage prevention (confidentiality), all related to the security of the data. Before you say “security”, data classification is required. Because this will answer all your questions, it will answer, for example, if it involves encryption, data leakage prevention, and securing data static or dynamic (database). All of this is decided based on data classification. After data classifications, you will develop data solutions to confirm the data. ”(3-0)(3-1)(3-2)(3-5)*

H.R1.19: *“Regarding the endpoint, there is a network security issue. There is a connection between the end user and the host. Is it secure at the endpoint? Is there a requirement for VPN or just a standard connection? ”(3-0)*

H.R1.20: *“Confidentiality is based on the data classification, however. Availability and integrity are, without question, “a must-have” in your framework.”(3-1)(3-4)(3-6)*

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Expert H

H.R1.21: “This system will get approved if information between specific users and ministries is disturbed. Employers would provide essential information to validate or verify a request on a resume (with some restrictions for privacy). Companies will accept this system (expert means when companies get some added value). The information should be viewed only by the person who issued it (Authentication and Authorisation) (employer or institute) + the owner of the information (Person) + the Mistry or Government agency (MOD or HRSD) + System managers + System developers (very imitated).”(3-2)(3-3)(4-1)(4-2)(4-3)

H.R1.22: “A procedure of information accuracy and still valid (expert means validation) and who is authorised to create or update it could have big benefits.”(3-3)(4-3)

H.R1.23: “Trust from the source of the data creator is beneficial. Also, I like the trust chain verification; you can verify and trust simultaneously by giving it a chain of authorised issuers.”(3-3)(4-0)(4-4)

H.R1.24: “Comment on employment history and achievements; when you acquire employment records from an information issuer, it gets trust inheritance.”(3-3)(4-0)(4-4)

H.R1.25: “There is no availability of an updated and accurate record of information; there is a need to gather the correct data which is up to date with high accuracy of being verified. Because when you take information from these entities (expert means the authorised creator), it becomes trusted for having strict procedures to create information (Expert means Authorisation).”(3-3)(3-4)(4-0)(4-3)(4-5)

H.R1.26: “Clear audit and trace for each information transaction are important through SharePoint.”(4-4)

TABLE G.9: Expert I Spoken Sentences and Their affected Components

Expert I		
Sentence ID	“Spoken Sentence”	Affected Components
I.R1.01:	“A system that supports freelancers would be beneficial when they are building their experience through small jobs, tasks or projects. This new system would help to strengthen their resumes and experience. Also, this new system would help to build a more interesting resume.”(1-2)	
I.R1.02:	“There is no need to go and collect data from each university under the Ministry of Education. You only need to convince the core benefits, which is the Ministry of Education which will issue an administrative circular allowing you to get the cooperation of different educational institutes. If you go directly to institutes, you will get an instant rejection. Here comes the top management commitment, which is mandatory for such a system.”(1-2)	
I.R1.03:	“Adding this system is plausible because most educational institutes have to graduate students considering the approval of an International Standardisation. Most graduates must have jobs based on what they have learned and how prepared they have been for the job market in the past 4 to 5 years of their studies.”(1-4)	
I.R1.04:	“I would appreciate seeing some intelligence to provide specific query requests for expertise and resumes. I discovered that many of my students; they like to work as freelancers alongside their job.”(1-4)	
I.R1.05:	“Opportunities should be open for everyone; a system with high credibility would help to reduce or remove favouritism to give opportunities for everyone. This way, the system will serve everyone based on the given criteria and not a specific type of candidate.”(1-4)	

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Expert I

I.R1.06: “Regarding the resumes in general, the system should be capable of Fetching/Looking at the candidate’s background to build a resume. (BI)”(1-4)(4-1)

I.R1.07: “Financial briars are not important, especially for government sectors, as long there is a need and benefit of the system. The non-government sector, which provides jobs in the market, does not mind investing in a system that can provide authenticated and accurate resumes. Their added value determines this”(1-6)

I.R1.08: “Administrative interference should be as low as possible because a system based on intelligence would make the administrative involvement low.”(2-0)

I.R1.09: “Regarding data validation, A system only with verified data and data are accurate and not altered—User-friendly for a typical user. Administrative interference should be as low as possible because an intelligence-based system would make executive involvement minimal. High reliability is a must, especially on large systems that have data chains. Also, it should be rugged (expert means supports updates and patches) without any unnecessary problems. System maintenance should be low to keep usability high. A system with many errors and problems will lose its reliability and credibility. Fixability so it works with handheld devices or smartphones. Storage can be expandable (expert means it would embrace scalability).”(2-0)(2-2)(2-4)(2-5)(2-6)(3-0)(4-0)(4-3)

I.R1.10: “Viewing the outdated infrastructure depends on what you are trying to achieve; however, there will be a requirement to change the infrastructure settings. I can assure you we have up-to-date infrastructures and a secure environment because we follow strict rules for network infrastructure. You will need configuration tools with the suggested system to run your system and to associate with the currently available systems.”(2-1)

I.R1.11: “Also, it should be rugged without any unnecessary problems. System maintenance should be low to maintain usability; a system with many errors and problems will be overlooked and lose its reliability. Fixability so it works with handheld devices or smartphones. Storage and capable of being expandable.”(2-3)

I.R1.12: “User-friendly for a normal user.”(2-4)

I.R1.13: “High reliability is a must, especially on large systems with data chains. ”(2-6)

I.R1.14: “Without a question, integrity, authenticity with authoritarian, data availability and confidentiality are critical.”(3-1)(3-2)(3-3)(3-4)(3-6)

I.R1.15: “A system should only have validated and accurate data and not allow any data altered.”(3-2)

I.R1.16: “The suggested system should be centralised to be accessed. And other users can gain access after configuring their systems, given access to each institute to change its criteria.”(3-2)

I.R1.17: “Update procedures, update information, update the description. This feature is important under this category because any authorised new update will happen within the system. Based on authentication services, it will make some handshake procedures to ensure the information before updating it.”(3-2)(3-3)

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Expert I

I.R1.18: *“For example, recommendation letters are issued from the department and not directly from the supervisor. This practice makes the letter official, and everyone knows about it. The head of the department will see the letter before they generate it. The recommendation letter was given as an example because you want your system to be reliant (expert means dependent on accuracy); the system must connect with government and education institutes databases. Based on a trusted data source, the system should issue the resume for the student. Data Acknowledgment on some given data is needed. For example, I attended a training secession without an exam and only had an attendance letter. Also, some data should be used as keywords to build networked data for someone’s Hobbies and Interests. BI”*(3-3)(4-1)(4-0)(4-4)

I.R1.19: *“As long there is an authentication server/service, encryption will be defaulted.”*(3-5)

I.R1.20: *“Encrypting is important; from my networking perspective, when building a database system based on personal information, there will be a need for an authentication server which will permit access to the data. The system is already doing the encryption for you.”*(3-5)

I.R1.21: *“Increasing trust procedures to validate information will improve all the current issues and problems.”*(4-0)(4-3)

I.R1.22: *“raising trust is not required during academic years; it is more mandatory and beneficial after employment.”*(4-0)

I.R1.23: *“This system will be beneficial, not might; it will benefit students, job seekers and head hunters. There will be questions on how you will communicate with the government and different organisations. I would appreciate seeing some intelligence to provide specifically requested resumes. I discovered that many of my students; like to work as freelancers alongside their job.”*(4-1)

I.R1.24: *“For data validity, a strong methodology to validate the information from more than one side/interface. This process requires each party that is involved, should validate the information.”*(4-3)

I.R1.25: *“Some of the graduated students I used to supervise or teach come to me after graduation to help them build their resumes. I am their supervisor, and I know they mess up many things or exaggerate something they did not do or classes they did not take. Also, this system could build fresh graduates’ resumes to assure creditability. (expert means providing validated and verified information).”*(4-3)(4-5)

I.R1.26: *“Your systems will show more strength if it shows students’ achievements. What I mean is not only what they have learned in classrooms but also what they have learned and done outside the educational institutes during their studies. For example, a student would learn a different programming language outside of their study curriculum. Their resume must have this part of achievements to leverage after graduating. (Not only accounted for during their studies) (Expert means validating and verifying different credentials and other forms such as online training).”*(4-3)

I.R1.27: *“Based on real-life situations, the trust chain begins from the issuers of the certificate, and then each certificate is an addition to the record. Each new certificate means the previous qualification is accurate.”*(4-4)

I.R1.28: *“Immutability, through keeping everything on a system and expanding the information lifecycle, even after an institute is closed down. Decentralisation of information to keep it different institutes will assure the survivor of the data even after shutdown.”*(4-4)(4-6)

TABLE G.10: Expert J Spoken Sentences and Their affected Components

Expert J		
Sentence ID	“Spoken Sentence”	Affected Components
J.R1.01:	<i>“Having the involvement of governmental organisations will give the authority to access and manage the data. The governmental organisation will also own, support in many forms and supervise the system.”</i>	(1-0)(1-2)(1-6)(2-0)
J.R1.02:	<i>“it is a must; it is a need, there is no way around it; a new development in any organisation or a country without the top management support will go nowhere.”</i>	(1-2)
J.R1.03:	<i>“The infrastructure is more related to the technical aspect. Also, it depends on how your staff is ready to advance with technological development; it could become a financial problem when no one is developing.”</i>	(1-2)(2-0)(2-1)
J.R1.04:	<i>“This investment (expert means top management support) will assure the investment return for hiring highly qualified which will satisfy plans for the country’s vision.”</i>	(1-2)(1-6)
J.R1.05:	<i>“Administrator will run the system as it is. However, the developer will handle and develop the dataset and database within the provided/given permissions by the administrator. regulation”</i>	(1-3)
J.R1.06:	<i>“Cooperation between Information holders for being shared between prospective parties could solve this problem integration.”</i>	(1-5)(4-1)
J.R1.07:	<i>“Cooperation and collaboration as a system of working together are essential.”</i>	(1-5)
J.R1.08:	<i>“This system helps the HR departments when they cooperate with open innovation. HR departments will gain access to validated information; then, HR can compare provided resume. A system with prospective candidates would bring many benefits. It can act as a head-hunter recruiting service system.”</i>	(1-5)(4-1)(4-3)
J.R1.09:	<i>“Regarding financial aspects, that depends; to have a solid local/area economy, then, yes, finance is vital to support the economic system. When an employer approves a candidate for a job, such as having applicable certification and training, this will ensure who got hired is helping the country build the economy, leading to more job opportunities and increased income. So, it is both ways, investing and return on investment.”</i>	(1-6)
J.R1.10:	<i>“It is not focused only from an administrative perspective but also from the developer perspective. The developer is responsible for maintaining the system and updating system patches. Reliability and IT Operation”</i>	(2-0)(2-6)
J.R1.11:	<i>“Yes, you can add this system as an add-on because when discussing security issues and verifications, you can build (expert means develop) your protocol with what is needed to achieve your proposed system.”</i>	(2-0)(3-0)(4-3)
J.R1.12:	<i>“Any old infrastructure means a loss in money and business; imagine having an OS so old that it is without support because it is outdated.”</i>	(2-1)
J.R1.13:	<i>“Data decentralisation should at balance with security; the more decentralisation, the more you lose control over the data, and it will also have a lower chance of getting lost. Centralisation means controlling your data, raising quality but lowering the quantity. (decentralisation)”</i>	(3-0)(4-6)
J.R1.14:	<i>“in any online system, web-based or local system, security is a significant concern, and it is the first concern to work on.”</i>	(3-0)
J.R1.15:	<i>“When you build a system, you do not need the over headache of security; not everything should be about it.”</i>	(3-0)

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Expert J

J.R1.16: *“Having governmental organisations have authority to access and manage the data. Also, the governmental organisation runs the system.”(3-2)*

J.R1.17: *“No encryption is needed because most information in resumes is wanted to be publicly available; think about linked-in; they have all the information publicly available on a candidate.”(3-5)*

J.R1.18: *“Integrity of the information is important; having a system that is up-to-date about the information that it handles means having the correct information always at any given time, even if the certificate issuer got shut down..”(3-6)*

J.R1.19: *“Yes, correct, there is an issue with the resumes’ creditability (expert means accuracy); they are not always accurate.”(4-0)*

J.R1.20: *“You can add this system as an add-on because when we talk about verifying records and accuracy, you can build your protocol with what is needed to achieve your proposed system.”(4-0)(4-3)*

J.R1.21: *“Information sharing between prospective parties could solve this problem. Integration ”(4-1)*

J.R1.22: *“The system should by default have access to different educational organisations and integration of employment sectors. ”(4-1)*

J.R1.23: *“Conflict of interest is an issue because head-hunters will take an organisation’s employees.”(4-2)*

J.R1.24: *“Favouritism is a significant issue; it would benefit a new system to contribute to solving it.”(4-2)*

J.R1.25: *“The system is a third party that validates information; the system can act as the intermediate of validation and provide verification service without accessing the data. (Confidentiality and Privacy)”(4-2)(4-3)*

J.R1.26: *“To reduce conflict of interest and raise privacy, provided information can be verified on only what the candidate/student requests from the educational institute/employment organisation to show or share. Subconsciously, what the certificate issuer/employment organisation agrees to verify would be validated. (Privacy)”(4-2)(4-3)*

J.R1.27: *“We should agree that there is a lot of information, and it is private information.”(4-2)*

J.R1.28: *“if every document related to education and employment is verified, the hiring process will be faster and smoother because the only needed document would be to validate the person through a passport or national ID.”(4-3)*

J.R1.29: *“When a non-governmental developer manages the system, it prevents them from accessing information. Instead, they can only confirm it while the data is encrypted. Their approach should only send requests concerning the confirmation of data accuracy data. The system should only verify the data as either correct or unrecognised.”(4-3)*

J.R1.30: *“There is a system with all educational certificates that the official Ministry of Education websites can verify. However, if a system takes it a step further and verifies the employment history, that would be beneficial and saves time and effort of the verifying procedures..”(4-3)*

J.R1.31: *“keep everything in history, and it has existed in educational institutes for a long time. ”(4-4)*

J.R1.32: *“The business sector will not revive if there are still not accurate certificates, having not certified people, and fake online courses. A system is needed to identify this type of certification in candidates’ resumes. Misrepresented ”(4-5)*

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Expert J
J.R1.33: <i>“There is an issue with the creditability of the resumes. Resumes are not correct all the time.”</i> ⁽⁴⁻⁵⁾
J.R1.34: <i>“There was a case of a graduate student who got a master’s degree from a well-known university; the student continued doing his PhD at the same university. Unfortunately, the student filed for the PhD program and left the university. However, the student forged a PhD degree. Consequentially, when the university learned about the forgery, the university withdrew his master’s degree. (Misrepresented information)”</i> ⁽⁴⁻⁵⁾
J.R1.35: <i>“Twitter has a function for detecting false news; this feature can be beneficial in detecting revoked certificates. misrepresentation ”</i> ⁽⁴⁻⁵⁾

TABLE G.11: Expert K Spoken Sentences and Their affected Components

Expert K		
Sentence ID	“Spoken Sentence”	Affected Components
K.R1.01:	<i>“Is your framework for a specific government or generalised? I would say you should start looking at it as a general framework, and when you get into details, you should go to an official government sector to get an official endorsement.”</i> ⁽¹⁻⁰⁾	
K.R1.02:	<i>“Utilisation of the involvement of a governmental sector would be the most important to facilitate the spread of the idea or the system. Also, the government sector has official support and approval to deploy in other organisations (Expert means Collaboration). So, the involvement of the government sector will be one of the essential facilitators (the expert gave an e-gov example).”</i> ⁽¹⁻⁰⁾⁽¹⁻⁵⁾	
K.R1.03:	<i>“When a government sector discovers the benefits, they will provide full support. Financial support and financial return are essential. You will find all the support and the needed push for such a system.”</i> ⁽¹⁻⁰⁾⁽¹⁻¹⁾⁽¹⁻⁶⁾	
K.R1.04:	<i>“Regarding the infrastructure, this system will not require a heavy load with other systems. It might need some other infrastructures, such as configurations or additional servers. However, the usefulness of the system will overcome any infrastructure barriers. integration”</i> ⁽¹⁻¹⁾⁽²⁻⁴⁾⁽⁴⁻¹⁾	
K.R1.05:	<i>“First thing and most importantly, you will need Top Management Support. Because if the idea convinced them, it would be a great assistant to success and deployment. Without top management, this system will be useless and not see the light. Top management will enforce the development and use of any system.”</i> ⁽¹⁻²⁾	
K.R1.06:	<i>“Top management would benefit from assuring they have highly qualified employees with high standers criteria in the right place. Large companies have a training phase and training secessions for new employees to show the importance of having the required training and elevate expertise. However, not all companies can do that, especially if they are not financially strong. ”</i> ⁽¹⁻²⁾⁽¹⁻⁴⁾	
K.R1.07:	<i>“Scalability is essential, especially when you take the system; it is step by step and will get bigger with heavy traffic. ”</i> ⁽²⁻²⁾	
K.R1.08:	<i>“Storage is important for some certificates but not a barrier. ”</i> ⁽²⁻³⁾	
K.R1.09:	<i>“Any system should support Cross-platform usage from different systems and devices. With user-friendly, attractive design while being reliable and easy-to-use qualities. Also, not complex to address all types of users with other smart devices or computer skills.”</i> ⁽²⁻⁴⁾⁽²⁻⁵⁾⁽⁴⁻¹⁾	

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Expert K

K.R1.10: *“Isolated system to be away from other involved systems to avoid interference or conflicts with other systems.”*⁽²⁻⁶⁾⁽³⁻⁰⁾

K.R1.11: *“The system must be secure, and it is a must and the main condition for implementing.”*⁽³⁻⁰⁾

K.R1.12: *“Confidentiality is a concern; only people with access privileges or provided access (Code) can see the information.”*⁽³⁻¹⁾⁽⁴⁻²⁾

K.R1.13: *“The data cannot have any alterations because it will lose its confidentiality and trustworthiness.”*⁽³⁻¹⁾⁽³⁻³⁾⁽⁴⁻⁰⁾⁽⁴⁻⁴⁾

K.R1.14: *“Having capabilities to raise validation is mandatory. There is a feature called chain for trust certificates through SSL. It has private critical infrastructure. It is a chain of trust certificates containing the root of trust (who is the issuer), the trusted issuer (for what), and who authorised the issuer. It has root, intermediate and server certificates all in one single certificate. Provenance and authorisation and validation and trust and investigation.”*⁽³⁻³⁾⁽⁴⁻⁰⁾⁽⁴⁻³⁾⁽⁴⁻⁴⁾

K.R1.15: *“Even though there is no concurrent system use, availability is essential. You will not find many users simultaneously who will be using the system.”*⁽³⁻⁴⁾

K.R1.16: *“When you have more than one point, the visualisation if you have servers while transforming or exchanging information, the information must not be in plain text, and it should be encrypted. Also, this kind of information exchange usually has an encrypted connection through a VPN, one of the main features of information exchange.”*⁽³⁻⁵⁾⁽⁴⁻⁰⁾⁽⁴⁻¹⁾

K.R1.17: *“To assure integrity. The information must be tampering proof and not capable of being forged.”*⁽³⁻⁶⁾

K.R1.18: *“There is an existing problem from a long time ago in resumes. While hiring someone, there is a lot of credibility questions. So, a validated resume that contains information that has been through different endorsements and verifications would make a huge impact. This problem involves many involved parties (education, employment, local embassies, and overseas). Integration”*⁽⁴⁻⁰⁾⁽⁴⁻¹⁾⁽⁴⁻³⁾

K.R1.19: *“Privacy is not a significant concern, especially when someone is looking for other jobs on the market, and some would like to advertise their achievements and certificates. However, there could be some conflict of interest, and privacy becomes a concern when a company issues an achievement certificate for the employees. It will be a challenge on what to mention on their employees’ resumes.”*⁽⁴⁻²⁾

K.R1.20: *“Data on resumes could benefit from data replication for the organisations and institutes you have been with, similar to features provided in an active directory in the network. Also, the strength of decentralisation is that no one has complete data because the data is decentralised information into parts across different platforms. Also, what if something terrible happened with the organisation’s network? Does that mean we lost that data or lost access to the data?”*⁽⁴⁻⁶⁾

TABLE G.12: Expert L Spoken Sentences and Their affected Components

Expert L		
Sentence ID	“Spoken Sentence”	Affected Components
L.R1.01:	<i>“All your factors are changeable depending on who is the sponsor /adopter of the system. The sponsor will give the system the power (Top Support). There is an example of how powerful the e-government is because it has all the support and the required resources, such as; programmers (expert means financial aid) and cooperation of departments to make the system.”</i>	<i>”(1-0)(1-6)</i>
L.R1.02:	<i>“The first thing to do is determine the sponsor, adopter or beneficiary. Because if the beneficiary is a governmental entity, a directive and a decision to take action must be presented.”</i>	<i>”(1-0)</i>
L.R1.03:	<i>“There will be a need for a responsible party and a funded party, with an administrative decision dedicated to assisting (expert means enforced cooperation) in documenting professional certificates.”</i>	<i>”(1-0)(1-2)(1-5)(1-6)</i>
L.R1.04:	<i>“To find the endless possibility and applicability for this system is by allocating a ministry who would manage and supports it and wants to implement the API system.”</i>	<i>”(1-0)</i>
L.R1.05:	<i>“Find the difference added value between companies, government agencies and planning. For example, planning needs to know what the market needs. Based on my experience, approximately 60% of the employees take specialised courses. They are not dealing with clients, which means there are weaknesses in dealing with customers and citizens. To fill the shortcomings within five years, how to find the needs of the country and the market for a degree or a certificate?”</i>	<i>”(1-1)</i>
L.R1.06:	<i>“Who are the beneficiaries? Who will benefit from each side? What is the Added value?”</i>	<i>”(1-1)</i>
L.R1.07:	<i>“I am convinced that any system, whatever it is, can work if it has strong supporters.”</i>	<i>”(1-2)</i>
L.R1.08:	<i>“It must be web-based to reduce the workload on organisations. No organisation will accept a new server or new tools for new systems. Based on my personal experience in IT for more than five years, to make things better, I would preferer providing an Excel (expert means a standard way for records) sheet with all the new certificates to the main beneficiary or system owner and then they have the job of validating certificates and even resumes, which means “NOT” the organisation or training institute. However, suppose there is a requirement for verification from the organisation or training institute. In that case, the confirmation should be done only through web-based systems by uploading a unified file for only uploading (having standardisations). There is no need for digital certificates to use less storage and upload faster.”</i>	<i>”(1-3)(4-3)</i>
L.R1.09:	<i>“Performance of the employee if they did something that matches their job description.”</i>	<i>”(1-4)</i>
L.R1.10:	<i>“Privacy of a company for conflict of interest. So, KPI is only for employees, not for organisations. KPIs could be something negative for the organisation’s image.”</i>	<i>”(1-4)(4-2)</i>
L.R1.11:	<i>“There are internal KPI systems inside most organisations; KPIs do not leave the organisation.”</i>	<i>”(1-4)</i>
L.R1.12:	<i>“There is an interest in measuring performance, and the employee is in the right place. KPI”</i>	<i>”(1-4)</i>
L.R1.13:	<i>“All development factors are changeable depending on who is the sponsor /adopter of the system. The sponsor will give the system the power (Top Support). There is an example of how powerful the e-government is because it has all the support and the required resources, such as; programmers (expert means financial aid) and cooperation of departments to make the system.”</i>	<i>”(1-5)(2-0)</i>

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Expert L

L.R1.14: *“Financial support will be essential if the orientation is private, not public. Private parties are thinking of the cheapest and fastest way. And the financial return comes through subscriptions.”*⁽¹⁻⁶⁾

L.R1.15: *“The system appears to be big and will need deep study for required infrastructure such as database (expert means storage) because you are thinking of a country that contains 30 million.”*⁽²⁻⁰⁾⁽²⁻¹⁾⁽²⁻³⁾

L.R1.16: *“The infrastructure should be adaptable to have integration with other exciting systems.”*⁽²⁻¹⁾⁽⁴⁻¹⁾

L.R1.17: *“Easy interface for easy use end user. As a requester for the information, the requester is not responsible for adding any new information; the data should be available for comparison. So, the system’s only job is to validate or verify whether the data is accurate. In other words, the issued certificate should have some digital mark, for example, a QR code; when certificate validation is required, the only thing done is to go to the official issuer website system and confirm the certificate’s validity.”*⁽²⁻⁴⁾⁽⁴⁻⁰⁾⁽⁴⁻¹⁾⁽⁴⁻³⁾

L.R1.18: *“Having Disaster recovery (DR) and being reliable.”*⁽²⁻⁶⁾

L.R1.19: *“If this system is a part of the e-government, they look at security from a completely different perspective and will use their security procedures and practices.”*⁽³⁻⁰⁾

L.R1.20: *“Security as a primary factor is fundamental and must be included in any system. Having information comes together with accountable risk. Security must not stop from building a new system. Risk Management must be accepted and mitigated through security practices. Not all risks by a single entity are manageable; some can share (given or handover) to 3rd parties.”*⁽³⁻⁰⁾

L.R1.21: *“Security from an information exchange perspective is a must.”*⁽³⁻⁰⁾

L.R1.22: *“Most essential factors in this framework are information integrity and confidentiality.”*⁽³⁻¹⁾⁽³⁻⁶⁾

L.R1.23: *“Viewing privacy, emailing resumes or going to job fairs to provide profile resumes with personal information written such as the photograph, achievements, certificates, email, birthday and mobile number could be harmful when reached into the wrong hands. Unfortunately, hard copies of resumes are a considerable drawback for information confidentiality and privacy of the data.”*⁽³⁻¹⁾⁽⁴⁻²⁾

L.R1.24: *“After the issuers provide the information, then authenticate users to access it, now the question is, are they authorised to change it? When getting information from different systems, sometimes it needs to be changed or altered. Why did you not mention Authorisation?”*⁽³⁻²⁾⁽³⁻³⁾

L.R1.25: *“Authentication is vital to know user identity and verify them based on credentials.”*⁽³⁻²⁾

L.R1.26: *“Availability of the information should be there most of the time. It is not time-sensitive, but it is still essential for the information to be available.”*⁽³⁻⁴⁾

L.R1.27: *“Encryption is irrelevant for resumes because it is not sensitive information like banks. However, if you say health records, it becomes essential. So, encrypting is vital for sensitive information exchange but not certificates and employment history. The information is fundamental; it requires encryption. Also, being sponsored will be very challenging if this system handles sensitive data.”*⁽³⁻⁵⁾

L.R1.28: *“Data accuracy is a must for this system.”*⁽⁴⁻⁰⁾

L.R1.29: *“The problem we have is the Validity or Accuracy of the assumptions provided (Expert means: the validity of the certificates or resumes supplied during hiring).”*⁽⁴⁻⁰⁾⁽⁴⁻³⁾

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Expert L	
L.R1.30:	<i>“The head of the department, I can assure you, it is easy for employees to share their information for ambiguous, general and without details achievements. Organisations will have no issues validating vague achievements. As long there is no liability of any kind or risk to the organisation, there will accept verifying employee information.”</i> (4-2)(4-3)
L.R1.31:	<i>“The system should limit the data available in many irrelevant systems for privacy reasons. The issuer of the information should have a copy, and the system owner (sponsor, adopter). Reduce decentralisation.”</i> (4-2)(4-5)
L.R1.32:	<i>“There will be better acceptance from involved organisations when they still have full control and ownership of their information while publishing or sharing minimal ambiguous information. Which will also put less stress on the owners of the system. Privacy”</i> (4-2)
L.R1.33:	<i>“The chain of previously validated information allows you not to ask how someone got the data. For example, for a graduate person with a degree, I’ll not ask where his high school diploma is because the degree is more important, and who issued the degree already validated the accuracy of the information. That practice can be the same on an organisational level; when data gets validated through a company, it means it should have been through a few people in a hieratical system to validate the accuracy of information before (I assume) it reached and then left the HR department.”</i> (4-3)
L.R1.34:	<i>“The school, the university, and any party have the required evidence for confirmation of validity; they all need a sharing system based on a platform (means integration) to confirm the validity of the given information.”</i> (4-3)
L.R1.35:	<i>“This might be easier to be accepted if the HR department had a new work task which is validating employees’ achievements after leaving the organisation, which would eliminate misrepresented or wrong achievements.”</i> (4-3)(4-5)
L.R1.36:	<i>“Provenance is important because it shows who owns what and who and when the information has changed or uploaded.”</i> (4-4)
L.R1.37:	<i>“This Framework or system supports transparency and removes favouritism.”</i> (4-4)
L.R1.38:	<i>“To find the usefulness of decentralisation, you must find the sponsor because they might have a different perspective.”</i> (4-6)

TABLE G.13: Expert M Spoken Sentences and Their affected Components

Expert M	
Sentence ID	“Spoken Sentence” Affected Components
M.R1.01:	<i>“There are many challenges in this system. However, the diagram you provided for your research idea looks very interesting. You connected the dots, but there are challenges to reaching the research idea; you will get more obstacles to achievement. However, mitigating all these obstacles can ease government orientation; government orientation and support are mandatory, opening many opportunities in both sectors for finding candidates and hiring recruitment. A government agency must sponsor this research (the expert means the Ministry of HRSD); otherwise, the lack of government sector support would not enforce cooperation between divided or distributed organisations. Integrating divided or distributed organisations managed by a government agency for accuracy through management with technology solutions (Expert means e-Gov) had a noticeable positive impact on both the public and private sectors. This government involvement improved productivity and protected workers’ and organisations’ rights (expert means to follow laws and regulations).”</i> (1-0)(1-3)(1-5)(4-1)

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Expert M

M.R1.02: *“Your framework is not as you described to validating the accuracy of a given information in resumes through information sharing. If applied correctly, it will solve many issues in organisations regarding hiring while aiding the recruitment of highly qualified candidates with job positions they genuinely deserve (Expert means some BI), leading to a quick win-win situation for both seeking and demanding jobs. Moreover, government involvement would accelerate and influence cooperation.”*(1-0)(1-5)

M.R1.03: *“Government support for this research is essential; there will be a collaboration between education, employment and NIC. However, that is only collaboration; the issue is who will be responsible for this system and provide full support. Unifying how to record and which data to store will be necessary. There will be financial infrastructure support for developers and integration with other organisations’ systems. I see no scenario where this system could benefit the private sector (expert means managing and implementing); this system is a national benefit. So, for that, it should have an official organisation party to do their government budgetary for such a system.”*(1-0)(1-2)(1-3)(1-5)(1-6)(2-0)(4-1)

M.R1.04: *“Every company has concerns about confidentiality and prefers their privacy. So, when employees change employment, especially in IT majors, the focus should be on being certified as they passed all the required tests of the credential to gain a certificate on a security (particular) product (Cisco, Palo Alto). Usually, in professional resumes, candidates write about their tasks and scope of work. To relate in depth with your framework, at least a job description should be provided in the system by the employers; there is no need for sensitive details. Also, I would genuinely value yearly performance assessments. KPIs will lead job positions (recruiters) to match employer-provided job descriptions with the candidate’s job description.”*(1-3)(1-4)(3-0)(3-1)(4-2)

M.R1.05: *“When writing my resume, I will write down (with limitation) my achievements and history, whether the previous employer accepted or not, because they are my achievements. Writing and creating Achievements as long as no obligation is on either side. So, if privacy is essential to the company, sharing some information will make a conflict of interest irrelevant because it shares with their approval.”*(1-4)(4-2)

M.R1.06: *“However, as an employer, how could anyone verify the information? The issue might be not having a performance measurement system attached (combined) with employment history.”*(1-4)

M.R1.07: *“Performance report would help determine if the employee did their targeted work. Since it came from the inline manager to ensure their skills and achievement.”*(1-4)

M.R1.08: *“You are filling the gap for hiring because there is no clear way to choose and find employees. Usually, to find a candidate, we turn to HR agencies or websites (Linked-In, Bayt.com), and they have their issues. However, if a single point, platform or system connects the education and employment sectors with government support, it will solve many problems (expert means integration). One of the critical things missing here is that there is no background check; there is no clear way to show employment history, individual achievements or employee performance.”*(1-4)(4-1)

M.R1.09: *“Decentralisation is necessary and practised; the current procedure has limitations on what data is decentralised. However, you will need more data, and you will need to find a way for how organisations would contribute through cooperation to provide data.”*(1-5)(4-6)

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 Expert M

M.R1.10: *“A project like this must consider which are the main factors. Infrastructure such as servers, networks, connectivity, and storage are required. However, no one can evaluate or determine what metric for factors until you know the data size, programming language and type of the database. (kind of database) Because they differ in capabilities, integration with the current data owners (ministries) is essential. The system’s programming language will define the compatibilities and integrations between the devices, the backend system, and individuals.”(2-1)(4-1)*

M.R1.11: *“Retrieving information from integrated organisations can be done through API or query to minimise information storage and interaction with sensitive data, which means no need to store data on a new system.”(2-3)(4-1)*

M.R1.12: *“When you are at this level of this type of information, firstly, security at most is crucial. So, there will be a talk on how to perform information exchange between related parties. Secondly, another conversation would be about how to keep this information secure in storage (if used), which is not only about encryption but also about disaster recovery and backup. However, requiring encryption while transmitting information (on the move) is critical.”(2-3)(2-6)(3-0)(3-5)*

M.R1.13: *“The system must be user-friendly and easy to use. One main point I did not see on your framework is accessibility and auditing (Covered by authorisation and provenance); I want to know, as a system admin at the backend, am I allowed to alter or change this information? The answer cannot be no. When I receive records from different organisations, there is a possibility that the data is messed up and needs to be altered and fixed. So, flexibility in changing information is required as long as there is a way to verify with high accuracy through recording the log-in of users and logging what the user changed, what command the user used, what record was changed, and at what time, from which computer. These recorded logs will allow another entity to audit information externally. The audit can be done by whoever is in charge to reduce manipulation and raise the system’s integrity.”(2-4)(3-3)(3-6)(4-0)(4-3)(4-4)*

M.R1.14: *“From a professional opinion, add another new category with two prospective for audit-ability and accountability. Because a third party or external ensures all factor requirements are met, available and functioning as expected. If there was a breach in one of your four categories, how do you ensure each category is covered and working as expected? Take the financial sector as an example; they have external auditors. So, this category has to cover the internal and external auditors. The external auditors make sure the internal auditors are doing their jobs correctly. Adding this category leaves no gap. Confidentiality, integrity, and authentication combine with audibility and accountability.”(3-2)(3-3)(3-6)(4-4)*

M.R1.15: *“Integrity and confidentiality are a grey area, but they, by default, come from auditing and encryption. Having also access controls with privileges to allow which users can access what and how (expert means authorise and authenticity.”(3-2)(3-3)(3-5)*

M.R1.16: *“You touched on a sensitive topic, and very important. I’ll not go into deep details about the size of the problem. However, based on my field of work and expertise, there is a gap or a distance between the public sector, the private sector, and human resource companies. As a senior manager, when I get the resume for a highly qualified candidate, there is no official administrative association to verify the accuracy of the information on the resume, which is one of the main problems, and I agree with the importance of your project.”(4-0)(4-3)(4-5)*

M.R1.17: *“Giving a line manager the power or authority to verify achievement does not work very often because of the personal involvement factor. There should be a distribution of control in verifying the information. The HR department records the annual performance and achievements. HR department always has a neutral side and is fair.”(4-3)(4-6)*

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Expert M

M.R1.18: “I came across resumes of candidates overdone (overemphasised) on their achievements, certificates and training, so it led me to request from HR to bring them for interviews. However, during the interview, I found they exaggerated many things, which led us to have a test period for candidates. There is no way to verify their resumes from the previous employer. Misrepresented”(4-3)(4-5)

M.R1.19: “I’ll give an example, when someone I know and trust, if that person approves something, I’ll trust their opinion (such as hiring someone to do a difficult job with limited resources). However, the challenge with Implementation is how to trust an entity (person) based on what factors. I imagine there will be a chain of workflow and a chain of approvals and some validation or trust procedure, But still, how to measure the reputation for trust? Because when they refer to or authenticate someone. How are you going to base that and build the system? In cyber security, while using an SSL certificate, the computer operating system has a chain of trust from trusted servers, which provide them with authentication. Certificate examples; discern and GoDaddy. Now the question for you is, in the system, how would you build these entities (people), could have a like a linked-in based solution (reputation based)? Also another way is to start the system based only on government agencies (miseries Edu, HR). Then, for the following step, consider reputation building that starts from high profiles with an exceptional experience. Then the final step is confirming the authenticator’s reputation and whether it is correct for what that person authenticated, which will lower or strengthen the reputation. THINK ABOUT REPUTATION BUILDER FOR information validation.”(4-3)

M.R1.20: “During interviews, a clear gap exists on a few resumes, which mismatches the person’s claim. A few factors can lead to this mismatch: outdated training certificate, not attending the training course, not practising, in reality, their training, or attending a symposium (as a listener), and in their perspective, that counts as experience. misrepresented”(4-5)

TABLE G.14: Expert N Spoken Sentences and Their affected Components

Expert N		
Sentence ID	“Spoken Sentence”	Affected Components
N.R1.01:	“As for the information, when taken from all sides, it needs a higher authority and a supporter. Then the application will start to happen.”	(1-0)(1-2)
N.R1.02:	“To gain access to this information needed for a new system, you will need top management or higher authority. ”	(1-0)(1-2)
N.R1.03:	“The base of any system is getting top management cooperation; it would be more obtainable when that happens. ”	(1-2)
N.R1.04:	“You will need a lot of support. Even before the financial support, there is a need for moral support. Many people do not understand the Blockchain. Blockchain would save a lot of spent money on servers. Also, there will be no need for data centres, not even a cloud. Blockchain has a bad reputation because most people link it with Bitcoin. ”	(1-2)(2-3)
N.R1.05:	“Different regulations will be needed when there is more than one Ministry or entity. ”	(1-3)
N.R1.06:	“Changing some minor infrastructure, such as investing in IoT or more Wi-Fi access points, would be very beneficial because the more you have devices on the Blockchain network means the more secure. Scalability would benefit the security of the Blockchain. So, this will increase reliability with scalability, on the other hand. ”	(1-5)(2-1)(2-2)(2-6)(3-0)
N.R1.07:	“Some infrastructures change could be paper to digital.”	(1-5)

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Expert N

N.R1.08: “Companies pay millions for security to protect their information from hackers and Cyber Attacks. ”(1-6)(3-0)

N.R1.09: “One of the benefits things from Blockchain, it can use the current infrastructure. There will be a small application that is responsible for making transactions. Then connect all devices inside Blockchain networks as peer-to-peer.”(2-1)

N.R1.10: “The framework has benefits to raise accuracy and information validation. However, the challenge is some with the infrastructure. There is no integration between who has the data to validate a provided resume. This framework is the ground floor for the integration (Expert means a platform or a system). ”(2-1)(4-1)(4-3)

N.R1.11: “The missing link and the challenging task are how to influence different organisations to upload information because many still use hard copies.”(2-1)

N.R1.12: “The problem and the missing link is how to force the parties to upload a large amount of information in the network. You can start small and with specific samples; all papers are digitised, not hardware paper. Gain access to the data from the completed database. Start a simple transaction based on Blockchain technology does not store information in servers but with the existing nodes.”(2-1)

N.R1.13: “Blockchain does not need servers because it is peer-to-peer. The strength of Blockchain is to eliminate servers and centralisation. Just think about it, an attacker can hack into a server and change the algorithm or the information; where is the security now? Servers would solve many issues. However, since servers have a centralised nature, it is a single point of failure and more likely to be attacked. However, if Blockchain got attacks, and the attack was on half of the nodes, the transaction would be dined. So, in other words, if you combine IoT with Blockchain, which means including all devices inside your Blockchain network, which I could easily estimate more than 10,000 devices for a medium-sized university, think how an attacker would make changes on more than 5,000 simultaneously. Blockchain needs no servers at all!”(2-2)(2-3)

N.R1.14: “To validate the operations, most nodes and nodes can be anything, even as a projector, to raise scalability and preserve information. Nodes are authentication sets according to the authentication process’s hierarchical classification. And nodes are devices of people who are of the same level.”(2-2)(4-3)

N.R1.15: “To reduce the blockchain weaknesses that hackers cause, increase the scalability and number of nodes. Having many devices will make attacks very difficult on hackers, the need to penetrate more than half of the devices. Your idea may be far from the technology, and the best way to get your goals is to use the Blockchain to verify the criteria or what is being claimed in resumes to increase or be more reliable. Blockchains in profile resumes will increase reliability because specific criteria are set on the Blockchain when there is a job offer. Then when these criteria are verified, employment is done. The two parties will be there, the builder for blocks in blockchains and the job seeker.”(2-2)

N.R1.16: “Blockchain provides integrity. While developers were building Blockchain, they developed it with a security mindset which had integrity by assuring only accurate information for being based on Blockchain; any unauthorised alteration means rejection. Blockchain provides availability when any device inside the blockchain network has the data. By default, the Blockchain would update and validate its information. Blockchain provides authenticity when using private Blockchain. ”(2-3)(3-0)
(3-2)(3-3)(3-4) (3-6)(4-3)(4-5)

N.R1.17: “I only use the database server for data storage and not decision-making. The Blockchain could retrieve the information from the servers and encrypt it based on the node’s permissions. You can use Blockchain as a tool and a secure cover for the data in the database.”(2-3)(4-1)(3-0)

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Expert N

N.R1.18: *“Storage in Blockchain is not a challenge, as long it is only text. However, it would be a significant concern if it started to become multimedia, like pictures and videos.”*⁽²⁻³⁾

N.R1.19: *“End-users are required only to upload the information to a database; then the technical Blockchain expert has to start taking the data from the database exposed to Blockchain. Until now, there is no user-friendly interface for Blockchain.”*⁽²⁻⁴⁾

N.R1.20: *“Usability is a primary concern because there is no interface that is easy to use with Blockchain. Especially if the user is not with a technical background.”*⁽²⁻⁴⁾

N.R1.21: *“They are overlooked for reliability in multiple places and approval for different parties. Even if someone puts a piece of information to ensure it, displaying data on all the nodes with a relationship would drop the wrong information.”*⁽²⁻⁶⁾

N.R1.22: *“When using e-gov, the security has less importance/impact because the government owns the information.”*⁽³⁻⁰⁾

N.R1.23: *“Privacy is guaranteed in Blockchain because it uses private and public with the use of encryption.”*⁽³⁻⁵⁾⁽⁴⁻²⁾

N.R1.24: *“The difficulty in adopting a blockchain is how it is possible to withdraw data from the database and save it on the hyper Ledger in the form of keys. Later, it will be easy to remove data. The nodes are only to indicate the information, and it is encrypted.”*⁽³⁻⁵⁾

N.R1.25: *“Blockchain could elevate by providing strength on some of the trust issues. Because when entities did not agree on the information, it falls and rejected..”*⁽⁴⁻⁰⁾

N.R1.26: *“Resumes are at some level not accurate; candidates either provide wrong or unrealistic information while claiming some training and expertise for something they did not do. This framework strengthens that the validation and verification start from the information issuer.”*⁽⁴⁻⁰⁾⁽⁴⁻³⁾⁽⁴⁻⁴⁾

N.R1.27: *“As an end-user, all needed to be a part of the blockchain network is providing access on your device so it becomes a nod in the blockchain network. Users will only add new data to the servers, which (the server) is connected to the Blockchain.”*⁽⁴⁻¹⁾

N.R1.28: *“Integration is essential when no information is available; however, everything Blockchain needs is already available.”*⁽⁴⁻¹⁾

N.R1.29: *“When overlapping more than one side, various permits will be required. (The expert means overlapping, integration between one and another department). Your system needs integration between other parties, and the idea is not a simple web browser.”*⁽⁴⁻¹⁾

N.R1.30: *“Blockchain does not save information; it only validates it; there will be another place to store information, like a database. Again, Blockchain only validates.”*⁽⁴⁻³⁾

N.R1.31: *“If we used Blockchain for educational certificate verification, with an assumption the Blockchain is on an educational institute network. After a validator or a certificate validates, the information is issued. Blockchain helps to assure the ownership of a student for a certificate; also, would the student, after achieving specific criteria, would that person gain a certificate?”*⁽⁴⁻³⁾

N.R1.32: *“Liability is a factor because the information is verified and accurate; how will you use it?”*⁽⁴⁻³⁾

N.R1.33: *“One of the sources of empowerment in the Blockchain is that it cannot put wrong information because data presents itself to more than one person with a relationship and the authority to document the information. Not a party but individuals inside the network, and an agreement must be made between them.”*⁽⁴⁻³⁾

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Expert N

N.R1.34: *“Immutability is a strong point of Blockchain; any alteration to the information labels it as “Fake” and has an unauthenticated and untrusted assignment.”* (4-4)

N.R1.35: *“Generally speaking, the suggested system has a strong idea. The idea is compelling. Usually, candidates write something that is not correct in their resumes, unrealistic or unclear, with an increase in some skills. Sometimes, misleading information with exaggeration to get an interview. But what distinguishes working with your project is that you get information validity and authenticity from the data source.”* (4-5)

TABLE G.15: Expert O Spoken Sentences and Their affected Components

Expert O		
Sentence ID	“Spoken Sentence”	Affected Components
O.R1.01:	<i>“First thing and most importantly, you will need Top Management Support. Because if the idea convinced them, it would be a great assistant to success and deployment. Without top management, this system will be useless. Top management will enforce the use of the system.”</i>	(1-0)(1-6)
O.R1.02:	<i>“Laws and Regulations will not be in your favour in many things. Different institutes and different organisations mean various obstacles.”</i>	(1-3)
O.R1.03:	<i>“Security as a concept is significant for having this type of information. You need your system to be always secured. There is a policy for data, but not standardised across all organisations..”</i>	(1-3)(3-0)
O.R1.04:	<i>“Standardisation and compliance with sensitive government data. Once complied with the given standers, you will be on the safe side.”</i>	(1-3)
O.R1.05:	<i>“The direct manager is the person that knows everything about their employee, and they know their achievements and projects. So, they are the best way to build up the experience. Which goes against decentralisation.”</i>	(1-4)
O.R1.06:	<i>“Cooperating for awareness of the private sector and public sector. If HR cooperates, it will help this system be active and find added value by gaining access to verified and accurate resumes in a matter of a click, which will significantly contribute to the system.”</i>	(1-5)
O.R1.07:	<i>“Financing and funding are factors for creating more than one department in a circle.”</i>	(1-6)
O.R1.08:	<i>“Considering storage, if clouding (expert means cloud services), you will need the involvement movement of cloud as a local company to store records for educational certificates and employment records. Also, you might need servers that also must be inside the country and preferably in the government sector (the expert means storage inside the country).”</i>	(2-3)(4-6)
O.R1.09:	<i>“Security for storing employment and sensitive data.”</i>	(2-3)(3-0)
O.R1.10:	<i>“Flexible to work on different and multi-platforms and systems. Usable and easy to use. Accessibility (expert means usability) from simple devices such as smartphones, tablets, and web browsers.”</i>	(2-4)(2-5)(4-1)
O.R1.11:	<i>“Reliability is vital; users need to rely on the system that it will do its tasks and services.”</i>	(2-6)
O.R1.12:	<i>“Cloud computing, or G-Cloud, provides data hosting inside the country, offering high-security whit with comfort and peace of mind.”</i>	(3-0)

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Expert O

O.R1.13: “The system must ensure confidentiality because it has personal data and should not be accessible to everyone—only specific users with specific credentials. Avoid being like Linked In (they started to lose creditability).”(3-1)(3-3)

O.R1.14: “Authentication is crucial for connecting with e-government systems. Also, the people rely on the e-government system and give them their complete trust. ”(3-2)

O.R1.15: “Encryption, during transferring the data while sharing to raise integrity. (Means During data exchange).”(3-5)(3-6)

O.R1.16: “Integrity is essential because once you lose integrity, you lose trust and users’ interest (user interest to use the system).”(3-6)

O.R1.17: “Elevating trust is essential for authenticating a resume profile. ”(4-0)

O.R1.18: “Any system created by the e-government systems is trusted and verified by default.”(4-0)(4-3)

O.R1.19: “The credibility issues caused some certificate issuers to validate their certificate with a link and specific code (QR Code) to confirm accuracy.”(4-0)(4-3)

O.R1.20: “The employment sectors do not waste too much time to verify resumes and check accuracy. However, if they have a ready and available system with accurate information, this will save much valuable time with high accuracy. ”(4-0)

O.R1.21: “There are significant issues with the credibility (Expert means trust) of data from candidates’ resumes. When hiring many applicants, employment organisations cannot double-check their criteria, and they will primarily focus on the profile resume and copies of certificates, which could lack credibility (expert means accuracy). ”(4-0)(4-3)

O.R1.22: “Unique code for confirmation of the certificate or issued paper from an authorised issuer like government agencies or schools.”(4-0)(4-3)

O.R1.23: “The idea of such a system is essential, and the strengths come within linking stakeholders such as educational institutes (academic and training) and employment organisations. This system is mandatory because it does not exist. Sharing information to authenticate a resume will give a solution to inaccurate information. ”(4-1)(4-5)

O.R1.24: “Your challenge here is to make the connection between the stakeholders. This connection would be between educational and employment institutes for both public and private sectors while gaining accurate information from e-government systems. ”(4-1)(4-3)

O.R1.25: “Conflict of interest will cause some red flags.”(4-2)

O.R1.26: “Control over the shared information outside the organisation.”(4-2)

O.R1.27: “Ensure privacy is another essential feature because when sharing information with unknown individuals or organisations, information owners want to know which part of their personal information was shared, which applies to both; individuals and organisations; so, data requesters must clarify privacy practices on which part of the information will acquire access. ”(4-2)

O.R1.28: “Privacy for having a conflict of interest. As a company, I want to keep my employees inside my organisation, and I do not wish competitors or job hunters to gain access to my employees’ information. Job hunters will start feeding them and take them away after, as a company, we invested in them, which could be a drawback as a reverse adverse reaction on my organisation. ”(4-2)

O.R1.29: “Privacy is important with in regards to conflict of interest.”(4-2)

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Expert O

O.R1.30: *“Recording everything in a transparent system will elevate trust.”*(4-4)

O.R1.31: *“In resumes, everyone can claim anything under their achievements. With limited access to previous employers, finding their actual accomplishments will be very challenging.”*(4-5)

O.R1.32: *“When starting a significant project, no one in HR will check all candidates if they are providing correct information. It is time-consuming, making some sectors hire candidates under a trial period to prove themselves; if they are not qualified, they get released. ”*(4-5)

References

- Abanumy, A., & Mayhew, P. (2007, 01). Government-to-citizens relationship: Evaluating the quality of information on saudi ministries' websites. *Proceedings of the European Conference on e-Government, ECEG*, 1-8.
- Abanumy, A. N., & Alshitri, K. I. (2014). Review of web-content assessment results of Saudi Ministries websites towards e-Government transformation. *ICISA 2014 - 2014 5th International Conference on Information Science and Applications*, 1-3. doi: 10.1109/ICISA.2014.6847456
- Abduilhafiz Mahboob. (2017). *How Do Universities Achieve The Kingdom's Vision 2030?* <https://www.al-jazirah.com/2017/20170401/ec18.htm>. News Paper: AL-JAZIRAH. ([Online; accessed 22-MAY-2023])
- Abdullah Sadiq Dahlan. (2018a). *Unemployment Among Saudi Doctors*. <https://saudigazette.com.sa/article/544650>. News Paper: Saudi Gazette. ([Online; accessed 22-MAY-2023])
- Abdullah Sadiq Dahlan. (2018b). *Unemployment Among Saudi Doctors is a Waste of the Economy*. <https://www.okaz.com.sa/articles/na/1675090>. Newspaper: OKAZ. ([Online; accessed 22-MAY-2023])
- Abrial, J.-R. (2010). *Modeling in Event-B: system and software engineering*. Cambridge University Press.
- Absher.sa. (2019). *Service Guide*. https://www.absher.sa/wps/wcm/connect/individuals_book1_updateV10_en_2908.pdf. Absher.sa. ([Online; accessed 18-OCT-2019])
- Ahlam Al-Zaim. (2016a). *8 specializations suffer from a shortage of graduates*. <https://makkahnewspaper.com/article/587441/>. Newspaper: Makkah. ([Online; accessed 22-MAY-2023])
- Ahlam Al-Zaim. (2016b). *Saudi's Employment identifies 8 Specialisations Required in the Labour Market Suffering from a Shortage of Graduates*. <https://www.argaam.com/ar/article/articledetail/id/459835>. Online News: Argaam. ([Online; accessed 22-MAY-2023])
- Ahmed Al-Juhani. (2019a). *Saudi Doctors on the Unemployment Sidewalk..!* <https://www.al-madina.com/article/609777/>. Newspaper: AL MADINA. ([Online; accessed 22-MAY-2023])
- Ahmed Al-Juhani. (2019b). *Saudi Doctors on the Unemployment Sidewalk..!*

- https://nshr.org.sa/en/?post_type=news. Online News: NSHR.ORG.SA. ([Online; accessed 22-MAY-2023])
- Ahram, T., Sargolzaei, A., Sargolzaei, S., Daniels, J., & Amaba, B. (2017). Blockchain technology innovations. *2017 IEEE Technology and Engineering Management Society Conference, TEMSCON 2017*(2016), 137–141. doi: 10.1109/TEMSCON.2017.7998367
- Akeel, F., Fathabadi, A. S., Paci, F., Gravell, A., & Wills, G. (2016). Formal modelling of data integration systems security policies. *Data Science and Engineering*, 1(3), 139–148.
- AL-Zuabi, H. F., & AL-Shaikhli, I. F. (2012, Nov). Quality evaluation of "safer" portal for saudi students studying abroad. , 295-300. doi: 10.1109/ACSAT.2012.92
- Alangari, M. (2019). *National Tests*. <http://www.al-jazirah.com/2019/20191023/ec8.htm>. Al-Jazirah News Paper. ([Online; accessed 27-OCT-2019])
- Alassim, M., Alfayad, M., & Abbott-Halpin, E. (2017). Understanding factors influencing e-government implementation in saudi arabia from an organizational perspective. *International Journal of Information and Communication Engineering*, 11(7).
- Alfarraj, O., & Alhussain, T. (2013). Making Sense of E-Government development in Saudi Arabia: A Qualitative Investigation. In *Proceedings of The Eighth International Conference on Forensic Computer Science* (pp. 59–71). Abeat. doi: 10.5769/c2013009
- Alfarraj, O., Alhussain, T., & Abugabah, A. (2013). Understanding the factors influencing the development of eGovernment in Saudi Arabia: The use of grounded theory techniques. *International Journal of Information and Education Technology*, 319–324. doi: 10.7763/IJIET.2013.V3.289
- AL-Ghamdi, J. S. (2015). *Noor Education Management System*. <http://groups.itu.int/LinkClick.aspx>. World Summit on the Information Society. ([Online; accessed 31-OCT-2019])
- Alketbi, A., Nasir, Q., & Talib, M. A. (2018). Blockchain for government services- Use cases, security benefits and challenges. *2018 15th Learning and Technology Conference, L and T 2018*, 112–119. doi: 10.1109/LT.2018.8368494
- Al-Nuaim, H. (2012). An Evaluation Framework for Saudi E-Government. *Journal of E-Government Studies and Best Practices*, 2011, 1–12. doi: 10.5171/2011.820912
- Alotaibi, F., Hoang, T. S., & Butler, M. (2023). A rigorous iterative analysis approach for capturing the safety requirements of self-driving vehicle systems. , 1697–1702.
- Alyaum Newspaper. (2018). *The Saudi Council Of Engineers Launches The Ejttiaz Service Which Is Obligatory For The Owners Of Specialisation*. <https://www.alyaum.com/articles/6062327/>. Alyaum Newspaper - Digital Issue. ([Online; accessed 31-OCT-2019])
- Aml Al-Hazani. (2022a). *Who Wins the Student: The Labour Market or The Academic*

- Major?* <https://ara.tv/y47nz>. News Paper: Alarabiya. ([Online; accessed 22-MAY-2023])
- Aml Al-Hazani. (2022b). *Who Wins the Student: The Labour Market or The Academic Major*. <https://aawsat.com/node/3962256>. News Paper: Asharq Al-Awsat. ([Online; accessed 22-MAY-2023])
- Andrian, H. R., Kurniawan, N. B., & Suhardi. (2019). Blockchain Technology and Implementation : A Systematic Literature Review. *2018 International Conference on Information Technology Systems and Innovation, ICITSI 2018 - Proceedings*, 370–374. doi: 10.1109/ICITSI.2018.8695939
- Angraal, S., Krumholz, H. M., & Schulz, W. L. (2017). Blockchain technology: Applications in health care. *Circulation: Cardiovascular Quality and Outcomes*, 10(9), 1–3. doi: 10.1161/CIRCOUTCOMES.117.003800
- Anguera, M. T., Blanco-Villaseñor, A., Losada, J. L., Sánchez-Algarra, P., & Onwuegbuzie, A. J. (2018). Revisiting the difference between mixed methods and multi-methods: Is it all in the name? *Quality & Quantity*, 52(6), 2757–2770.
- Arab News. (2019). *Saudi Digital Solutions Company Elm Invests In Syarah*. <https://www.arabnews.com/node/1464381/corporate-news>. ARAB NEWS. ([Online; accessed 31-OCT-2019])
- ARAB NEWS. (2021). *Saudi Human Resources Development Fund holds workshop to support graduates*. <https://arab.news/4pmjv>. ARAB NEWS. ([Online; accessed 01-07-2023])
- ARAB NEWS. (2023a). *KSA raises employment support to 50 percent for 160 cultural professions*. <https://arab.news/yp7gu>. ARAB NEWS. ([Online; accessed 01-07-2023])
- ARAB NEWS. (2023b). *Saudi HR development fund spends 590m in Q1 on job growth facilitates hiring of 96k Saudis*. <https://arab.news/4gr77>. ARAB NEWS. ([Online; accessed 01-07-2023])
- Assad, S. W. (2000). Recruitment Criteria and Training in Human Resources Development: A Case Study of Women Office Workers at an Institution of Higher Education in Saudi Arabia. *Journal of King Abdulaziz University-Economics and Administration*, 14(2), 13–29. doi: 10.4197/Eco.14-2.2
- Assad, S. W. (2002). Sociological analysis of the administrative system in Saudi Arabia: In search of a culturally compatible model for reform. *International Journal of Commerce and Management*, 12(3-4), 51–82.
- Atzori, M. (2017). Blockchain Technology and Decentralized Governance: Is the State Still Necessary? *Journal of Governance and Regulation*, 6(1), 1–37. doi: 10.22495/jgr_v6_i1_p5
- Barrios, M., Guilera, G., Nuño, L., & Gómez-Benito, J. (2020). Consensus in the delphi method: What makes a decision change? *Technological Forecasting and Social Change*, 120484.
- Basili, V. R. (1992). *Software modeling and measurement: the Goal/Question/Metric*

- paradigm* (Tech. Rep.).
- Basili, V. R., Caldiera, G., & Rombach, H. D. (1994). The goal question metric approach. *Encyclopedia of software engineering*, 528–532.
- Benjamin, B. (2017). *Meet TrueRec by SAP: Trusted Digital Credentials Powered by Blockchain*. <https://news.sap.com/2017/07/meet-truerec-by-sap-trusted-digital-credentials-powered-by-blockchain/>. SAP News Center. ([Online; accessed 31-OCT-2019])
- Bertalanffy, L. v. (1968). *General system theory: Foundations, development, applications*. G. Braziller.
- Biswas, K., & Muthukkumarasamy, V. (2017). Securing smart cities using blockchain technology. *Proceedings - 18th IEEE International Conference on High Performance Computing and Communications, 14th IEEE International Conference on Smart City and 2nd IEEE International Conference on Data Science and Systems, HPCC/SmartCity/DSS 2016*, 1392–1393. doi: 10.1109/HPCC-SmartCity-DSS.2016.0198
- Boiten, E., & Abrial, J.-R. (2012). Modeling in event-b-system and software engineering. *Journal of Functional Programming*, 22(2), 217.
- Braun, V., & Clarke, V. (2006, 01). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77-101. doi: 10.1191/1478088706qp063oa
- Bruegge, B., & Dutoit, A. (2013). *Object-Oriented Software Engineering Using UML, Patterns, and Java*. Pearson Education, Limited.
- Butler, M. (2013, 06). Mastering system analysis and design through abstraction and refinement. In (p. 49-78). doi: 10.3233/978-1-61499-207-3-49
- Butler, M. (2017, 04). Reasoned modelling with event-b. In (p. 51-109). doi: 10.1007/978-3-319-56841-6_3
- Carter, N. (2014). The use of triangulation in qualitative research. In *Oncology nursing forum* (Vol. 41, p. 545).
- Carugi, C. (2016). Experiences with systematic triangulation at the Global Environment Facility. *Evaluation and Program Planning*, 55, 55–66. Retrieved from <http://dx.doi.org/10.1016/j.evalprogplan.2015.12.001> doi: 10.1016/j.evalprogplan.2015.12.001
- Clarke, E., & Wing, J. (1996, 12). Formal methods: State of the art and future directions. *ACM Computing Surveys*, 28. doi: 10.1145/242223.242257
- Cohn, M. (2004). *User stories applied: For agile software development*. Addison-Wesley Professional.
- Creswell, J. W., & Creswell, J. (2018). *Qualitative, Quantitative & Mixed Methods Approaches*. Sage publications Thousand Oaks, CA.
- Curtis Stanier. (2020). *TEDW — A simple model for asking better questions*. <https://crstanier.medium.com/tedw-a-simple-model-for-asking-better-questions-146ba98de94a>. Medium.com. ([Online; accessed 31-May-2023])
- Davies, D. W. (1983, February). Applying the rsa digital signature to electronic

- mail. *Computer*, 16(2), 55–62. Retrieved from <https://doi.org/10.1109/MC.1983.1654301> doi: 10.1109/MC.1983.1654301
- Dissanayake, D. (2013). Research, research gap and the research problem. Education Affairs Agency. (2023). *About Ministry*. <https://departments.moe.gov.sa/EducationAffairsAgency/RelatedDepartments/offsetcertificates/Pages/DepartmentOfClassification.aspx>. Ministry of Education - Saudi Arabia. ([Online; accessed 20-JAN-2023])
- EduWave EMIS. (2018). *Noor Educational Management System Contributes In Saudi Schools Renaissance*. <https://www.itgsolutions.com/noor-education-the-e-learning-solution-that-contributes-in-saudi-schools-renaissance/>. Integrated Technology Group. ([Online; accessed 31-OCT-2019])
- Elm. (2019). *Elm at a glance*. <https://www.elm.sa/en/about/Pages/Elmataglance.aspx>. Elm. ([Online; accessed 31-OCT-2019])
- Fadhel, N. F., Crowder, R. M., Akeel, F., & Wills, G. B. (2014, Dec). Component for 3d printing provenance framework: Security properties components for provenance framework. In *World Congress on Internet Security (WorldCIS-2014)* (p. 91-96). doi: 10.1109/WorldCIS.2014.7028174
- Faisal Al-Sharifi. (2022). *The Future of Graduates is Linked to The Efficiency and Quality of Education*. <https://www.aljarida.com/articles/1642435655110903700>. Newspaper: ALJARIDA. ([Online; accessed 22-MAY-2023])
- Fathabadi, A. S., Snook, C., Dghaym, D., Hoang, T. S., Alotaibi, F., & Butler, M. (2023). Systematic hierarchical analysis of requirements for critical systems.
- F.El-Sofany, H., Al-Tourki, T., Al-Howimel, H., & Al-Sadoon, A. (2012). E-government in Saudi Arabia: Barriers, Challenges and its Role of Development. *International Journal of Computer Applications*(5), 16–22. doi: 10.5120/7344-0119
- General Organisation for Social Insurance. (2018). *Brief on the General Organization for Social Insurance*. www.gosi.gov.sa/gosionline/about_portal. General Organisation for Social Insurance - Saudi Arabia. ([Online; accessed 31-OCT-2019])
- GOV.SA. (2023). *National Profile*. <https://www.my.gov.sa/wps/portal/snp/content/NationalProfile/>. MY.GOV.SA. ([Online; accessed 31-May-2023])
- Gräther, W., Kolvenbach, S., Ruland, R., Schütte, J., Torres, C., & Wendland, F. (2018). Blockchain for education: lifelong learning passport. In *Proceedings of 1st ERCIM Blockchain Workshop 2018*.
- Grech, A., & Camilleri, A. F. (2017). *Blockchain in education*. Luxembourg: Publications Office of the European Union.
- Grover, P., & Prasad, S. (2021). A review on block chain and data mining based data security methods. , 112-118. doi: 10.1109/IBDAP52511.2021.9552120
- Guberman, S. (2004). Reflections on ludwig bertalanffy's" general system theory: Foundations, development, applications". *Gestalt Theory*, 26(1), 44–57.
- Harbi, S. A., Thursfield, D., & Bright, D. (2017). Culture, wasta and perceptions of performance appraisal in saudi arabia. *The International Journal of Human*

- Resource Management*, 28(19), 2792–2810.
- Hassan Onik, M. M., Miraz, M. H., & Kim, C. S. (2018). A recruitment and human resource management technique using blockchain technology for industry 4.0. *IET Conference Publications*, 2018(CP747), 11–16.
- Jala Mansour. (2022). *The Journey of Job Hunting.. A Continuing Struggle and Solutions Await Implementation*. <https://www.alanba.com.kw/1133966>. Online News: ALANBA. ([Online; accessed 22-MAY-2023])
- Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. *Educational Researcher*, 33(7), 14–26. doi: 10.3102/0013189X033007014
- Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research*, 1(2), 112-133. Retrieved from <https://doi.org/10.1177/1558689806298224> doi: 10.1177/1558689806298224
- Keeney, S., Hasson, F., & McKenna, H. (2006). Consulting the oracle: ten lessons from using the delphi technique in nursing research. *Journal of advanced nursing*, 53(2), 205–212.
- Kuppusamy, P. (2019). Blockchain Architecture to Higher Education Systems. *International Journal of Latest Technology in Engineering, Management & Applied Science (IJLTEMAS)*, 8(2).
- Lemieux, V. L. (2016). Trusting records: is Blockchain technology the answer? *Records Management Journal*, 26(2), 110–139. doi: 10.1108/RMJ-12-2015-0042
- Li, B., Qi, P., Liu, B., Di, S., Liu, J., Pei, J., . . . Zhou, B. (2023). Trustworthy ai: From principles to practices. *ACM Computing Surveys*, 55(9), 1–46.
- Liu, Y., Lu, Q., Zhu, L., Paik, H.-Y., & Staples, M. (2023). A systematic literature review on blockchain governance. *Journal of Systems and Software*, 197, 111576. Retrieved from <https://www.sciencedirect.com/science/article/pii/S0164121222002527> doi: <https://doi.org/10.1016/j.jss.2022.111576>
- Martin, A. (2008). The ten-page introduction to trusted computing.
- McCONNELL, J. M. (1994). National Training Standard for Information Systems Security (Infosec) Professionals. (4011), 29. Retrieved from http://www.cnss.gov/Assets/pdf/nstissi_{_}4011.pdf
- Ministry of Civil Service. (2019). *E-Services*. <https://www.mcs.gov.sa/en/eservices/Pages/MainPage.aspx>. Ministry of Civil Service - Saudi Arabia. ([Online; accessed 04-NOV-2019])
- Ministry of Economy and Planning. (2023). *About Ministry*. <https://www.mep.gov.sa/en/AboutUs>. Ministry of Economy and Planning. ([Online; accessed 12-December-2023])
- Ministry of Education, Saudi Arabia. (2019). *Ministry of Education - Budget*. <https://www.moe.gov.sa/en/TheMinistry/AboutMinistry/Pages>. Ministry of Education. ([Online; accessed 01-OCT-2019])

- Ministry of Education, Saudi Arabia. (2021). *About Ministry (Education, Establishment, Vision and Mission and Objectives)*. <https://www.moe.gov.sa/en/aboutus/aboutministry/Pages/visionmissiongoals.aspx>. Ministry of Education - Saudi Arabia. ([Online; accessed 01-Jan-2024])
- Ministry of Human Resource and Social Development. (2020). *About Ministry*. <https://hrsd.gov.sa/en/page/about-ministry>. Ministry of Civil Service - Saudi Arabia. ([Online; accessed 19-JAN-2021])
- Ministry of Labor and Social Development. (2019). *About Ministry, Ministry Information, Mission, Labor Sector, Social Development Sector*. <https://mlsd.gov.sa/en/page/about-ministry>. Ministry of Labor and Social Development - Saudi Arabia. ([Online; accessed 31-OCT-2019])
- Moore, G. A. (2014). *Crossing the Chasm, 3rd Edition: Marketing and Selling Disruptive Products to Mainstream Customers*.
- Morris Wright, K. V., Hoang, T. S., Snook, C., & Butler, M. (2023). Formal language semantics for triggered enable statecharts with a run-to-completion scheduling. , 178–195.
- My Gov SA. (2023). *Registration Job Seekers at HADAF*. <https://online.hrdf.org.sa/MYGOVSA>. ([Online; accessed 01-May-2023])
- Najem, M., Alnoeim, F., & Najem, H. (2016, 03). E-portals are valuable productivity multipliers, important shortfalls in the safer system in ksa and proposed possible solutions for them. *International Journal for Infonomics*, 9. doi: 10.20533/iji.1742.4712.2016.0135
- National Information Centre. (2023). *Saudi National Digital Identity Management*. <https://www.iam.gov.sa/about.html>. IAM.GOV.SA. ([Online; accessed 31-May-2023])
- News: ALWATAN. (2023). *The University Council Closes Specialties in 70 Colleges That The Job Market Does Not Need*. <https://www.alwatan.com.sa/ampArticle/1120040>. Newspaper: ALWATAN. ([Online; accessed 22-MAY-2023])
- Nurunnabi, M. (2017, Jun 01). Transformation from an oil-based economy to a knowledge-based economy in Saudi Arabia: the direction of Saudi Vision 2030. *Journal of the Knowledge Economy*, 8(2), 536–564. doi: 10.1007/s13132-017-0479-8
- Ølnes, S. (2016). Beyond bitcoin enabling smart government using blockchain technology. In H. J. Scholl et al. (Eds.), *Electronic Government* (pp. 253–264). Cham: Springer International Publishing. doi: 10.1007/978-3-319-44421-5_20
- Ølnes, S., & Jansen, A. (2017). Blockchain Technology as a Support Infrastructure in e-Government. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 10428 LNCS, V–VI. doi: 10.1007/978-3-319-64677-0
- Ølnes, S., Ubacht, J., & Janssen, M. (2017). Blockchain in government: Benefits and implications of distributed ledger technology for information sharing. *Government*

- Information Quarterly*, 34(3), 355–364. doi: 10.1016/j.giq.2017.09.007
- Public Pension Agency. (2012). *About The Agency - Overview*. <https://www.pension.gov.sa/sites/en/AboutPPA/Pages/general.aspx>. Public Pension Agency - Saudi Arabia. ([Online; accessed 31-OCT-2019])
- Ramez Al-Homsi. (2022). *University Graduates and The Labour Market. A Debate Over Employment and Compromise for The Sake of Earning A Living*. <https://7al.net/?p=324725>. Online News: AL-HAL NET. ([Online; accessed 22-MAY-2023])
- Recker, J. (2012). *Scientific research in information systems: a beginner's guide*. Springer Science & Business Media.
- Riad, A. M., El-bakry, H. M., & El-adl, G. H. (2010). A Novel DSS Framework for E-government. *International Journal of Computer Science Issues*, 7(6), 33–37.
- Rizal Batubara, F., Jolien Ubacht, T., & Marijn Janssen, T. (2018). Challenges of Blockchain Technology Adoption for e-Government: A Systematic Literature Review. *Proceedings of 19th Annual International Conference on Digital Government Research*, 9. doi: 10.1145/3209281.3209317
- Russo, D., Ciancarini, P., Falasconi, T., & Tomasi, M. (2017). Software quality concerns in the italian bank sector: the emergence of a meta-quality dimension. In *2017 IEEE/ACM 39th International Conference on Software Engineering: Software Engineering in Practice Track (ICSE-SEIP)* (pp. 63–72).
- Safeer Program - MOE. (2019). *Safeer Program*. <https://www.moe.gov.sa/en/eproducts/e-Services/Pages/SafeerProgram.aspx>. Ministry of Education - Saudi Arabia. ([Online; accessed 04-NOV-2019])
- Sahar Abushahin. (2018). *Recommendation NOT to Open Medical and Pharmacy Colleges for the Next 12 Years*. <https://makkahnewspaper.com/article/790957>. Newspaper: Makkah. ([Online; accessed 22-MAY-2023])
- Sattam Althagi. (2016). *Labour Market .. and Congestion*. https://www.aleqt.com/2016/12/21/article_1112024.html. Newspaper: ALEQTISADIAH. ([Online; accessed 22-MAY-2023])
- Saudi Arabian Cultural Mission. (2001). *Educational System in Saudi Arabia*. http://www.sacm.org/Publications/58285_Edu_complete. Saudi Arabian Cultural Mission, Washington DC. ([Online; accessed 30-OCT-2019])
- Saudi Commission For Health Specialties. (2012). *About SCFHS, Vision and Mission*. <https://www.scfhs.org.sa/en/about/>. Saudi Commission For Health Specialties. ([Online; accessed 31-OCT-2019])
- Saudi Council of Engineers. (2018). *Chairman of the Board of Directors of the Saudi Council of Engineers (SCE) launched online EJTTIAZ service*. <https://www.saudieng.sa/English/MediaCenter/News/Pages/Ejtiyaz.aspx>. SCE MEDIA CENTER, News. ([Online; accessed 31-OCT-2019])
- Saudi Council of Engineers. (2019). *ABOUT SCE, Origin And Definition*. <https://saudieng.sa/English/AboutSCE/Pages/OriginAndDefinition.aspx>. Saudi

- Council of Engineers. ([Online; accessed 31-OCT-2019])
- Sedgwick, R. (2001). *Education in Saudi Arabia*. <https://wenr.wes.org/2001/11/wenr-nov-dec-2001-education-in-saudi-arabia>. World Education Services. ([Online; accessed 30-OCT-2019])
- Shaw, M. (2002). What makes good research in software engineering? *International Journal on Software Tools for Technology Transfer*, 4(1), 1–7.
- Shen, C., Zhang, H., Wang, H., Wang, J., Zhao, B., Yan, F., ... Xu, M. (2010, 03). Research on trusted computing and its development. *SCIENCE CHINA Information Sciences*, 53, 405-433. doi: 10.1007/s11432-010-0069-x
- Sidiqa AllahMorad, Sahel Zreik. (2020). *Education in Saudi Arabia*. <https://wenr.wes.org/2020/04/education-in-saudi-arabia>. World Education Services. ([Online; accessed 01-Jan-2024])
- Šijan, A., Karabašević, D., & Rajčević, D. (2019). The importance of the general system theory for the modern world. *Trendovi u poslovanju*, 7(2), 87–94.
- Silcock, B. Y. R. (2001, 01). What Is e-Government? *Parliamentary Affairs*, 54, 88–101. doi: 10.1093/pa/54.1.88
- Sony Global Education Inc., F. R. I., Fujitsu Limited. (2019). *Fujitsu and Sony Global Education Initiate Blockchain Field Trials for Course Records and Transcript Management*. <https://www.fujitsu.com/global/about/resources/news/press-releases/2019/0227-01.html>. Fujitsu. ([Online; accessed 31-OCT-2019])
- Statista Inc. (2018). *Number of students in Saudi Arabia from 2013 to 2017*. <https://www.statista.com/statistics/628665/saudi-arabia-total-number-of-students/>. General Authority for Statistics (Saudi Arabia). ([Online; accessed 31-OCT-2019])
- Sukina Almeshekhis. (2014). *Graduates AGING on the sidewalk of unemployment!* <https://www.alwatan.com.sa/article/22332>. Newspaper: AL WATAN. ([Online; accessed 22-MAY-2023])
- The Scholarship Department - MOE. (2019). *Scholarship*. departments.moe.gov.sascholarshipdocumentsscholarships_april. Ministry of Education - Saudi Arabia. ([Online; accessed 06-NOV-2019])
- Tupper, C. D. (2011). *22 - Distributed Databases* (C. D. Tupper, Ed.). Boston: Morgan Kaufmann. Retrieved from <https://www.sciencedirect.com/science/article/pii/B978012385126000022X> doi: <https://doi.org/10.1016/B978-0-12-385126-0.00022-X>
- Turkanović, M., Hölbl, M., Košič, K., Heričko, M., & Kamišalić, A. (2018). EduCTX: A blockchain-based higher education credit platform. *IEEE Access*, 6, 5112–5127. doi: 10.1109/ACCESS.2018.2789929
- Van Latum, F., Van Solingen, R., Oivo, M., Hoisl, B., Rombach, D., & Ruhe, G. (1998). Adopting gqm based measurement in an industrial environment. *IEEE software*, 15(1), 78–86.
- van Steen, M., & Tanenbaum, A. S. (2016). A brief introduction to distributed systems.

- Computing*, 98, 967-1009.
- Vision 2030 Official Website. (2017). *Vision 2030 Kingdom of Saudi Arabia*. https://vision2030.gov.sa/sites/default/files/report/Saudi_Vision2030_EN_2017. Vision2030.gov.sa. ([Online; accessed 01-OCT-2019])
- Wang, H., Chen, K., & Xu, D. (2016). A maturity model for blockchain adoption. *Financial Innovation*, 2(1). Retrieved from <http://dx.doi.org/10.1186/s40854-016-0031-z> doi: 10.1186/s40854-016-0031-z
- Wang, L., Liu, W., & Han, X. (2018). Blockchain-based government information resource sharing. *Proceedings of the International Conference on Parallel and Distributed Systems - ICPADS, 2017-Decem*, 804–809. doi: 10.1109/ICPADS.2017.00112
- Wang, X., Asif, H., & Vaidya, J. (2023). Preserving missing data distribution in synthetic data. In *Proceedings of the ACM Web Conference 2023* (p. 2110–2121). Association for Computing Machinery. doi: 10.1145/3543507.3583297
- Wang, X., Feng, L., Zhang, H., Lyu, C., Wang, L., & You, Y. (2017). Human Resource Information Management Model based on Blockchain Technology. *Proceedings - 11th IEEE International Symposium on Service-Oriented System Engineering, SOSE 2017*, 168–173. doi: 10.1109/SOSE.2017.34
- Wiegers, K. (2021). *Software Development Pearls: Lessons from Fifty Years of Software Experience*. Addison-Wesley Professional.
- Wiegers, K., & Beatty, J. (2013). *Software requirements*. Pearson Education.
- Woodside, J. M., Augustine, F. K., & Giberson, W. (2017). Blockchain Technology Adoption Status and Strategies. *Journal of International Technology and Information Management*, 26(2), 65–93. Retrieved from <http://scholarworks.lib.csusb.edu/jitim/vol26/iss2/4>
- Yesser - E-Government Program. (2019). *About Us, Overview*. <https://www.yesser.gov.sa/EN/ProgramDefinition/Pages/Overview.aspx>. Yesser Official website. ([Online; accessed 31-OCT-2019])