



AI Based E-Recruitment System

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by

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Abstract

Modern web-based e-recruitment methods have revolutionised advertising, source tracking, and online inquiry forms with the associated start-up and maintenance costs. Attracting and hiring qualified candidates, navigating online recruiting tools, increasing unsuitable applications, and discrimination and diversity issues are just a few of the drawbacks of e-recruitment. A platform with AI algorithms is developed to overcome limitations, especially for Saudi private and public sector recruiters who lack AI in their application processes.

The Unified Theory of Acceptance and Use of Technology (UTAT) measured user acceptance of e-recruitment systems, with a Cronbach's alpha of 0.96 indicating high reliability. The platform and its features were evaluated using five-point Likert scales, with mean responses exceeding 3.4, indicating high acceptability.

This PhD developed the Artificial Intelligent Recruitment (AIRec) platform, ranking candidates with 99 per cent accuracy. Improve corporate image and profile, reduce recruitment and overhead costs, use better tools to select candidates based on sound criteria, provide tracking for both candidates and employers. AIRec also aims to change HR and line management culture and behaviour. The platform and its contributions were tested in real-world scenarios in the top Saudi government and university recruiting bodies. Based on Cronbach's alpha testing and validation, the result was 0.97 out of 1. The results show the system's high reliability.

Declaration

I declare that the research in this thesis is the author's work and submitted for the first time to the post graduate research office at Brunel University London. The study was originated, composed and reviewed by the mentioned author in the department of Electronic and Computer Engineering, College of Engineering, Design and Physical Sciences, Brunel University London, UK. All the information derived from other works has been referenced and acknowledged.

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Publications

- Abdularahman Aljuaid, Maysam Abbod, “Artificial Intelligence Based E-Recruitments System”, IEEE *Intelligent Systems*, 2020-Bulgaria.
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List of Abbreviations

AI	Artificial intelligence
AIRec	AI e-recruitment system
ANN	Artificial Neural Network
AU	Actual use
BI	Behaviour intentions
DOI	Diffusion of innovation model
EE	Effort expectancy
EREC	E-recruitment
EV	External variables
FC	Facilitating conditions
GA	Genetic Algorithms
GCC	Gulf Cooperation Council
HR	Human resources
HRM	Human resource management
IoT	Internet of Things
IS	Information System
IT	Information technology
L/CLE	Last or current level of education
MHRSD	Ministry of Human Resources and Social Development
MS	Marital Status
OS	Occupational status
PE	Performance expectancy
PROSS	Process
PSO	Particle swarm optimisation
PU	Perceived usefulness
QUAL	Quality
RMSE	Root-Mean-Square Error
SI	Social influence
SYS	E-recruitment system
SUS	System Usability Scale
TAM	Technology Acceptance Model
TAM2	Extended Technology Acceptance Model
TPB	Theory of planned behaviour
TRA	Theory of reasoned action
USE	Use of social media

USE SHARE	Use to share information
USE TEC	Use social media technology
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter 1

Introduction

1.1. Background

Artificial Intelligence (AI) is praised for carrying out the most complex tasks with ease and making various tasks much easier for humans. It is increasingly applied in innumerable applications, and with growing importance in the Internet of Things (IoT). Data management has been incredibly simplified by the implications of AI, and it is used by many organisations to deal with comprehensive statistics, offering previously unattainable advantages that surpass traditional human efforts, aside from increasing efficiency in existing operations. One application in recent years is the deployment of AI to revolutionise the complete recruitment process. AI can assist organisation in various aspects of recruitment, from understanding the body language of candidates to assisting decision-making. However, there are debates about the extent to which AI can be effective in recruitment, and in some regards it has been argued that it is not a viable substitute for conventional recruitment processes [1]. Nevertheless, AI increasingly exerts positive impacts on recruitment, and it is a major asset for HRM and the recruitment process, especially in achieving equality between the applicants by avoiding managers' biased decisions. Therefore, this research investigates and examines the role of AI and e-recruitment (AIRec) in selecting the right person for the right job in a company or governmental organisation as a case study.

1.2. Definition of E-Recruitment System

The concept of e-HRM is the most commonly used method in digital HRM systems, but it is not easy to define [2]. [3] defined it as the implementation of technology to serve the purposes of human resources (HR) practices. It is a tool that derives its existence from the digital revolution, which the organisations can deploy to improve the performance and attitudes of employees to align their efforts with the achievement of organisational goals. E-HRM can also be defined as an online recruitment system that helps an organisation in adopting technology and web-based services organisations to recruit the right people at the right time [4].

The tasks handled by online recruitment systems include finding appropriate candidates, attracting them towards the organisation, assessing their capabilities, interviewing them, and hiring them for different branches of the organisation [4]. [5] defined e-HRM in general, drawing the attention of the reader to the Internet as a medium to execute HR policies and activities. According to [6], the concept of e-HRM can be defined as the implementation of IT to enhance networking and support the two individuals engaged in the HR process. Several features of e-

HRM have been emphasised in the research work under observation. For example, utilisation of IT by e- HRM is carried out in two ways:

- Building connections between two independent personnel or actors to enable communication of data and information between them irrespective of their locations. This reflects that IT serves as an intermediate to ensure connectivity and integrity between the actors.
- Technology supports actors executing HR activities, partially or completely[2].

Moreover, the process of e-HRM has different stages wherein multiple actors play various roles. Multiple actors may be in the form of organisational units, individual organisations, or groups of individuals interacting to perform HR activities. The concept of e-HRM was defined as the execution of HR activities using the platform of the Internet [7]. However, [8]disagreed with this understanding, and opined that e-HRM has been misunderstood due to superimposing concepts and assumptions derived from the extensive use of e-commerce. They further argued that the use of the prefix “e” (i.e., “electronic”) is erroneous, because – among other things – it implies the use of automation in decision making and task execution, which remains tentative in HRM applications. They argued that the word “online” (i.e., “online recruitment”) would be more apt, signifying the availability of information to managers on the online platform at any time or place [7].

The term “e-HR” is representative of many functions performed by HR professionals, including planning for human recruitment, selection and recruitment, performance evaluation and appraisal, communication, rewarding performance, compensation and benefits, training and development, and career management. Online recruitment is the main focus of this study, as it is the e-HR function which is most commonly used and discussed [8]. The term “online recruitment” can be explained as the performance of recruitment procedures and methods using the Internet as the technological basis for executing HR functions that were traditionally performed manually.

In other words, the process of Internet recruitment can be defined as a process that starts from advertising job requirements, obtaining CVs from applicants, and structuring and constructing a wide database from which suitable candidates may be recruited based on the skills, competence, and experience matching the job requirements [8]. In the opinion of [8], online recruitment has a similar definition as that explained above, but she argued that online recruitment could be differentiated between the corporate website and the website of an online recruitment vendor. According to [9], online recruitment can be defined as the process of placement of vacancies on the website of the organisation seeking recruitment or on the website of recruitment vendor to enable job seekers to send their CVs through email or any

other electronic means. E-recruitment can also be defined as “a description of the process companies follows to discover and recruit talented individuals from the Internet”[10].

The benefit of an online recruitment system is that it enables HR professionals to make strategies rather than diverting their focus from transactional activities. According to [11], recruitment can also be defined as the pool of jobs generated by job seekers by forwarding applications to online recruitment websites. To fill job vacancies, organisations are required to create interest among the job seekers for the vacant job profile in the organisation. This can be achieved by offering attractive remuneration and other incentives to applicants [12]. The online recruitment process makes the recruitment process easy and fast for an organisation. It also increases the approach of an organisation to national and international applicants, and it enhances the recruitment functions [13].

In this study, recruitment is defined as expounded by [13], as a process of attracting applicants and filtering them based on their qualifications to find the best-suited applicant for the offered job by an organisation. There are several ways in which an applicant can be recruited by an organisation, such as recruitment by the Internet, telephone calls, or mailing. Nowadays, the Internet plays an important role in the recruitment of applicants, and the process of attracting applicants with the help of the Internet and filtering the best-suited applicant for a job offered by an organisation.

1.3. Research Significance

Studies in the field of AI and its implementation in recruitment hold as much significance as the concept of AI itself, which is ultimately only as useful as its practical applications. AI is complex, and requires careful management for effective deployment. While it can enable organisations to explore various aspects of achieving success in business and deploying the best possible strategies in employing the new candidates, this is predicated on *effective* deployment, and there are innumerable instances of organisations failing in expensive IT investment projects due to a failure to effectively select and adapt systems and prepare their organisations for such adoption. However, the efficiency with which the organisations can handle the tasks for managing employees can itself be explored by the use of AI [14].

It seems that the increase of technology used in HRM practices in today’s world will continue to grow to enhance HRM services [15]. This suggests that studies should commensurately increase, particularly for developing countries with a shorter history of effective technological adoption in organisations, such as Saudi Arabia, the focus of this study. By exploring e-recruitment in a developing country in the Gulf Cooperation Council, this country makes an original academic contribution. Saudi Arabia targeted digital technology transfer and adoption,

including the use of AI, in the national socio-economic development plan, Vision 2030. This study, therefore, may be beneficial for many organisations and HR practitioners, as well as decision-makers in the e-recruitment process for Saudi private and public sector organisations. The results of this study also contribute to HRM departments to develop the recruitment process by using the AIRec system and achieve the credibility of choosing the right candidates for the vacancies jobs in a company or governmental organisation.

1.4. Identifying the Problem

Most existing literature in this field is directed toward e-recruitment experiences in Western and developed countries (mainly in the EU and North America)[16]. There is a manifest dearth of investigations of e-recruitment systems and solutions in developing countries, particularly concerning higher education in Saudi Arabia, where a traditional and ambiguous process continues to impede national socio-economic development. The legacy system is based on filling in applications manually, and it does not allow applicants to track their applications, in addition to the lack of transparency of how job candidates are selected. Furthermore, the lack of implementations of AI in the recruitment process and applicant quality selection in a company or governmental organisation

1.5. Research Question

This study explores a platform to develop a unified AI system for the recruitment process to fill job vacancies for Saudi public and private sector organisations by answering the following questions:

- What is the impact of using AI on the recruitment process in Saudi Arabia?
What the extent of Saudi user acceptance of e-recruitment system?
- Does e-recruitment affect the quality of recruitment positively?
- What types of services and functionality provided by the AIRec?
- What types of AI algorithms are used in the AIRec?

1.6. Research Aim and Objectives

Forming aims and objectives in a research study helps in the understanding of the actual work involved in the research and the expanse of investigation carried out. Developing aims and objective help in deciding the future course of the research and making the process simpler for the researcher. The aim and objectives of this study of the role of AI in the Saudi recruitment process are described below.

1.6.1. Research Aim

This research work aims to develop an intelligent system that can assess the experience, qualifications, and suitability of candidates applying for specific jobs in companies or governmental organisations. The system should analyse job requirements and match the skills of the employees and select the best candidates for shortlisting. Hence the human factor in the preliminary selection process can be eliminated.

1.6.2. Objectives

Major objectives of the research undertaken in this study are to:

- Critically analyse literature linked to the e-recruitment practices and the contributions of using technology in HRM functions.
- Investigate the perceptions on the current usage of the e-recruitment system in Saudi companies and governmental organisations.
- Implement a suitable measurement survey for e-recruitment technology acceptance.
- Design and develop an intelligent e-recruitment system with specific needs for functionalities and services.
- Examine how e-recruitment affects the recruitment quality of employees in Saudi public and private sector organisations.
- Evaluate the extent to which AI can enhance the recruitment process of organisations.
- Evaluate the newly designed AIRec e-recruitment system.

1.7. Research Methodology

The research method that will be used to conduct this study is a structured quantitative questionnaire. It is the most powerful research tool used in the collection of quantitative data, and it consists of short questions formulated to suit the data needs of the researcher. Questionnaires were administered to job seekers and managers of HR departments in different universities in Saudi Arabia. Quantitative data analysis methods were used, including various statistical analysis techniques, such as graphical method, measures of association, and trend detection methods, to ensure the internal reliability and validity of the questionnaires.

1.8. Contributions to Knowledge

The work presented in this thesis offers the following contributions to knowledge:

- 1 The literature survey has identified the current status of e-recruitment systems in Saudi Arabia. Their status and characteristics are explored and evaluated.

- 2 The survey questionnaire design and distribution offers a basis for future studies of similar contexts.
- 3 The author designed a survey for JS, HR managers, and the Saudi Human Resources Development Fund (SHRDF), whose results have identified user acceptance of e-recruitment systems, based on UTAUT.
- 4 An intelligent system has been designed, developed and implemented; the system contains a recruitment process, vacancies, job, shortlisting for an interview that selects the most suitable candidate.
- 5 A search system that can select the best candidate for the right job by using Neural Networks.
- 6 Data and usability analysis.

1.9. Thesis Structure

This thesis comprises this introduction, the data analysis, system design, AI model, and discussion and conclusions in literature review, methodology, data analysis, findings and conclusion as shown in Figure 1.1.

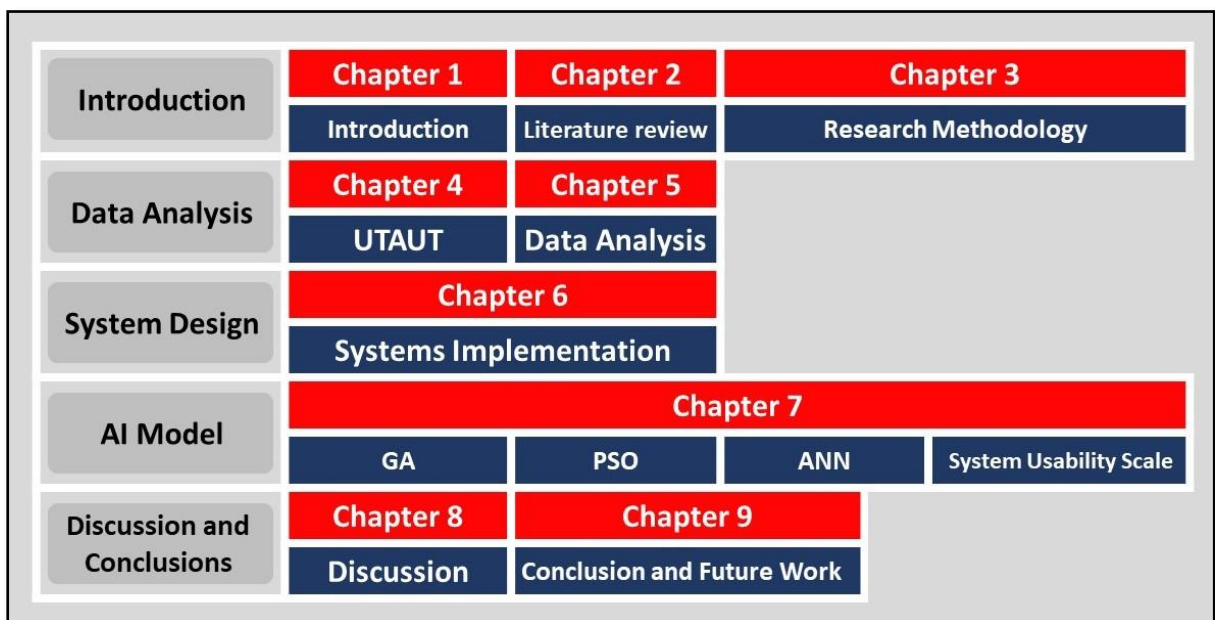


Figure 1.1: Thesis structure

Chapter 1: Introduction

This chapter introduces the study background, research question, aims, objectives and the thesis structure. The chapter explains the significance of the research and explains why the author selected this topic and how the thesis is presented.

Chapter 2: Literature Review

This chapter reviews of recruitment literature concerning national cases in the UK, USA, Greece, and Saudi Arabia. It also critically analyses academic studies of the recruitment process, and e-recruitment advantages and disadvantages.

Chapter 3: Methodology

This chapter discusses the research philosophy emerging from the literature review, explains the research approach, and justifies the methodological research choices.

Chapter 4: Unified Theory of Acceptance and Use of Technology (UTAUT)

This chapter explains the measurement model assessment (UTAUT) paradigm used to analyse technology acceptance in e-recruitment adoption.

Chapter 5: Data Analyses'

This chapter presents the data analysis of the assessment model.

Chapter 6: Systems Implementation

This chapter presents the system designed in response to the results presented in Chapter 5, including the framework, existing systems review, presentation of informational requirements, functional requirements, architecture of present system, non-functional requirements, AIRec development, and the functionality of the proposed system, which are presented and tested.

Chapter 7: E-Recruitment Modelling-Based AI

This chapter explains the theoretical basis of the study and AI, and the various methods used to solve related issues. It presents the data sets containing information about candidates who applied for different jobs, and the normalisation of all input variables and their features, to make sure all the input variables have the same weight, and to accelerate the training of the model. The results of AI algorithms are presented to choose the most suitable algorithm for ranking candidates. Testing and validation is undertaken by integrating software, testing complete system, and external validation of the system using System Usability Scale (SUS).

Chapter 8: Discussion

This chapter discusses the main findings related to demographic variables (gender, age, education level, marital status, and nationality), and the e-recruitment process in terms of the UTAUT, quality, AI, and SUS.

Chapter 9: Conclusion and Future Work

This chapter summarizes the study process and results, identifies the major contributions of this research in terms of knowledge, implications, and constraints, and identifies avenues for future research.

Chapter 2

Literature Review

2.1. Background

Using efficient recruitment strategies helps organisations recruit employees with high potential and helps execute talent management strategy in an enhanced way [17]. Fundamental changes in recruitment practices have been observed since the 1990s. Recruitments through online procedures have increased enormously due to the growth in the global economy, which has raised the demand for talented and potential employees in organisations worldwide [18]. This research discusses the contribution of an AI-based e-recruitment system that can assess the experience, qualifications, and suitability of candidates applying for specific jobs in a company or governmental organisation.

The Internet has brought a revolution in the entire process of recruitment by completely transforming the methods of recruitment formerly used in recent decades. According to [19], limited content is available on the topic, and extant studies are often unreliable, with a weak theoretical basis and narrow focus [19]. [20] argues that the new and dynamic nature of the subject has made it somewhat troublesome for researchers, and proclaims that content available on the subject of online recruitment method is limited, which makes it a challenging subject area. Various factors exacerbate the task of studying e-recruitment solutions, such as the interdependency of different process variables (for example, the attention and self-insight of applicants, and the credibility of messages), which are responsible for creating a link between the recruitment activities.

This project is mainly focused on understanding the importance of online recruitment procedure in hiring job-seekers in Saudi public and private sector organisations in comparison to the procedures that are highlighted by most of the literature. It also highlights the issues that online recruitment research needs to be addressed. In this study, it has been observed that most of the literature on this topic is based on the procedures adopted in Europe and North America, with few studies of Asian countries, and almost none of procedures adopted in the GCC. Therefore, it can be inferred that the task of understanding the impact of online recruitment in Saudi organisations will have to be based primarily on general global literature relating to the subjects of concern.

2.1.1. Recruitment in the UK

Small UK organisations primarily rely on informal approaches of recruiting and selecting appropriate candidates for organisations. Some of the advantages of the informal approach of

recruitment and selection are the candidate usually has previous knowledge about the job and the organisation. The informal approach focuses on word-of-mouth strategy, whereby existing employees try to refer candidates, and make sure that such employees fit into the organisation. However, using informal approaches of recruitment and selection can render small UK organisations vulnerable to diversity imbalances (i.e., a lack of diversity), such as reduced employment of disabled employees or various ethnicities, as well as reduced ability to recruit optimum candidates due to drawing from a relatively narrow recruitment pool [21].

According to [22], the use of e-HRM has proved to be a complex process; however, positive sides of e-HRM, such as its effectiveness, adoption process, and strategic positioning benefits have increased usage by UK organisations [23]. The increase in the adoption of e-HRM has shown a significant relationship between the adoption of innovative techniques by organisations and employee creativity. It has been observed that e-HRM use has enabled UK organisations to sustain their business performance in the business environment [22].

Online and technological recruitment techniques are widely used by UK organisations to recruit candidates. It was initially predicted by the media that online recruitment techniques would transform and dominate the recruitment industry in the UK, but subsequent empirical findings after the extensive introduction of online recruitment techniques revealed that they were primarily used to simplify and facilitate latent recruitment methods. Approximately 64% of UK organisations have adopted online recruitment techniques, reflecting the rapid growth and penetration of the Internet and e-services in the UK. It has also been analysed that the online recruitment technique is a complex process, which was not predicted initially [21].

Various factors influenced the adoption of e-recruitment techniques in the UK, where about two-thirds of organisations use jobs boards to recruit and select new candidates. This shows that the Internet is a major part of the recruitment process of UK organisations. As of 2009, many organisations in the UK had still not adopted e-HRM techniques to facilitate and simplify their recruitment processes, but it is expected adoption has greatly increased in the subsequent years [22].

2.1.2. Recruitment in the USA

Online recruitment methods to get the right candidate at the right time are used by over 96% of US firms [24]. In the year 2001, it was observed that US organisations spent around \$48 million, which increased to \$460 million in the year 2006, on the online recruitment of candidates. The same study literature also reported that 50% of employees working in organisations came through their online recruitment techniques. Therefore, it can be stated that in the US, the organisations have replaced their traditional recruitment method with an

online recruitment system have effectively sustained their business performance and increased their competitiveness as employers [25].

Many US organisations focus on adopting online recruitment techniques to hire the most suitable candidates more easily. Many US organisations have adopted online recruitment techniques, while others continue to rely on professional agencies to hire the right employees at the right times. Third-party professional agencies in the US help organisations by providing social mining and automatic screening services for candidate selection. Such agencies follow-up the privacy law of the US, which does not allow them to reveal information about the companies. If an organisation in the US hires employees through an online recruitment system, then also they have to abide by diversity legislation, including the Americans with Disabilities Act and Age Discrimination in Employment Act. These Acts help organisations avoid any future liabilities regarding organisational discrimination in hiring [26].

2.1.3. Recruitment in Greece

Greek organisations have increasingly adopted e-HR practices to reduce operating costs, enhance company image, and improve time management. The major reasons that promoted the successful implementation of e-HR practices in Greece are the technology awareness of the Greece organisations and amenable organisational cultures. It has been observed that there is an effective collaboration between HR and IT in the Greece organisations, which has also led to the success of the implementation of e-HR practices, which can be considered as tools for Greek organisations to transform HRM from administrative to strategic roles. It has also helped in improving the overall service quality of the organisations. As in the UK, many Greek firms focused on e-HR practices adoption for competitive advantages in their business environments. Greek organisations have also focused on ensuring the security of data, and the control of data being transferred [8].

2.1.4. Recruitment in Saudi Arabia

In Saudi Arabia, organisations use the Internet and traditional recruitment methods, but there is no reliable data available to support the processes. International firms are facing a shortage of qualified employees, particularly with increasing fiscal penalties for failing to meet quotas for the employment of nationals, and Saudi organisations have to seek new strategies for recruitment [27]. The shortage of qualified employees and the war of talent are the main reasons which increase the level of competition all around the world. To attract qualified employees, petroleum and high technology companies changed their recruitment policies, and these policies helped them to attract qualified workers. This approach is now followed by organisations in Saudi Arabia.

The strategies and procedures that help to fulfil the need of qualified workers are driven and developed by the Saudi government, and have a strong effect on the recruitment policies of an organisation in Saudi Arabia [28]. The importance of new technologies was identified by the government, and the e-government program launched in 2001, seek to enhance IT infrastructure, “supporting the country’s economy, e-learning, e-government and e-health, improving productivity at a low cost, setting up standards and guidelines for a national network, developing a security framework and the preserving of the society’s characteristics in a digital age” [29].

Nevertheless, the widespread trend is to use traditional methods of recruitment instead of using the latest technologies for hiring new people, due to bureaucratic issues, the importance of personal networks and connection, and top management lacking control over recruitment. Consequently, the use of new technologies is considered a risk in organisations in Saudi Arabia. Bureaucracy is the main reason that slows down work, and results in low productivity of organisations in Saudi Arabia [30]. This is contrary to the professed ethos of the country. As explained by [31], in Islamic countries, such as Saudi Arabia, it has been observed that organisations conventionally follow Islamic perspectives in their organisational cultures. Islamic guidelines can be observed in the guidelines of any organisation and also in the organisation’s HRM policies. As per Islamic guidelines, a candidate must have certain qualifications, such as shouldering capability, competency, organisational fit, experience, and reputation. It is necessary that in no case should the selection of a candidate be based on his or her political power, blood relationships, or wealth. In the case of e-recruitment of an employee, in Islamic countries, it is essential that the recruitment and selection process is fair and equitable; however, personal connections are often highly instrumental in professional life in GCC states [32].

Banks operating in Saudi Arabia and private sector organisations prefer to use online recruitment techniques to improve their banking operations by hiring the right candidates. These banks and private sector organisations also prefer professional agencies to recruit the right staff. Compared to online recruitment methods, it has been observed that major Saudi private sector organisations and banks rely on professional agencies for recruiting people, which provide them with ease in recruiting qualified candidates. Organisations are prepared to pay for the right candidates hired by such professional agencies, outsourcing their recruitment activities to a large extent [33].

2.2. Types of Recruitment Process

The recruitment process in an organisation refers to the overall process of attracting, shortlisting, and appointing suitable candidates for vacant job positions [34]. The recruitment process in an organisation can be primarily classified into two categories: internal promotion or recruitment, and external recruitment. Internal recruitment or promotion is the process under which an organisation uses its internal sources to fill vacant positions with the help of its existing employees (i.e., rewarding junior employees by promoting them to more senior positions). External recruitment is the process of hiring new candidates or employees outside the organisation. An external recruitment process is conducted by the HR department of the organisation, with the help of traditional and modern recruiting techniques, such as e-recruitment and newspaper advertisements [34].

Internal recruitment or promotion is much easier in comparison to external recruitment, as it requires less amount of time and money. The organisation and senior managers are well aware of the skills, knowledge, and capabilities of their junior employees; hence it is more efficient than external recruitment. The promotion of junior employees can encourage and motivate them to perform better. On the other hand, external recruitment helps bring new talent and ideas into the organisation. External recruitment procedures also provide an opportunity for the organisation to select from a larger pool of candidates who possesses a more diverse set of skills and knowledge. External recruitment also avoids employees becoming complacent and entrenching counterproductive practices and cultures.

Internal recruitment or promotion motivates and encourages all existing staff to perform better, and reduces costs associated with hiring new employees. Conversely, external recruitment is a time-consuming, cumbersome, and expensive process for organisations, but it is the route to bring in new and talented employees into organisations, who can help in improving the overall organisational performance [35]. The focus of this study is the recruiting process for new candidates from outside Saudi public and private sector organisations, which is an external recruitment process.

2.3. Different Viewpoints on E-Recruitment Process

The e-recruitment process is concerned with the hiring of potential candidates to fill vacant job positions with the use of electronic resources. For some, this specifically refers to the Internet [36]; however, the modern e-recruitment process has a wider scope, which is inclusive of searching for prospective candidates for the job and assessing them following the job requirements for hiring them for the vacant job position [37].

E-recruitment is the process of use of electronic resources and technology for attracting, selecting, as well as managing the recruitment processes of the organisation. The process of e-recruitment is inclusive of the practices which are carried by the organisation with the use of web-based technology, which helps in the identification of suitable candidates for the respective job position. E-recruitment helps organisations save resources with the help of reaching the maximum potential candidates. It also involves the facilitation of the recruitment process of the organisation with the use of assessment tools that have been incorporated into the recruitment software [38].

E-recruitment processes include important elements such as applicant tracking, employer websites, job boards, online testing, and multiple posting tools. Thus, e-recruitment is considered an important process that helps organisations search for suitable candidates who match the requirements and specifications of the required job posting [39]. In addition to this, the e-recruitment process involves several major steps which result in the hiring of suitable candidates for vacant job positions [39].

Seven steps can be discerned in the typical e-recruitment process that lead to optimum candidate selection, of which the identification of hiring needs and planning are considered the two most important, followed by the creation of job description and posting, promoting job openings, and screening and interviewing candidates [40]. These steps in the e-recruitment process need to be followed in HRM to ensure the selection of suitable candidates for the required job posting [40].

2.3.1. Finding the Job Folder

The searching for suitable candidates is an essential step in the e-recruitment process which affects all future activities in the process of the selection of the right kind of candidates. Finding the job folder is concerned with the identification of the applicants based on the hiring requests of clients. It is concerned with the identification of the required qualifications and candidate profiles. These requirements and candidate profiles form the basis for the development of the job specifications and description [41].

The identification of an appropriate pool of candidates for a vacant job position is a crucial step in the e-recruitment process [42]. It is concerned with the identification of the segment of the labour market which will be targeted for searching the potential candidates for the required job position. In addition to this, the e-recruitment process is based on the searching process of the organisations concerning the suitable candidates for the vacant job positions. Thus, it helps in generating a large pool of candidates for the selection of the appropriate candidates for the job position [41].

2.3.2. Candidate Assessment

Assessing the applicants is the major component of the selection of the appropriate candidates for the vacant job position, which involves accessing the documents of the potential applicants. These documents are inclusive of the application form, CV and other supporting documents. The applicant's documents are assessed based on the information they contain, and assessment is completed by reviewing all the details and information concerning candidates' skills and qualifications relative to the requirements of the job position; those who meet the requirements are selected for the vacant job position, or for further consideration (e.g., interview) [40].

Candidate assessment forms a significant part of the process of e-recruitment that enables the selection of the right kind of job applicants that match the skills and requirements of the vacant job positions. The assessment process of candidates for the job position is based on software, which helps in the selection of suitable candidates for the vacant job position [20]. Assessment scores also form an important part of the recruitment of candidates in the online process as it helps in searching for the candidates with the proficiencies and skills required for the job position [26].

Assessment is a major part of the recruitment process, which helps the organisations in selecting candidates within the stipulated period. The assessment process in the e-recruitment process is focused on the candidate selection, which is based on the scores secured by the selected candidates, as well as their qualifications and skills. It has been observed that organisations have the flexibility to modify information based on the demands of the job position. The expectations of the management of the organisation strongly affect candidate selection based on required skills and qualifications [43].

2.3.3. Shortlisting Candidates for Interview

The shortlisting process is based on the selection of the best candidates out of the pool of applicants concerning a job position. Candidates who have applied for the required job position are shortlisted by the HR department for interviews, possibly with the involvement of recruitment team managers. The role of recruiting managers is considered significant in the shortlisting of candidates for the required position [44]. Recruiting managers at this stage of the e-recruitment process are engaged in the decisions concerning the next stage of the selection of the candidates, and the recruitment team is involved in the decisions which might lead to rejection or acceptance of the candidate for the required job position. The recruitment team is presented with three major decisions concerning the selection of the candidates for the required job: shortlisting the candidates for interview, reserving the candidates, and holding the recruitment of the candidates [45].

The decision to shortlist the candidates is taken by the recruitment team based on the documents and skills of the candidates that match the requirements of the job position. This decision of the recruitment team means that the selected candidates will be invited to participate in the interview process for the job. In addition to this, the decision of the recruitment managers concerning reserving the candidates means that the candidates will be listed in the reserved list for the process of the interview, to replace the existing candidates who drop for the interview process. The decision of recruiting managers concerning holding the candidates means that the recruiting managers will have the option for the progress of the candidates [46].

2.3.4. Final Decision

The final decision of the managers is the basis for the selection of suitable candidates for the required job position. In this context, the final decision of the recruiting managers is based on different factors such as the score of the candidates during the assessment process and shortlisting decisions; it is not based on the single factor of the score in the assessment process concerning e-recruitment. However, the recruiting managers in certain circumstances might direct the selection of certain candidates based on their scores in the assessment process [47].

The selection of the candidates is based on the final decision of the recruiting managers, who assay the skills, scores, and qualifications of the candidates, along with their backgrounds to decide about the recruitment of the potential candidates. While the skills and qualifications of the candidates are intrinsically fundamental for making effective decisions concerning the recruitment of eligible and proficient candidates, it has been observed that the recruiting managers might take biased decisions in certain cases when the referrals have been provided by existing employees of the organisation. The consideration of referrals might hamper work productivity at the later stages of job tenure, due to the weaknesses attached to the process of e-recruitment [48]. Thus, there is a need for recruiting managers to pay attention to the recruitment process and to carefully select suitable candidates for positions.

2.4. Quality of Hiring Through Online Recruitment

E-recruitment methods generally help in hiring more skilled and talented personnel than traditional recruitment methods. Using electronic gadgets and social media platforms promotes reaching a higher number of job seekers without inducing any substantive additional costs. Most organisations in the global world are opting towards online recruitment portals for easy and fast sharing of the information between and among recruiters as well as job seekers,

and improved quality of candidates and roles (i.e., superior matching), in the latter case by providing candidates with a better overview of the company and the target role [49].

Similarly, [50] reviewed online recruitment as the best recruiting technique in various organisations as it provides efficiency and effectiveness to the recruiters in selecting the suitable candidate for the given job profile. Compared to traditional methods of recruitment (such as advertising), online recruitment platforms provide detailed information about recruiters and the means for contacting them. With the availability of such options, candidates with high levels of skills, talent, and potential can seize these opportunities to claim their positions.

Furthermore, [51] found that online recruitment in organisations provides better opportunities to employers for hiring skilled and talented workers who can help in achieving organisational goals and objectives. With e-recruitment methods, individuals can easily upload their résumés and CVs to online job portal websites, and send them to recruiters matching their qualifications as per the job openings. Online recruitment has minimised the unnecessary costs incurred by organisations in recruitment, and optimised their return on investing in searching methods for and employment of skilled personnel [52].

In addition to this, [35] highlighted that online recruitment through social media platforms is trending among organisations on a global scale, as it helps in uncovering individuals possessing unique skills and talent. They also discovered that e-recruitment systems contribute to developing brand identity for most organisations, as well as to recruiting and retaining talented employees. The hiring of skilled and talented workers guides the organisations in improving their core competencies, resources, and operational abilities for providing an effective competitive edge. Moreover, employers hiring through online recruitment represent higher qualifications and better usage of technological sources, thereby attracting more individuals.

E-recruitment methods are helpful in hunting for a skilled and talented workforce, utilising digital social media tools that provide professional mobility to organisations and employees. These techniques are being applied globally at an increasingly ubiquitous rate. Additionally, with the advantages of attracting the attention of a large number of people through social media platforms and online website portals, the chance of recruiting talented individuals also increases, thereby promoting a higher number of skilled employees at work for achieving the aims of the organisation [52].

2.5. Advantages of E-Recruitment Process

2.5.1. Reduced Costs

The modern business paradigm posits that the success of an organisation fundamentally depends upon its employees; therefore, the recruitment strategy adopted by the organisation is highly critical in the selection of a diversified workforce. In the contemporary business environment, organisations focus on e-recruitment or online recruitment to hire skilled and talented employees for the organisation. The e-recruitment process is related to the use of Internet-based tools and technology for hiring potential candidates for the organisation. There are varied benefits or advantages of using e-recruitment for selecting employees, which include reduced recruitment costs, improved corporate image, reduced administration process, the reduced cycle time of recruitment, and availability of a large pool of applicants. E-recruitment also provides better HRM recruitment tools with reduced costs [53].

In [54] it was reported that e-recruitment could cost just 10% of traditional recruitment methods, and that 70% of the organisations use Internet websites for employment, 92% of candidates use the Internet for job postings, and 89% of job candidates use specific job search criteria for findings suitable costs. Moreover, the cost associated with hiring a single candidate for a vacant position in an organisation can be reduced by 87% using modern e-recruitment sources, such as corporate career websites, e-recruitment consortiums, and e-recruitment applicant service providers.

2.5.2. Reduced Recruitment Cycle Time

Explaining the benefits of e-recruitment, [54] stated that the e-recruitment process is also beneficial in reducing the overall cycle of the recruitment process. E-recruitment provides immediate interaction and round the clock services to organisations for recruiting or interacting with potential candidates. Employers can use e-recruitment tools, such as websites, to post a job immediately on different career websites and get quick responses from the participants. Conversely, using traditional recruitment processes or methods, such as newspaper or radio advertisements, can take more time to receive responses from job candidates. As per the data, the e-recruitment hiring process is 70% faster than the traditional recruitment process, and employers also do not have to wait for a long period to receive the responses of candidates regarding job postings [54].

2.5.3. Clear Communication, Broader Search, and Wider Reach to Candidates

The use of Internet tools during the e-recruitment process allows employers to have clear communication with job candidates without any miscommunication related to job requirements. Employers can provide a detailed description regarding job specifications to the

candidates. Similarly, candidates can quickly respond to the employer regarding his or her field of specialisation.

The use of websites during the e-recruitment process allows an employer to reach a larger pool of candidates, and thereby increase their chances of recruiting the right candidate for the position vacant in the organisation [55]. Similarly, [56] opined that the use of e-recruitment is beneficial for both employers and job candidates. Employers can use wider databases of online recruitment portals containing information about job candidates from diverse industries. Similarly, e-recruitment tools also help the candidates to search for specific jobs related to their industries and allows them to regularly update their CV and personal information on online job portals [56].

2.5.4. Enhanced Corporate Image, Reputation, and Brand

According to [57], the e-recruitment process is highly beneficial for organisations to enhance their corporate image, brand, and reputation. Corporate websites are used by employers to display information about their organisational culture, vision, mission, and values to candidates, which further contributes towards the creation of a positive brand image as perceived by potential employees (i.e., candidates). Besides this, organisations use corporate websites to display other information such as virtual tours to attract more job candidates and create a positive corporate brand image. For example, candidates who visit a corporate website are often influenced by the information displayed on the website regarding the organisation, and visit attractive websites' career pages frequently to see if job opportunities are available to them. This helps organisations to create a positive brand image and attract skilled and talented candidates [57]. Similarly, [56] opined that organisations use job advertisements to create a consistent and positive brand image in the mind of job candidates, which further helps organisations and their recurrent team in hiring highly skilled, innovative, and skilled employees.

2.5.5. Reduced and Standardised Administrative and Recruitment Processes

The use of e-recruitment in the selection of candidates also standardises the recruitment procedures and methods related to gathering candidates' information. The HR department in organisations uses a standard format to gather candidate information from different job portals and filter out specific candidates who possess the required skills, knowledge, and talent for the vacant job positions. Furthermore, the use of the e-recruitment process also reduces the cumbersome recruitment period as the use of e-recruitment tools and techniques allows the HR department to control and monitor all the recruitment activities, such as posting vacancies, receiving CVs, screening and prioritising candidates, and contacting them individually or collectively [58].

Similarly, the usage of modern IT tools during e-recruitment allows candidates to track the progress of their application forms and rejection or approval status from their workplaces. Moreover, the use of e-recruitment tools also allows the confidentiality of both candidates and employers sensitive and personal information. For example, employers can post job advertisements by keeping their personal and organisational information disclosed, and candidates can also post their CVs online without disclosing their current employer's name and information. In this way, the procedures and methods of e-recruitment reduce the overall administrative processes related to recruitment in organisations [58].

2.6. Disadvantages of E-Recruitment Process

2.6.1. Applications: Quantity versus Quality

[20] stated that the process of e-recruitment is highly beneficial in attracting a large number of job applicants, but it also affects the overall quality of the selected job applications. Employers have to face varied challenges during the e-recruitment process, such as a large number of unsuitable job applications, difficulty in integrating online and offline recruitment methods, and IT system-related issues. Similarly, [59] stated that the primary objective of the e-recruitment process is to attract highly qualified candidates from diverse backgrounds, but the e-recruitment process also tends to be skewed in favour of potential job seekers with a high level of computer efficacy rather than the ones who possess the skills required for the specific job posted by the employer.

2.6.2. Requires High Efficacy in Computer Skills

The e-recruitment process adopted by organisations often neglects candidates who are only moderately familiar with the use of modern IT tools. The use of Internet-based technology in e-recruitment also harms individuals who do not have frequent access to the Internet. While this is less significant in developed countries, it can remain a major issue in developing countries, particularly in rural areas with limited technology infrastructure. Organisations often use varied online job portals and their corporate websites for posting job requirements; consequently, it may become difficult for individuals who have a lower level of computer efficacy and who do not frequently access Internet technology. Furthermore, the e-recruitment process may also be harmful to candidates from lower-income groups who do not have access to IT and Internet technology [56].

2.6.3. Diversity

The e-recruitment process adopted by organisations may discriminate against individuals of lower socio-economic status, such as ethnic minority groups and the economically disadvantaged, for various reasons that are mainly manifest in reduced access to supporting

technologies, known as the “digital divide”. While blind shortlisting processes generally reduce the scope of ethnic and other forms of discrimination, online recruitment tools can also provide tools to enhance selection according to particular criteria or characteristics, which might be used to execute discriminatory practices. For instance, aside from role-related characteristics, applicant profiles may be filed by gender, ethnicity, and even sexual orientation etc. While such nefarious activities are intrinsically difficult to quantify, empirical evidence exists that many organisations exclude online job applications from participants according to social class, gender, age, race, religion, and nationality [60]. Furthermore, implicit contextual data in applications not officially included in online forms can be used to enable discrimination, such as detecting discriminated-against characteristics from profile photos or names. In the Netherlands for instance companies frequently discriminate against job applications from applicants with Arabic names during the online recruitment process [61].

However, such activities are not intrinsic to e-recruitment *per se*, but rather to firms’ own organisational characteristics. The primary function of e-recruitment platforms is to enable firms to select the best candidates according to their proficiency and suitability; if a candidate is *de facto* excluded from the process due to a lack of knowledge related to IT systems or computer skills, this may reflect their intrinsic unsuitability for the role, rather than discriminating against them *per se* [60]. Nevertheless, restricting the scope of recruitment to those able to use e-recruitment platforms effectively is inherently exclusive, and can narrow the scope of skills and experience otherwise available to firms. [59] opined that e-recruitment processes adopted by organisations could also exclude the older individuals and employees who are looking for a job but who do not possess the ability to use Internet technology or who are not familiar with modern IT systems. These older individuals or employees may feel a sense of de-alignment with the use of modern e-recruitment tools for searching for jobs. Furthermore, the e-recruitment process might also be less effective for the ones who do not want to use the Internet technology due to security matters. The use of e-recruitment procedures may also create gender and age differences. For example, employed young men more frequently search for jobs online compared to employed women and older employees, which has been attributed to lower computer efficacy and higher computer anxiety among such groups [59].

Similarly, [56] also argued that organisations could lose talented and skilled female employees or candidates due to poorly designed e-recruitment systems, because female candidates or employees may feel a sense of disconnection and are uncomfortable with the e-recruitment process in comparison to the males. In this way, the e-recruitment process adopted by the organisations may limit their extent to attract a large number of women, minorities, or older employees. Organisations are required to be highly attentive regarding their e-recruiting

process because it may affect their diversity-related goals in the recruitment process. Thus, the e-recruitment process has an adverse impact on broader category people, which includes minority community people, female candidates or employees, and older people [56].

2.6.4. Alignment

[61] argued that organisations also have to face issues related to aligning their online and offline methods, such as newspaper advertisements and face-to-face interviews for recruitment. The usage of both methods for the recruitment process may prohibit the recruitment team from utilising the Internet properly, as the use of traditional recruitment procedures requires the HR team to review and process paper-based applications of candidates, which incurs a significant time cost. In addition to this, lack of HR-related knowledge to use online recruitment systems may also affect the overall recruitment process. This is more applicable to those organisations that are heavily reliant on external recruitment agencies and service providers. Furthermore, small- and medium-sized organisations may find the technologically advanced equipment and tools to implement the e-recruitment process in their organisations prohibitively expensive [61].

According to [62], organisations are also required to perform an in-depth analysis of the sample population that they are targeting when recruiting candidates with the help of e-recruitment procedures, as most of the people do not use or are not familiar with the Internet resources. In addition to this, organisations are often required to screen, check, and map the skills of a large number of applications of applicants with specific job position that is required or vacant in the organisation. This process becomes a cumbersome and time-consuming process for the online recruitment team of the organisation. In addition to this, organisations cannot solely rely on online recruitment channels, hence organisations should align their online and offline recruitment channels to make their recruitment process more efficient and effective. Organisations also have to face the challenges of aligning their recruitment methods with the overall business strategy of the organisation to create a competitive advantage. For instance, if an organisation wants to hire a software developer or web designer, then it may use online or e-recruitment channels for posting job requirements, as it will provide more opportunities for the organisation to find a skilled candidate, because members of that channel's applicant pool will be more technologically advanced in comparison to offline channels. Conversely, organisations offering non-technical positions must use offline channels to find specific job candidates regarding that vacant positions in the organisation [62].

2.7. Artificial Intelligence

There are various ways in which AI has now begun to influence people's daily activities. Technological innovations are now commonplace throughout the world in a way that was not the case merely two decades ago, and this is evident in the ubiquitous use of voice-enabled assistants, keypads on smartphones, and personal technological devices. What is more, AI has been embraced by various sectors of the economy to enhance productivity, including healthcare, financial services, education, and government. Indeed, AI is now used in fundamental applications in the vast majority of economic sectors [63].

There are various productive purposes for which AI can be deployed in HR, but Kestenbaum [64], a technology recruitment specialist, recognised that many working in the sector will initially be nervous about how AI could affect their roles in the long term. However, he stressed that AI is effectively being used to help automate routine duties that are laborious and time-consuming, thereby helping to free up time to perform other tasks. [65] stated that people mature when they acquire a core strength that is capable of enduring any negative development, arguing that the best quality that a person can have is to survive adversity, keep fighting for what they believe in, and not stop until they realise their goal. In terms of recruitment, the main target is to find the most suitable candidate to fill the position, and this may entail considering many people or looking in many places to fill all of the vacancies, the full range of mediums must be considered to be certain of finding the most suitable candidates.

A combination of internal and external factors can be utilised, depending on the organisation's effectiveness in terms of exploiting the available processes and methods during the recruitment process. In order for the recruitment process to be considered a success, suitable candidates must be appointed to the available positions who are willing and able to perform to the required standards. The recruitment process can be made more effective by utilising customised data and sources. Forbes magazine published an article entitled "The rise of Facebook recruitment", in which it was claimed that those seeking employment now have a good idea about what they are looking for in their new role. Similarly, those responsible for recruiting are also better informed about who is likely to apply for the available positions [66].

Facebook Career Pages can be used to help ensure that candidates and employers can be more appropriately matched. An example of a company that has utilised Facebook to run a recruitment process is Earls, which operates restaurants in North America. They used Facebook for this purpose because it offered an effective way for the firm to provide details of its culture, policies, and procedures to potential applicants. Besides, they noted that Facebook was better suited than LinkedIn or Twitter for such purposes.

2.8. Summary

It can be summarised from the review of relevant literature that the e-recruitment process involves the use of technology to attract and select suitable candidates for the job. It has been observed that the e-recruitment process involves the stages such as searching the job folder, assessing and shortlisting candidates, final decision of the recruiting managers, and quality of hiring through online recruitment. The advantages of the e-recruitment process have also been reviewed, which include reduced recruitment costs (including time and money), enhanced corporate image, clear communication, broader search, standardisation of recruitment procedures, and wider reach to job candidates. In addition, the process faces certain challenges, such as an increased number of unsuitable job applicants, discrimination and diversity issues, and alignment issues. Although adequate literature sources are available on the benefits and challenges of the e-recruitment process and AI-based e-recruitment systems, there is a lack of literature on the clear process of e-recruitment and correct procedures, which present the scope for further research in this domain.

Chapter 3

Research Methodology for Recruitment

3.1. Introduction

This chapter explains the research methodology used in this study. The discussion in this chapter is developed in consideration of the “research onion” model [67], which is depicted in Figure 3.1. This chapter expounds this study’s research philosophy, approach, methodological choices, strategy, data collection and analysis, which are components of the onion model. The model helps in efficiently designing research methodology by providing an effective platform. [68] state that the research onion model’s utility lies in its ability to be adapted for use in numerous contexts and almost any form of research. An overview of research paradigms is shown in Appendix A.

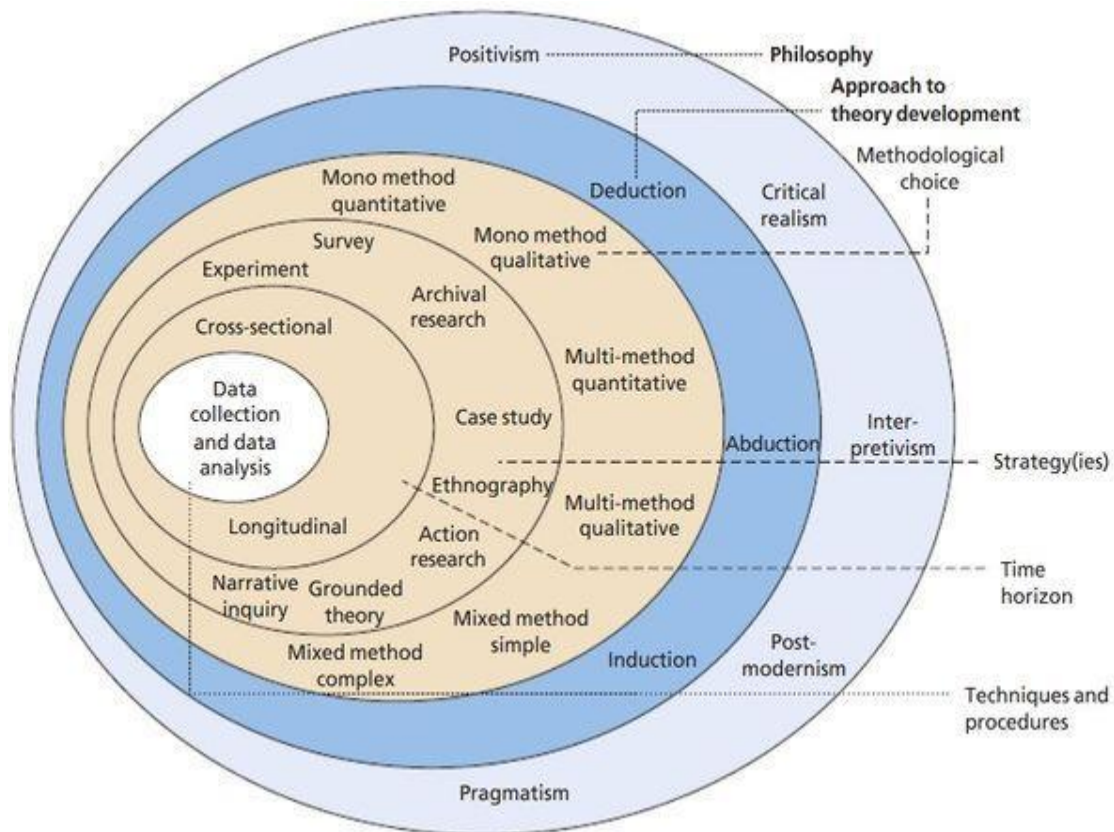


Figure 3.1: Research Onion Model [67]

3.2. Research Philosophy

A research philosophy is a set of assumptions and beliefs concerning the way in which knowledge can be developed [67]. It is a basic explanation of the essence of knowledge and how the study is conducted and is derived from the philosophy of research [68]. The research

philosophy varies based on research goals [69]. Consequently, the researcher's philosophical point of view determines what is investigated and how it is examined [70]. The research philosophy highlights the adopted research process and its basics. There are five research philosophies in the research onion model: interpretivism, positivism, postmodernism, critical realism, and pragmatism.

HRM researchers mostly use the positivist paradigm for researching HR phenomena [70]. Positivism is centred on the ontological assumption that an existent external reality can be measured by an objective researcher, using epistemological ways of understanding that reality. The use of systematic procedures is considered for testing developed hypotheses. Most existing HRM literature aims to evaluate assumptions, measure constructs, and conduct statistical analysis via quantitative methodologies. To prevent possible confounding effects, researchers must remain impartial and objective to follow a positivist philosophy [67].

Positivist research is developed using the existing scales and theories, then using the collected data, hypotheses are empirically tested [71]. In compliance with the methodological conventions from the previous research in the HRM domain, and the context of research aimed at the testing relationship between the constructs, the positivist approach is adopted in this research to underpin the analysis of proposed relationships between the e-recruitment system, process of e-recruitment, quality, technology acceptance, AI, SUS, and other associated constructs, which can be identified and tested empirically.

3.3. Research Approach

[60] state that deductive, inductive, and abductive are the three main research approaches. The main differences between these three approaches lie within their usage and how they are related to the hypotheses. In the deductive approach, the process starts with the development of theory based on the literature, which is then tested in the research. The inductive approach focuses on developing a theory based on the collected data. On the other hand, the abductive approach begins by collecting data, identifying the themes, and then developing theory. The theory is tested based on the data collection process that has been considered additionally in the research. As per the research purpose, the relevant literature is reviewed concerning technology acceptance, e-recruitment and AI.

This research work is focused on the development of an intelligent system that will help assess candidates' suitability, experience, and qualification for a specific job, in either private or public organisations. The developed intelligent system will help in analysing the job requirements so that the skills of the candidate can be matched based on the candidate's skills. The system

will then allow for selecting the suitable candidate for the job, thereby leading to eliminating the human factors from the selection process.

3.3.1. Deductive Approach

In the deductive approach, the focus is first laid on a conductive extensive literature review so that hypotheses are developed with support from existing theories [72]. [73] states that a deductive approach is best applicable when the previous research work is being considered in the development of potential relationships related to the existing phenomenon. In the positivist research approach, the deductive approach is best suited as it is dependent on the already existing theories, quantifiable observations, and statistical analysis [67]. Although the researcher also acknowledges deductive research, qualitative techniques can also be considered [67].

According to [74], certain consecutive steps are used in the deductive research process. These steps are identifying a tentative idea, using previous literature in refining testable propositions, using the previous studies to analyse the argument, confirming or disapproving hypotheses based on the results gained from statistical analysis, and assessing whether the findings comply with the existing theory. Based on these consecutive steps, it has been identified that the deductive approach begins with developing a theoretical knowledge base and then testing relationships empirically so that further knowledge can be advanced.

[75] states that the deductive approach begins when the literature is reviewed by the researcher. E-recruitment has not been identified as a factor that influences the recruitment process when a candidate applies for a technology job (to the best of the researcher's knowledge), thus the research question "*What is the impact of using AI in the recruitment process?*" was developed (as explained in Chapter 1). The technology acceptance level and recruitment process are affected with the use of AI, which eventually leads to affecting the recruitment quality in relation with skills matching and shortlisting the suitable candidate. Based on the e-recruitment system literature (Chapter 2), there is no way of measuring the intelligent system by itself. However, UTAUT can be used to measure the technology acceptance level (Chapter 4).

Chapter 4 explains that research on IT acceptance led to developing some contending models, each of which has acceptance determinants that are of alternate arrangements. In this part of the research, there are some of the most established models such as TAM, TAM2, DOI, UTAUT and TRA for technology acceptance. However, based on the available models for technology acceptance, the researcher has to select the most appropriate model for the research that has fewer limitations. Therefore, according to the limitations of each model

identified from the literature, the UTAUT model will be used in this study for analysing the e-recruitment in Saudi public and private sector organisations.

The main purpose of testing the hypotheses is explaining the certain relationship and its nature or establishing differences between the groups or a situation with two or more factors that are interdependent [76]. This study is focused on verifying the causal relationships between the variables and then testing the adopted theories in a projected conceptual model. SPSS software was used to test the relationship between the hypotheses.

The work is presented in the thesis in the following order. Chapter 5 defines the questionnaire output using a differential analysis method. These outputs are used as inputs in the development of a new system structure and design. Chapter 6 includes the architecture development of the AIRec system, where the design of the website has taken place based on the conducted survey. Chapter 7 ensures the effectiveness of the AI system. A manual approach was considered for the ranking, and MATLAB was used in testing the data in the initial step. Genetic algorithms, swarm intelligence, and neural network were implemented for optimisation, to automatically assess candidates.

It was found that the neural network was the most effective in giving accurate results. Therefore, based on the results from the neural network, it was used further in the research.

3.4. Methodological Choices

Generally, there are three different kinds of methodological choices available, as indicated in Figure 3.2: mixed-method, mono-method, and multi-method [67]. As per the mono-methodology, qualitative or quantitative research methods must be used exclusively to conduct research. On the other hand, mixed methodology suggests the implementation of more than two methods to conduct research. Similarly, the multi-method suggests the use of wide qualitative or quantitative methods to conduct detailed research [68]. The key difference between multi-method and mixed-method is in the composition used for the dataset. The mixed-method creates a single dataset through the combination of various kinds of data collected with the help of different techniques of data collection [68]. However, multi-method segregates the whole study into different isolated sections consisting of datasets separate from each other [78].

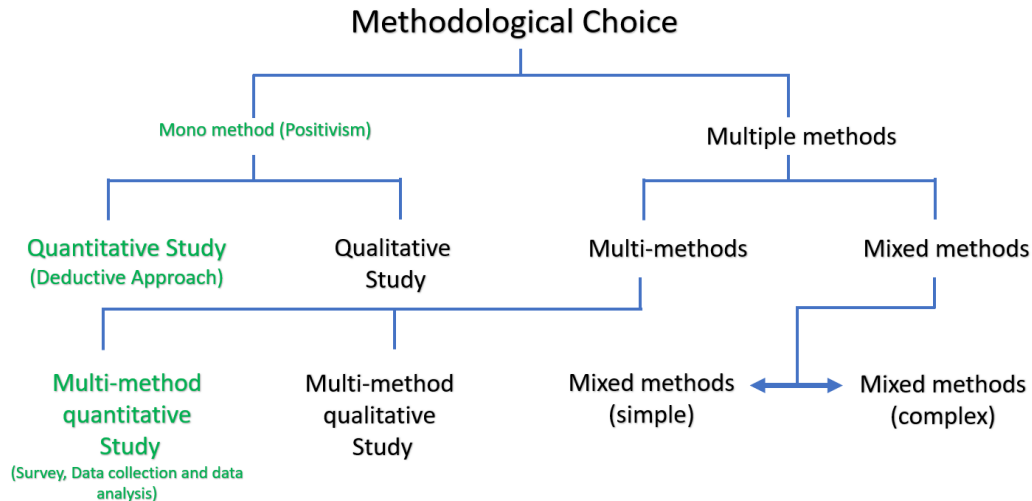


Figure 3.2: Methodological choice

Qualitative, quantitative, and mixed are the main research method types. The chief difference between qualitative and quantitative methods is the nature of data collected: the former uses non-numerical, contextually rich data (e.g., narrative accounts of perceptions), while the latter uses numerical, quantifiable data, germane to statistical analysis. However, the mixed method of data collection comprises both quantitative as well as qualitative data collection on the same research topic. The researcher always perceives with a positivist outlook while conducting research, and therefore deductive research approach should be adopted. Most existing studies in this field were based on different theoretical paradigms, but they used quantitative methods. In this context, the presented research will implement a quantitative mono-method research design.

While researching with the help of an appropriate methodology, one must rely upon the knowledge possessed concerning the occurrence and phenomenon's nature during the investigation process [78]. Numerical, quantitative data can be used to prove relationships and thus hypotheses that are generalisable and objective [68]. The key objective of conducting quantitative research is to study and explore phenomena with the help of statistics or numbers, instead of using images or secondary text. Quantitative research starts with theory and thereby is guided further by literature on developing hypotheses and research questions, which are tested using robust empirical procedures to obtain validity, like complying with the recommended conventions to develop valid results; the approach always remains in alignment with positivism [69], [70]. The presented research study also tests the related hypotheses through a large sample comprising various respondents (as discussed later), as per the conventions of quantitative research.

When an adequate theoretical background is available to form hypotheses, it is recommended to use a quantitative research approach and, thereafter, empirically test and operationalise

the constructs of the research [71]. The research domain of HR normally uses only a quantitative approach while analysing the behaviour and thereby suggesting the rationale of applying this in the research study [77], [78].

3.5. Research Strategy

According to [67], a research strategy is defined as a plan used to answer the research questions. The research strategy can include one or more than one research method, such as interviews, surveys, case study research, systematic literature review or experimental research. In data collection procedures for quantitative research, structured surveys are used generally. Research sampling (used to test research hypotheses), time frame, issues in research strategy, and data analysis are discussed below [68].

3.5.1. Samples

Sampling is a way of limiting the number of units that the researcher has to process and interpret to validly deduce general conclusions concerning a larger target population. The most commonly used sampling techniques are probability and non-probability sampling. Probability sampling provides equal opportunities for each population to be used in the sample, whereas non-probability sampling allows researchers the opportunity to choose population respondents in the sample subjected to their ease and intent [67]. In the presented study, to recruit the required number of participants, a simple random (probability) sampling technique was used. The adoption of simple random sampling means that the sample participants are unbiasedly chosen, which in turn increases the credibility of the test findings. The sample population consisted of 506 participants from universities that included faculty members of Saudi universities with different education levels, a diverse community of officials from the SHRDF, and some business owners.

3.5.2. Research Time Frame

The data collection took place over four months, during 08 -11 2019. At the beginning of the first stage of the study, the data collection process was undertaken. In the final stage of the study, the system was tested. In taking the first measurements, the start date of the research was considered as the baseline data. On the end date, the final questionnaires and measurement were completed.

3.5.3. Questionnaire Design

There are four commonly used questionnaire formats, of which self-completed ones are the most common [79]. The self-completed questionnaire is also of four types: online, postal, telephone, and face-to-face, in which the researchers and participant are in the same place

(or potentially via modern video conferencing, which spans the traditional telephone and face-to-face categories). A self-completed online questionnaire was implemented in this study, whereby respondents electronically completed the questionnaire at their own convenience in time and place.

Moreover, there are also various kinds of questionnaire questions, which determine the nature of data collected, including open, closed, structured, or verbal questionnaires [79]. Quantitative questionnaires have been regarded as the most effective and expedient way of collecting data, and structured and semi-structured questionnaires enable the gathering of large volumes of standardised data that can be used to generate statistically robust universal conclusions; conversely, qualitative questionnaires may use open-ended questions, but their in-depth and “thick” data requires significantly more specific analysis, which makes sample sizes (and thus statistical importance and generalisation) restricted [80], [81].

The questionnaire has been regarded as the most effective research tool used in qualitative and quantitative research methods, as it consists of targeted questions calibrated to satisfy researchers’ needs [82]. In the quantitative questionnaire method, there is negligible scope for introducing biases in the results. Self-administered questionnaires also help increase participant response rates by allowing participants to complete the instrument at their own convenience. Other advantages associated with online questionnaire methods include accessibility, anonymity, probable reduction in bias, and automated data structuring [83].

The questionnaire survey research method helps in gathering the information from the sample population related to the characteristics or actions of a community. This method also helps in gaining an overview of the perceptions of the people and their attitudes regarding a specific issue [84]. As explained previously, there are different types of questionnaire methods, with the most common methods being telephonic surveys, face-to-face surveys, mail surveys and a recently popular method called electronic surveys [85]. This study used an electronic questionnaire survey method to save time and cover a large geographical area, to gain diverse perspectives from Saudi participants freely able to express their views.

The study questionnaire avoids complex questions to increase response rates. It was developed to be convenient for different members of university staff and graduate students from different academic years and academic specialities across, as well as participants from various Saudi public and private sector organisations. The questionnaire survey comprises seven different parts, covering AI, e-recruitment, e-recruitment system, quality, process, and UTAUT.

The first part of the questionnaire includes demographic questions related to age, gender, specialisation area, and education. The second part is related to existing e-recruitment in

Saudi public and private sector organisations. The third part is focused on those systems and things that should be included in the system so that they can be developed. The fourth part of the questionnaire is related to the e-recruitment process that constitutes the attraction, selection, recruitment and on-boarding of candidates for the job. The fifth part focused on recruitment mechanism quality so that the right candidates are selected for the right job. In the sixth part, the measure of technology acceptance and questions regarding electronic recruitment's application in Saudi universities has been considered. The seventh part is related to AI, in which job seekers and employers were asked about AI technology. Both were asked about the functions which they want to improve in the selection process before the system is designed so that some of the parts of recruitment are made automatic, particularly the ones that are repetitive and are high-volume tasks. The final part, SUS, is related to employers, who will be asked about their thinking related to system usability and the results generated by the AI. There is a total of ten item questionnaires, where the respondents are provided with five Likert-type options ranging from 1 = *strongly disagree* to 5 = *strongly agree* (Appendix B).

3.5.4. Language Issues

Both Arabic and English questionnaire options were offered. The materials and issues undertaken in the study have been considered from the faculty members of different education levels from the universities in Saudi Arabia, a diverse community of officials working with the SHRDF, and some of the business owners. Some of the participants were not well versed in the English language, so a copy of the questionnaire was also prepared in Arabic. The relevant research materials were also translated into the Arabic language. Unbiased analysis of the translated material was done with support from an expert panel that consisted of faculty members of Jeddah University, to prevent any difference in the understanding of the subject matter between the participants.

3.5.5. Consent Form

A consent form was provided to the participants before the start of the questionnaire so that they are provided with the research purpose. The participants were also assured of the confidentiality of the research study. The consent form sets out the voluntary essence of the research and informs participants that they can opt out of the study at any point. The ethical form also includes instructions for completing the questionnaire in the set time frame. The method of storing and managing research data is then clarified by highlighting that the secure university server would be used for storing data, which would also be encrypted and protected by a password. Lastly, the contact details of the researcher were provided so that respondents could contact the researcher or research supervisor if they had any queries, concerns, or

complaints. This consent form aimed to ensure that the data collected remained confidential, safe, and anonymous, and to motivate participants to complete the whole survey honestly.

3.6. Data Collection and Analysis

The researcher decides how data will be collected and analysed based on the methodological approach selected [68]. The items (written statements) used in compiling the questionnaire for capturing and measuring the constructs of the research collected the primary, first-hand data [68]. Survey Google Forms was used to collect the exported data in .sav files, and was analysed using SPSS. In the analytical process, descriptive analysis has been used in its first phase of the process, after which data reliability and its validity checks were followed. The data collection and analysis are responsible for the reliability and validity of data [67]. The research model was tested using MATLAB.

3.6.1. Primary Data

The first-hand sources were used to derive the primary data, generally using the interview or survey method [86-87]. The target population for the research were Saudi adults aged 18 and above. The respondents meeting the criteria were asked to complete the questionnaire. The respondents that failed to meet the criteria were automatically eliminated from the study and a thank you note was sent to them.

3.6.2. Reliability and Validity

Reliability is the extent to which consistent results are produced by the scale in the case of repeated measurements [88]. To ensure that results are trusted, the scale that has been adopted for the research must be reliable. Therefore, there is a need for a reliability test on the selected measurement scale before the results are analysed as it will help in gaining trustful outcomes. In this study, internal consistency reliability has been used in checking the reliability of the model. In testing the internal consistency, alpha and composite reliability of Cronbach has been considered.

Composite reliability tests the overall reliability of the set of heterogeneous but related items without requiring equal loading of items [89]. Composite reliability considers the outer loading differences indicator variable. To verify the internal accuracy of the scales, Cronbach's alpha and composite reliability were utilised. Validity tests the degree to which the study measures the constructed structures, instead of something else [90]; it has also been described as the degree to which differences present in observed scale scores represent true differences between objects on the characteristics being tested, instead of random effects [91].

The criterion validity is verified when the scale functions with other variables as expected [91]. As the scales used in this study have been adapted from earlier pre-tested scales, the criterion validity is verified. Content/ face validity assesses the degree to which a scale corresponds to the field of a particular construct [92]. In establishing content validity, the utilisation of measures and measurements to conceptualise and calculate the research constructs was considered, and an expert panel validated the adapted scales.

There are three types of construct validity: nomological, convergent, and discriminant. Nomological validity is established when a scale correlates with different constructs as depicted by underpinning theory [93]. An extensive review of the literature led to the careful development of the framework adopted for the research, thus establishing nomological validity. Convergent validity demonstrates that two items in a scale are related to each other, and can be assessed in PSS by reviewing the average variance extracted (AVE) [94]. Finally, discriminant validity is assessed by one-way analysis of variance (ANOVA), and Duncan's multiple range tests. This study applies the above-mentioned tests, and the results are presented in Chapter 5.

3.7. Summary

This chapter discussed the research onion model and the research approach to develop an intelligent system that will be used in this research. The methodology choice was the quantitative analysis method, utilising structured online surveys to collect data. In addition, this chapter concluded that the relationship among study variables will be examined by ANOVA and independent sample t-test utilised to analyse the difference in demographic variables in the e-recruitment process, with Cronbach's alpha coefficient to verify the internal accuracy of the scales.

Chapter 4

Unified Theory of Acceptance and Use of Technology (UTAUT)

4.1. Introduction

Information technology acceptance research has developed various contending models, each with an alternate arrangement of acceptance determinants. These models have developed throughout the years as an outcome of tireless endeavours to approve and expand the models throughout the period each one was exhibited. This part exhibits the most recognised models in information systems research: the Theory of Reasoned Action (TRA) [95], Theory of Planned Behaviour (TPB) [96], Technology Acceptance Model (TAM) [97], augmented TAM (TAM2) [98], Diffusion of Innovation Model (DOI) [99], and the adopted Unified Theory of Acceptance and Use of Technology (UTAUT) [100].

4.2. Theory of Reasoned Action (TRA)

The oldest model used to clarify technology acceptance was created in the social psychology field, TRA was developed to “sort out and coordinate research in the state of mind territory inside the structure of an efficient hypothetical introduction” [95] (p.2). It was posited to anticipate, clarify, and affect human conduct. The system gives a differentiation between convictions, attitudes, subjective norms, intention, and behaviours: the significant concern is the connections between these factors. These ideas shape a model for the expectation of particular intentions and behaviours. TRA is claimed to be a suitable model for the investigation of the cognitive factors of the conduct of the client as a theoretical basis, since it predicts and clarifies conduct over a wide assortment of spaces [95]. TRA affirms that the essential determinant of conduct is not the individual’s attitude towards the behaviour *per se*, rather it is the intention to *perform* the behaviour, called “behavioural intention”.

Two factors are responsible for controlling behavioural intention: the individual’s attitude towards the conduct, which is the degree to which the individual has a suitable or unsuitable assessment of the conduct; and the subjective norms or social pressure associated with implementing or not implementing the conduct. These two elements are supported by sets of convictions. For the attitude component, the convictions are behavioural convictions that are interested in the perceived probability that implementing the conduct will result in a certain output and the degree to which these results are esteemed. For the subjective norm element, the convictions that are concentrating on the apparent social stress from specific referents and the individual’s inspiration to agree to these referents. The TRA inspects behavioural

expectation, as opposed to mentality, as the primary indicator of conduct [95]. The hypothesis can be clarified by the model in Figure 4.1.

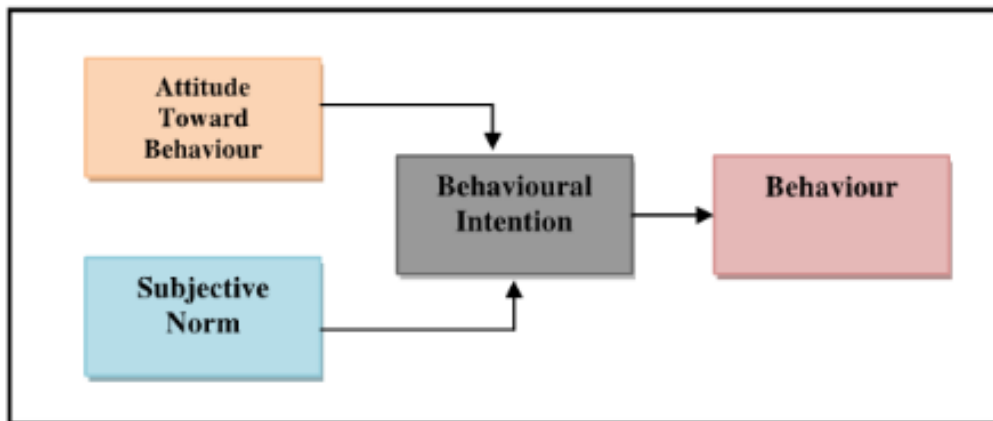


Figure 4.1: Theory of Reasoned Action [95]

4.2.1. Limitations of the TRA

According to [96], TRA is restricted by correlation; for the theory to anticipate particular conduct, attitudes, and intention must concede to activity, target, time frame, and attentiveness [101]. The best limitation of the theory comes from the presumption that the individual conduct is under voluntary control over behaviour. In other words, the theory only applies to conduct that is intentionally thoroughly considered in advance. The TRA cannot explain irrational decisions, habitual actions, or any behaviour that is not consciously considered by the actor.

4.3. Theory of Planned Behaviour (TPB)

TPB was proposed to address the issue of involuntary control/ “irrationality” identified above with regard to TRA [96]. TPB is the model which is used to foresee and clarify human conduct, while additionally thinking about the character of an individual, organisational associates, and social frameworks in this procedure [102]. TPB was intended to foresee behaviours not exclusively under volitional power by including the estimate of apparent behavioural control [102]. TPB varies from the TRA in its addition of the perceived behavioural control constituent, which pertains to circumstances wherein an individual has less control over the behaviour. This can shift crosswise over circumstances and activities [102]. The TPB places the build of perceived behavioural control (PBC) inside the broader system of connections among beliefs, attitude, intentions, and behaviour. PBC is engrossed to impact both intention and behaviour, as shown in Figure 4.2. The impact of PBC on conduct can be immediate or intuitive (through behavioural intention). As indicated in the TRA, when the circumstances or conduct convey an individual to have full control over behavioural execution, the motives alone ought to be adequate to foresee conduct.

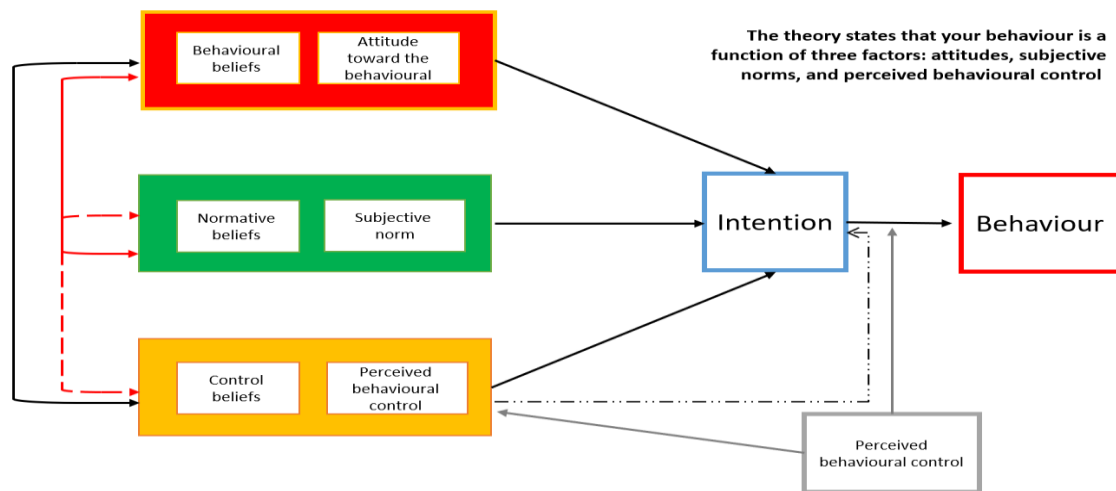


Figure 4.2: Theory of Planned Behaviour

According to [102], under situations where behavioural intention alone would represent just a small measure of the difference in conduct, PBC ought to be autonomously prescient of conduct. The intent and PBC are imperative to anticipate the conduct, yet one might be more essential than the other, given the predominance of specific conditions. Keeping in mind the end goal to clarify and anticipate conduct, TPB manages the precursors of attitude, subjective norms, and perceived behavioural control. The TPB supposes that conduct is a component of striking beliefs pertinent to that conduct. These notable convictions are considered as the overall determinants of an individual's expectations and activities.

4.3.1. Limitations of the TPB

Feedback of the TPB is that the model does not research the connection between expectation and conduct, where there is regularly a lot of unexplained difference. As a psychological model concentrating on inner procedures, TPB excludes statistical factors, and accepts that everybody would encounter the model's procedures correspondingly. It additionally does not account well for changes in conduct [103]. [104] reprimanded TPB for its utilisation of one variable (PBC) as a precaution for all non-controllable components of the conduct. Beliefs behind the PBC were totalled to calculate it. This conglomeration has been criticised for not distinguishing particular factors that may foresee conduct, and additionally, for the inclinations it might make.

4.4. Technology Acceptance Model (TAM)

TAM represented a more pragmatic approach than the TRA and TPB, focusing on practical outcomes and interactions of technologies within adopting systems (i.e., organisations), rather than approaching the issue primarily from the psychological perspectives of social

behaviourism. TAM is grounded in the IT/IS acceptance and use behaviour (USE) paradigm [102]. It reorients the TRA [96] to clarify why users accept and use technology, and what impact factors are associated with these procedures. As shown in Figure 4.3, TAM utilises two discernments, “perceived usefulness” and “perceived ease of use” (PEOU).

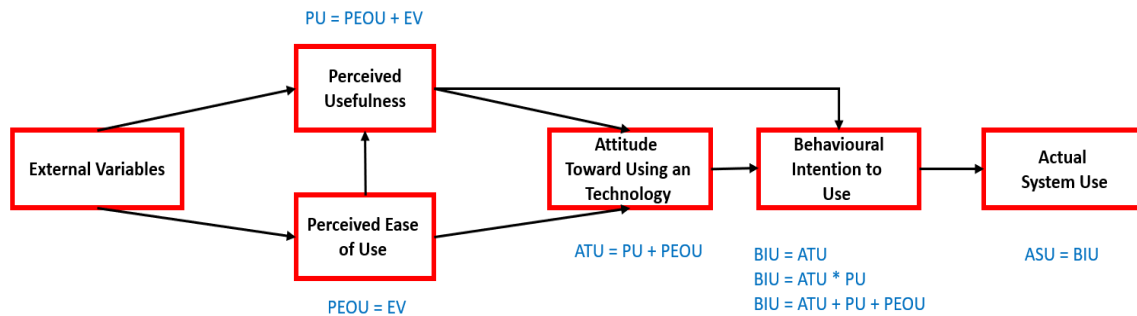


Figure 4.3: Technology Acceptance Model

Perceived usefulness of use concerns the degree to which a potential user thinks the technology can assist in achieving goals. PEOU is characterised as “the level to which an individual trust that utilising a specific framework would be free of exertion” [103]. The TAM has become an effective method to explore real technology adoption phenomena in modern organisations since the mass popularisation of computing during the 1990s. The utilisation of computers is dictated by intention, which is seen as being together controlled by the individual’s state of mind towards utilising the framework and its perceived usefulness. Figure 4.3 shows the first TAM, which recommends that state of mind (a positive reaction) and helpfulness, may affect the goal of utilising the framework. The connection between usefulness and intention suggests that the individual believes that his or her activity execution is improved, paying little respect to positive or negative emotions [104]. The external variables in the model allude to a group of variables, for example, target framework plan qualities, preparing, computer self-viability, client contribution in outline, and the idea of the execution procedure [105].

TAM has been continually developed, and revised versions (including TAM2, discussed below) present new outside factors influencing perceived usefulness, PEOU, and *actual* use or behaviour. Among the most habitual referenced constructs are framework quality, similarity, computer uneasiness, delight, computing assistance, and event [106]. As per [96], the objective of the TAM is to clarify the determinants of computer acceptance that are normally competent for clarifying client conduct over a wide scope of end-user technology and the groups of users. TAM has turned out to be a useful structure in anticipating and clarifying use over an assortment of frameworks [107].

4.4.1 Limitations of the TAM

The most serious deficiency of TAM is its dependence on respondents' self-detailing, and expecting that self-announced usage reflects real usage [108]. The second deficiency is identified with the kind of respondents, inspected frameworks, or the example decision used in empirical studies of its effectiveness, often using expert technology users [108]. Additionally, [90] identified that one of the restrictions of the TAM is that it gives constrained direction about how to affect utilisation through planning and execution, which does not help to comprehend or clarify acceptance in ways that guide improvement beyond the proposal that framework qualities affect the ease of use. [109] expressed two noteworthy deficiencies of learning on TAM; the illustrative energy of the model, and the irregularities between earlier examinations.

4.5 Extension of the Technology Acceptance Model (TAM2)

[98] extended TAM to incorporate extra key determinants of TAM's perceived usefulness and user intention with regard to social impact and intellectual instrumental processes. The adjusted TAM2 includes extra ideas covering social impact forms (subjective norm, voluntariness, and image) and instrumental psychological procedures (job relevance, output quality, result demonstrability, and PEOU) (Figure 4.4).

The model supposes that in an association with the required framework, the subjective norm will specifically affect the intention to use in the initial execution and subsequent utilisation of the framework. As time passes, however, the impact of the subjective norm on intention to utilise will diminish and will be substituted by experience in using the framework. TAM2 theorizes that, in a computer usage context, "the direct compliance-based effect of subjective norm on intention over and above perceived usefulness and perceived ease of use will occur in mandatory, but not voluntary, system usage settings" [98].

Additionally, the subjective norms in the TAM2 directly affect intention over perceived usefulness, and PEOU will happen in required framework use settings. The model sets voluntariness as a moderating variable to recognise compulsory versus deliberate consistency with hierarchical settings. However, subjective norms can influence intention through perceived usefulness or internalization. Also, TAM2 speculates that internalization, as opposed to consistency, will happen regardless of whether the utilisation setting is voluntary or required. Eventually, the discoveries detailed that all the social impacts and instrumental psychological procedures have a fundamentally solid effect and influence users on the acceptance of technology [98].

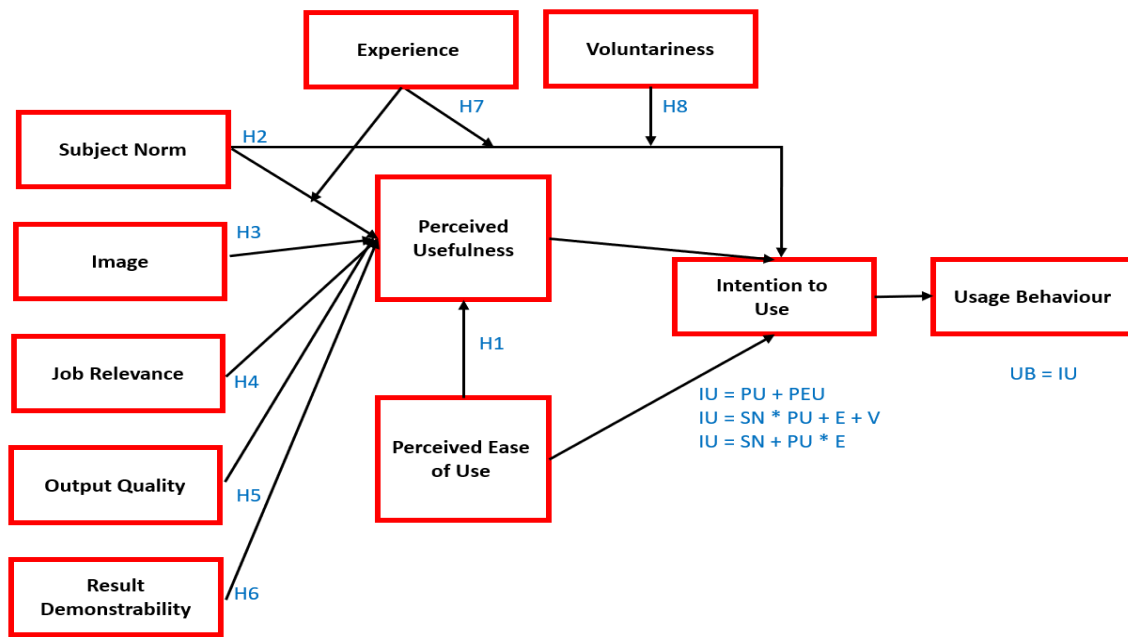


Figure 4.4: Extended Technology Acceptance Model (TAM2)

4.6 Diffusion of Innovation Theory (DOI)

DOI explains how innovations scatter through society, and how organisations and individuals accept such transformations [91]. Rogers distinguished the acquisition procedure from the diffusion operation, whereby the latter happens within whole societies, as a category procedure; while the former unfolds on the level of the individual user. Diffusion in DOI is “the process by which an innovation is communicated through certain channels over time among the members of a social system”, while adoption is “a decision to make full use of an innovation as the best course of action available” [99].

DOI is a combination of innovation-decision process, opinion leadership, adopter characteristics and innovation characteristics, played out over five stages by individuals or decision-making units, as shown in Figure 4.5 and described below [99]:

1. *Knowledge*, when a person or decision-making unit identifies an existing innovation and its functioning.
2. *Persuasion*, when perceived characteristics regarding the innovation are identified as favourable or unfavourable according to the attitudes of the potential adopter.
3. *Decision*, when an individual or unit decision-making elects to choose from adoption or rejection activities in relation to the innovation. In this phase, challenging forces can be evident that may support or may oppose the overall process.

4. *Implementation*, when the decision made is executed, operationalised by adopter-user behaviour.
5. *Confirmation*, the final stage of the innovation-decision process in which evaluation is undertaken to determine the outcomes of the adoption or rejection of an innovation. In this stage, the decision can be reviewed again if any problems occurred regarding the innovation, to inform future decisions (whereby the process may be reiterated relative to new knowledge and experience).

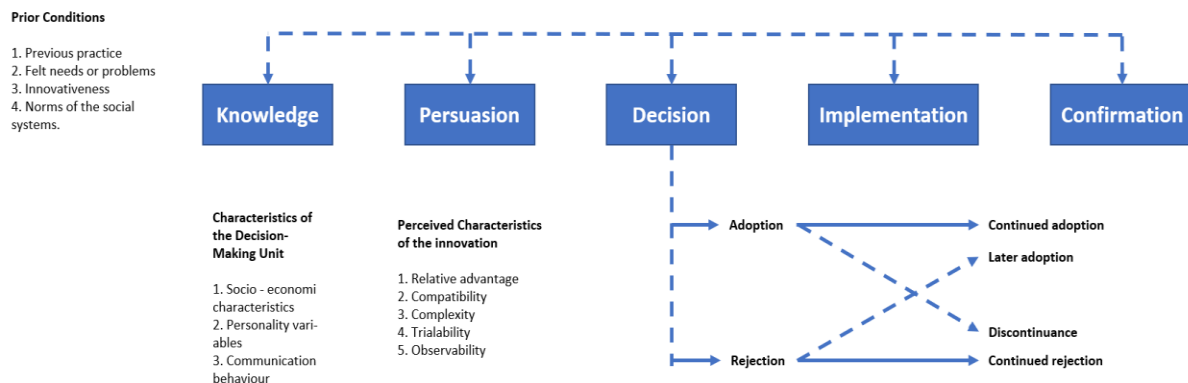


Figure 4.5: Roger's Model of Innovation Decision Process

4.6.1 Limitation of DOI Theory

There are various disadvantages associated with DOI theory that have been expounded by [109]. These include IS discipline issues relating to DOI being a suitable descriptive tool, but one which lacks explanatory power. According to this critique, DOI is limited in predicting outcomes, and it cannot guide adoption acceleration. It has also been criticised for being culturally bound to the Western contexts in which it arose, rendering it less germane to innovation diffusion in other contexts, such as East Asia and Africa. DOI theory is also criticised for focusing on demand of innovation, without considering the supply side. It is assumed under the DOI theory from the demand view that the adoption rate is governed by knowledge regarding the innovation, and also by the amount of time taken by the potential adopters in hearing the benefits of adopting the innovation.

It is also argued by [101] that the suppliers of innovation can influence the overall diffusion, as these suppliers are focused on the educational initiatives and also on their marketing techniques. This leads to unequal adoption opportunity of innovation as the marketing is focused on particular business types. The author also argued that if the innovations are complex, then the knowledge and its associated benefits can be widespread; however, the adoption rate is not evident.

4.7 Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT is considered the most popular framework in general technology acceptance field models. As described by [100], it explains user intention for using technologies, and their behaviour in doing so. It was developed to synthesise the acceptance perspectives of the previous individual models. There is a total of eight models that merged the integrated models in the IS field, which emerged from communications, psychology, and sociology, namely: TAM, TAM2, TRA, TPB, Motivational Model (MM), DOI, Model of PC Utilisation (MPCU), and Social Cognitive Theory (SCT). All of these models predict and explains the behaviour of users with the help of independent variables. After reviewing eight models, a unified model was developed by [100] based on the empirical as well as conceptual similarities found in the eight models.

As per the theory, there are four key constructs, namely effort expectancy, performance expectancy, facilitating conditions, and social influence, which are the direct determinants of usage behaviour and intentions. Four key constructs (gender, experience, age, and usage voluntariness) are the factors that impact the constructs (Figure 4.6). In addition to this, the UTAUT model has explained that individual differences also influence the use of technology. It has been explored that the relationship between intention to use, ease of use and perceived usefulness can help in moderating age, gender and experience. For instance, age and gender are commonly found to relate to differences in perceived usefulness and intention to use. There are four predictions under UTAUT regarding the usage or behavioural intention, which are effort expectancy, performance expectancy, facilitating outcomes, and social influence:

- *Performance Expectancy (PE)* is the degree to which an individual believes that usage of the system is helpful in improving job performance.
- *Effort Expectancy (EE)* is defined as the ease associated with the system and its usage.
- *Social Influence (SI)* relates to the role of peers on an individual's perceptions of and decision to use a technology.
- *Facilitating Outcomes (FC)* can be defined as the beliefs of individuals regarding the existence of technical infrastructure and organisational support for the usage of the system.

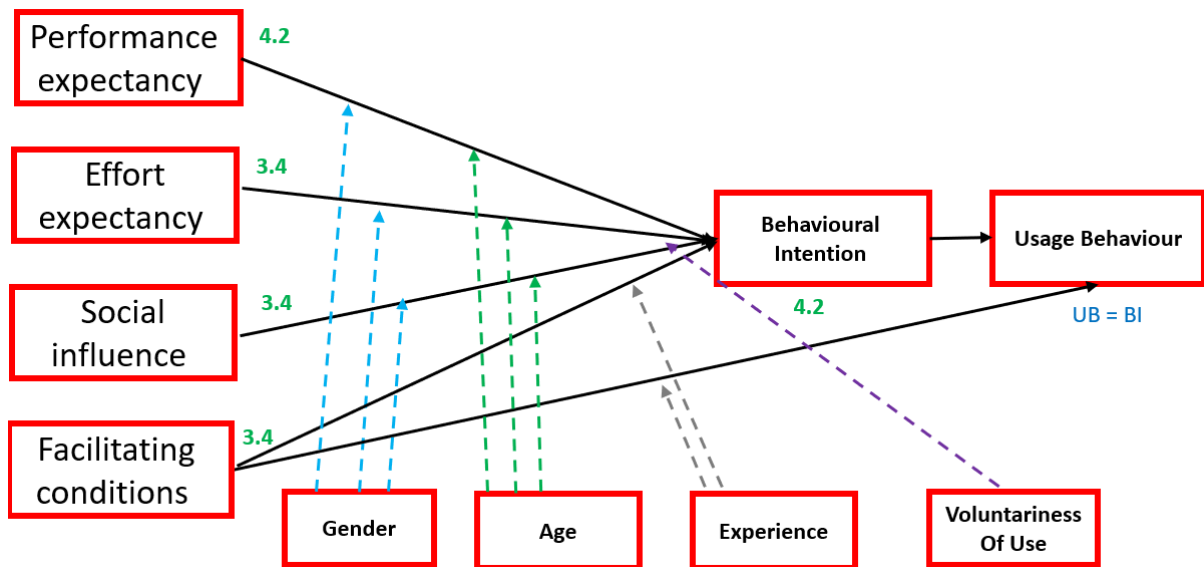


Figure 4.6: UTAUT Model

In the UTAUT model, performance expectancy is derived from the construct's extrinsic motivation, perceived usefulness, job-fit, outcome expectations, and relative advantage. It has been explored that performance expectancy is the strongest predictor of intention [100].

4.7.1. Performance expectancy (PE)

Perceived usefulness, extrinsic motivation, job-fit, relative advantage, and outcome expectations are among the five factors that make up performance expectancy (PE) [100]. Performance expectation is regarded as one of the most powerful predictors of intention among the evaluated models. It significantly impacts both voluntary and compulsory usage [100]. The system's efficacy, the system's improvement of work performance, the system's improvement of productivity, the possibility to develop transferrable skills, and better control of work are all variables contained in Performance expectation[100].

4.7.2. Effort expectancy (EE)

The perceived ease of use and complexity is explained by effort expectation (EE). One of the primary components in TAM is ease of use, which has a significant impact on perceived usefulness and technological acceptance [100]. In both voluntary and forced usage scenarios, effort expectation considerably impacts UTAUT validation. Ease of obtaining data, data clarity, capacity to identify essential data, smoothness of engaging with the system, and the system's general presentation and layout are all variables in EE [100].

4.7.3. Social influence (SI)

The major focus of Social Influence is on a person's impression of other people, groups, or having a cultural image, particularly interpersonal agreement with others and the impact of technology on their self-image [100]. SI also looks at the influence of innovation on a user's social image and whether it improves or degrades it [100]. Previous constructs, such as subjective norms, social circumstances, and pictures, are covered by SI. In the validation test, Venkatesh et al. (2003) discovered that SI was significant in forced but not voluntary usage. Organizational encouragement, pressure for change, management communication and engagement in the change process, prior demonstration experiences, and the availability of an open-door policy to address elements of change are all variables covered in SI [100].

4.7.4. Facilitating conditions (FC)

Perceived behavioural control, facilitating conditions, and compatibility from prior models such as TAM and TRA make up the facilitating conditions (FC). The UTAUT validation demonstrates that facilitating conditions influence forced and voluntary use [100]. The completeness of the manual or training sessions, the ability to imagine applying the system to tasks, the mention of the extensiveness of the search criteria, the offer of logical to use, apply, and recall steps, and the coverage of all essentials to perform tasks and overcome difficulty are all variables included in FC [100]. Effort expectancy presents the perceived ease of complexity and usage. As per [97], ease of use significantly influences the acceptance of technology and the perceptions regarding its usefulness.

Social influence considers people's perceptions regarding others, the subjective culture of the reference group, interpersonal agreement, and perceived value regarding innovation. The value helps enhance the social image or status in the social system. These constructs explore the sensitivity of the auditor regarding the opinions of other people that often result in decision-making, which is consistent concerning the social norms. As per [101], social influence is not significant regarding the voluntary constructs but can become important in mandatory contexts.

The facilitating conditions predictor shows the support of an organisation that involves compatibility with prior models, behavioural control and facilitating conditions. From the validation of the UTAUT model, it has been explored that facilitating conditions are essential in both mandatory and voluntary contexts only in the initial phase, as later the usage intentions disappear. It has been explored that there is 70% accountability regarding the variance in the intention of usage, which is better than other models present who have 40% accountability. Facilitating conditions can be moderated entirely by the effort expectancy predictor in cases

where PE and EE are there, and FC is in the non-significant situation regarding the intentions of prediction. It has been explored that content validity can be limited due to measurement procedures. It is recommended to future researchers that they must be focused while developing validating scales for each of the constructs. This development will help emphasise the content validity or extend the new measures of UTAUT.

Based on the proposed theory of [101], which presents 70% of the accountability for measuring UTAUT, the author of this paper for this case study used the same theory because of its high reliability in measurement.

4.8 Reliability and Validity for UTAUT Survey

The reliability of the survey for UTAUT was tested using Cronbach’s alpha coefficient, with a benchmark of 0.70 indicating reliability. A sample of 506 participants from the HR departments in Saudi public universities was used to test their technology acceptance. Based on their performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention with the system, they answered the provided survey. The overall Cronbach’s alpha for the UTAUT of 0.96 indicates the high validity and acceptance of technology use (based on the questionnaire measurements), as shown in Table 4.2, which depicts the responses regarding the questionnaire elements constructed according to UTAUT. It includes multiple constructs such as performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention. It has been analysed that the mean response value corresponding to each element included in the survey is 4.2 overall, which shows the high need of the system compared with the minimum of 3.4 based on the Likert scale (Table 5.1). The response of participants has been gathered on each construct and analysed, and the mean response rate indicates that respondents positively responded regarding each question statement in the UTAUT questionnaire.

Table 4.1: Reliability and validity statistics

Variable	Cronbach’s alpha	No. of items
UTAUT	0.96	18
UTAUT-PE	0.865	4
UTAUT-EE	0.903	4
UTAUT-FC	0.889	3
UTAUT-SI	0.846	3
UTAUT-BI	0.837	4

Table 4.2: UTAUT model survey

Question	1	2	3	4	5	Mean	Direction
PE1	6(1.2)	15(3)	39(7.7)	220(43.5)	226(44.7)	4.275	5
PE2	1(0.2)	7(1.4)	31(6.1)	237(46.8)	230(45.5)	4.36	5
PE3	4(0.8)	5(1)	26(5.1)	225(44.5)	246(48.6)	4.391	5
PE4	4(0.8)	8(1.6)	49(9.7)	236(46.6)	209(41.3)	4.261	5
EE1	4(0.8)	12(2.4)	62(12.3)	244(48.2)	184(36.4)	4.17	4
EE2	4(0.8)	12(2.4)	66(13)	250(49.4)	174(34.4)	4.142	4
EE3	2(0.4)	7(1.4)	84(16.6)	237(46.8)	176(34.8)	4.142	4
EE4	10(2)	19(3.8)	63(12.5)	250(49.4)	164(32.4)	4.065	4
SI1	13(2.6)	16(3.2)	71(14)	254(50.2)	152(30)	4.02	4
SI2	8(1.6)	23(4.5)	82(16.2)	247(48.8)	146(28.9)	3.988	4
SI3	6(1.2)	19(3.8)	90(17.8)	249(49.2)	142(28.1)	3.992	4
FC1	5(1)	21(4.2)	79(15.6)	253(50)	148(29.2)	4.024	4
FC2	7(1.4)	21(4.2)	62(12.3)	250(49.4)	166(32.8)	4.081	4
FC3	4(0.8)	15(3)	85(16.8)	245(48.4)	157(31)	4.059	4
FC4	0(0)	11(2.2)	48(9.5)	276(54.5)	171(33.8)	4.2	5
BI1	3(0.6)	9(1.8)	39(7.7)	270(53.4)	185(36.6)	4.235	5
BI2	3(0.6)	7(1.4)	46(9.1)	266(52.6)	184(36.4)	4.227	5
BI3	2(0.4)	5(1)	44(8.7)	280(55.3)	175(34.6)	4.227	5

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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4.9 Summary

This study has explored the most important models of technology acceptance, such as TRA, TPB, TAM, TAM2, DOI, and UTAUT. However, from the multitude of models and theories, the researcher selected UTAUT as the best model for this research, with the fewest limitations. Based on the limitations and applicability of each of the models revealed in the literature, this research utilises UTAUT to study and explore the adoption of e-recruitment in Saudi public and private sector organisations.

Chapter 5

Data Analysis

5.1 Introduction

Procedures and techniques for data processing, as well as methods of analysis, are described here. In addition, the findings of this research are reported.

In terms of private and public sector employment service facilitators, there are several practical initiatives that organisations in Saudi Arabia may do to enhance. In this scenario, a variety of research methodologies, such as qualitative and quantitative, are used to perform the study.

Surveys, case study research, experimental research, a systematic evaluation of literature, and interviews are the research methodologies employed in this chapter to perform the research. For structured surveys, quantitative analysis was used. Furthermore, statistical data analysis is performed by descriptively analysing the variable; the study's questions are based on demographics and technology, such as familiarity with AI and if the e-recruitment process is entirely automated or not.

Cronbach's alpha coefficients for items suggested that they were legitimate (e.g., e-recruitment estimated at 0.84, system at 0.868, and so on). The questionnaires in the study contain 506 questions on the SHRDF. The male gender was the most prevalent in the study, with roughly 372 male respondents and 132 female respondents actively participating. Furthermore, the majority of those who took part in the study were employed bachelor's grads. The majority of the participants were full-time employees, with 108 respondents (21.3%) being jobless. Furthermore, the link between research variables was investigated using inferential analysis; ANOVA and independent sample t-tests were used to analyse the differences in demographic factors in the e-recruitment process.

5.2 Research Strategy

The research strategy includes the methods used to conduct the research, which can take different forms and approaches, such as surveys, experimental research, case study research, interviews, or systematic literature review. Structured surveys are generally used to collect data for quantitative analysis. As detailed in the section that follows, sampling involves the use of a relatively large sample to test research hypotheses [103]. In the following paragraphs, issues concerning the research strategy, selection of data sample, time horizon and data analysis explained.

After reviewing the study instruments (Appendix B, Appendix C), the author obtained approval for the research from the ethics committee at Brunel University London (Appendix D). First, before data collection, the researcher sought Permission from the targeted organisation by providing a document that had an overview of the research title, objectives, focus of the examination, and the potential contribution of the study (Appendix C). The second phase was to seek consent from the respondents. An electronic-designed questionnaire contained an opening paragraph that provided each participant with information about the purpose, focus and value of this study.

In terms of communication with the researcher, contact details were given at the end of the questionnaire. Ethical consideration includes the participant's confidentiality in terms of personal information. In the opening section of the questionnaire, all the collected data will only be used for research purposes and will be kept anonymously, thus promising confidentiality. This emphasis on privacy encouraged respondents to participate without showing any bias. The author designed the questions and the terms used in the questionnaire ethically considered to avoid any influenced or biased attitude.

The number of participants, distribution of the survey, and collection and analysis of results are described in this chapter.

5.2.1 Pilot Study

After designing the questionnaire, it was sent to a panel of experts from the HR Department at Jeddah University, who checked the questionnaire design and its seven variables (demographic questions, e-recruitment, system design, system process, quality, UTAUT, and AI). For validation, the panel approved the distribution of the survey.

5.2.2 Sampling Technique and Sample Size

Sampling reduces the number of units that need to be processed and analysed by the researcher to make valid conclusions. There are two standard sampling techniques used in the research, probability sampling and non-probability sampling. Probability sampling constitutes equal opportunity with each population subject to be included in the sample. On the other side, non-probability techniques allow the researchers to select population subjects according to their convenience and purpose [110].

In the current research, a simple random sampling that is a part of probability sampling was used to recruit the specified number of subjects. The use of simple random sampling ensures the unbiased selection of participants in the sample, enhancing the credibility of the research outcomes. The sample population consisted of 506 university participants, including faculty members from Saudi universities, with different levels of education, a diverse group of officials

in the SHRDF, and some owners of the enterprises selected with the simple random sampling [111].

The process of the data analysis completed in three stages: descriptive analysis, inferential analysis, and factor analysis. SPSS version 26 was used to analyse the data collected from the sample respondents.

5.2.3 Analysis of the Participant Questionnaire Responses

This section provides the results obtained from data analysis that received from questioning 506 questionnaires academic staff at the universities in Saudi Arabia and a diverse group of officials in the SHRDF and some owners of the enterprises. Based on the electronic survey. The results were grouped into seven sections, as shown in Table 5.2. The section also has sub-sections representing data that comprises the answers to the proposed research questions, and a summary developed from the analysis. It concludes and highlights the main findings from the research study.

5.3 Statistical Data Analysis

The statistical analysis depends on the study's objectives, to obtain information about the researched subject from the study population. The first statistical task, therefore, is to do a descriptive analysis of variables. This analysis is necessary to present results obtained for each variable, where the association between variables and predictive analysis is analysed. Concerning the objectives outlined in Chapter 1, several statistical approaches used to analyse the questionnaire. Some questions in this study easily answered with a simple single answer, such as demographic questions and questions related to the technology used, e.g. "Are you familiar with the various AI applications? (y/n)" and "Do you think e-recruitment should be fully automated? (y/n)". However, others may require multiple choices, a scale or, perhaps even a grid, such as "Does AI removes human biases?" and "Does AI use in recruitment improve the selection process?".

Quantitative statistical analysis was applied in this study on data of educational measurements. The study used Cronbach's alpha coefficient to test for the reliability of data, and factor analysis and statistical hypothesis tests were used, including one-way ANOVA, to determine whether there are any statistically significant differences between the means of two or more independent groups. According to the ANOVA outcomes, the results show more sub-questions, which suggests using more tests like Duncan's test. In this study, to ensure the internal reliability of the questionnaires, Cronbach's alpha tests were carried out using an Excel software program to check for internal reliability.

The Cronbach's alpha values for the internal consistency of the scale and the items were all above standard agreed measures (0.96; Table 5.1) for good internal consistency (Jones-Smith and Popkin, 2010).

Table 0.1: Cronbach's alpha analysis results

Variable	Cronbach's Alpha	No. of items
E-recruitment	0.84	10
System	0.868	14
Process	0.861	7
UTAUT	0.96	18
UTAUT-PE	0.865	4
UTAUT-EE	0.903	4
UTAUT-FC	0.889	3
UTAUT-SI	0.846	3
UTAUT-BI	0.837	4
Quality	0.889	9
AI	0.889	11

5.4 Descriptive Statistic Tests and Quantitative Analysis

This study used several statistical approaches: normalised and percentiles, graphical method measures of association, graphical trend analysis methods, and several statistical trend detection methods. Several descriptive statistics tests were used in this study, including graphical form, measures of association, and statistical trend detection methods. The quantitative analysis in this study includes several different statistical tests such as graphical method, measures of association and trend detection methods [112].

5.4.1 Cronbach's Alpha

To ensure the questionnaire's internal reliability, Cronbach's alpha tests carried out using the SPSS software program to check for internal reliability. The Cronbach's alpha values for the reliability of the questionnaire indicated a high standard (0.96; Table 5.1).

5.4.2 Factor Analysis

To reduce many variables into fewer numbers' factors, factor analysis was used. This technique extracts maximum common variance from all variables and puts them into a standard score as an index of all variables [113]. The null hypothesis states that knowing the level of variable A does not help you predict variable B (i.e., the variables are independent):

- H₀: Variable A and Variable B are independent.
- H_a: Variable A and Variable B are not separate.

In the interpretation of results, if the P-value is greater than the significance level (0.05), the null hypothesis can be accepted, indicating that there is no relationship between variables.

5.4.3 ANOVA

One-way ANOVA without replication at a confidence level of 95% was used in this study to analyse the significant associations between:

- Age groups and e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.
- Marital status with the e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.
- Educational levels with the e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.
- Occupational status with the e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.
- Gender with the e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.
- Nationality with the e-recruitment, e-recruitment system, process, UTAUT, quality, and AI.

5.4.4 Duncan's Test

The first stage consists of comparing the mean for each trial using one-way ANOVA followed by Duncan Multiple Range Test. The results are shown in tables with different columns, where treatments falling on various columns without overlapping represents significance, and treatments being grouped in the same column means there is no significance. Values of $P > 0.05$ indicate no importance (i.e., no overlapping of the results in the columns), and of $P < 0.05$ indicate significance (i.e., the results overlap in the columns).

5.5 Survey Results Analysis

5.5.1 Part A - Demographic Questions

This section surveys the following: (1) gender, (2) age, (3) education level, (4) occupational status, (5) marital status, and (6) nationality for all 506 university participants, including faculty members from Saudi universities, with different levels of education, a diverse group of officials in the SHRDF, and some owners of enterprises.

5.5.1.1 Gender

The findings shown in Table 5.2 indicate that the majority (n = 374) of the respondents were men, while 26.1% were women (Figure 5.1).

Table 0.2: Gender frequency distribution (male and female)

Gender	Frequency	Percentage
Male	374	73.9
Female	132	26.1

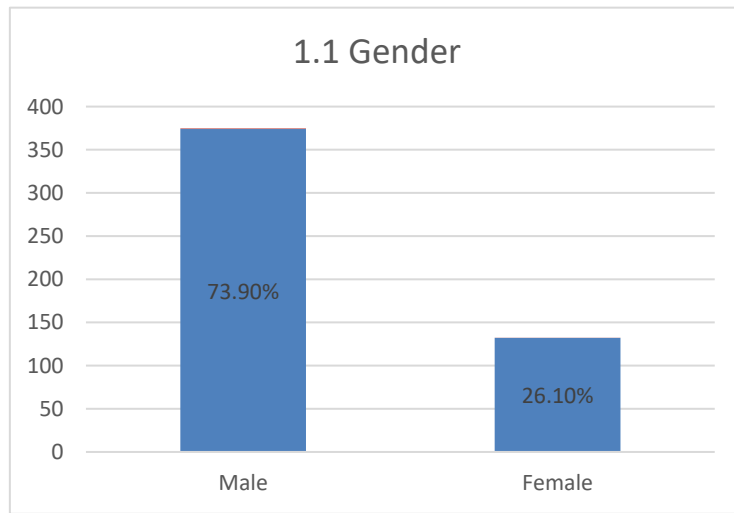


Figure 0.1: Gender distribution

5.5.1.2 Age

The largest cohort (33.2%) of participants were aged 41-60 years (Table 5.3), closely followed by those aged 27-35 (29.2%); then those aged 36-40 (24.1%); smaller numbers aged 23-26 (7.7%) and 18-22 (5.1%); and a negligible proportion aged over 60 (0.6%) (Figure 5.2).

Table 0.3: Age frequency distribution

Age	Frequency	Percentage
18- 22	26	5.1
23-26	39	7.7
27-35	148	29.2
36-40	122	24.1
41-60	168	33.2
Over 60	3	0.6

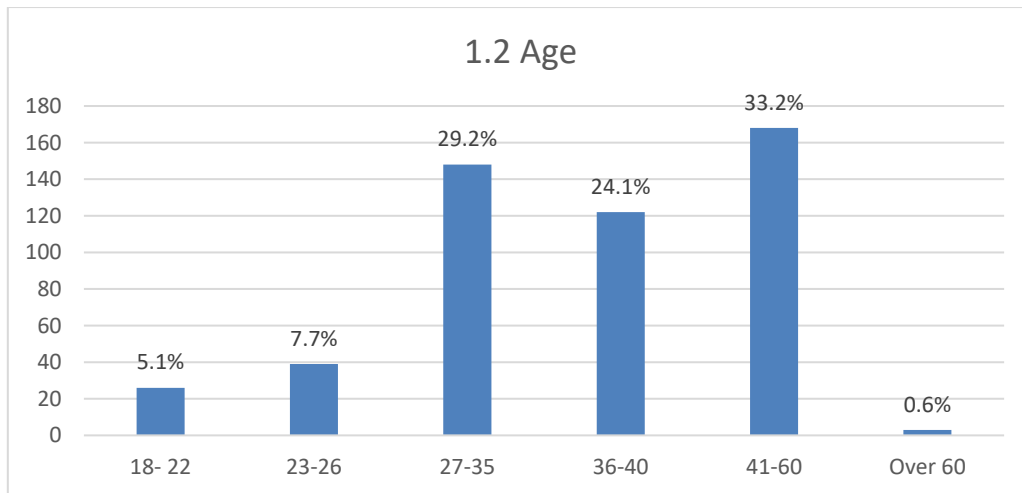


Figure 0.2: Age distribution

5.5.1.3 Education Level

As shown in Table 5.4, the largest group (n = 260, 51.4%) held bachelor's degrees, followed by 16.8% (n = 85) with master's degrees, 13.0% (n = 66) with secondary school education, 10.5% (n = 53) with diplomas, and 8.1% (n = 41) with PhDs (Figure 5.3).

Table 0.4: Education frequency distribution

Educational level	Frequency	Percentage
Secondary school or less	66	13.0
Diploma	53	10.5
Bachelor	260	51.4
Master	85	16.8
PhD	41	8.1

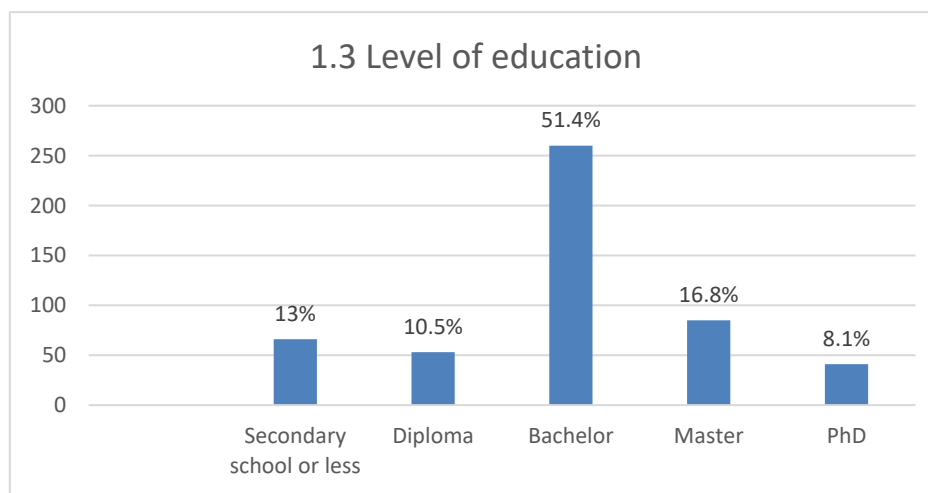


Figure 0.3: Level of education distribution

5.5.1.4 Occupational Status

In terms of occupational status, Table 5.5 shows that 108 of the participants were unemployed and were interested in using the e-recruitment system to find suitable jobs, while 326 were experts in HRM and specialist academics in Saudi universities, who represented the largest percentage of respondents (64.4%). Twenty (4.0%) of respondents categorised themselves as “other” (specifying that they were either company owners or were retired), while the smallest group (1.8%) were in part-time employment (Figure 5.4).

Table 0.5: Occupational status frequency distribution

Occupational status	Frequency	Percentage
Full-time employment	326	64.4
Part-time employment	9	1.8
Full time student	40	7.9
Unemployed	108	21.3
Other	20	4.0

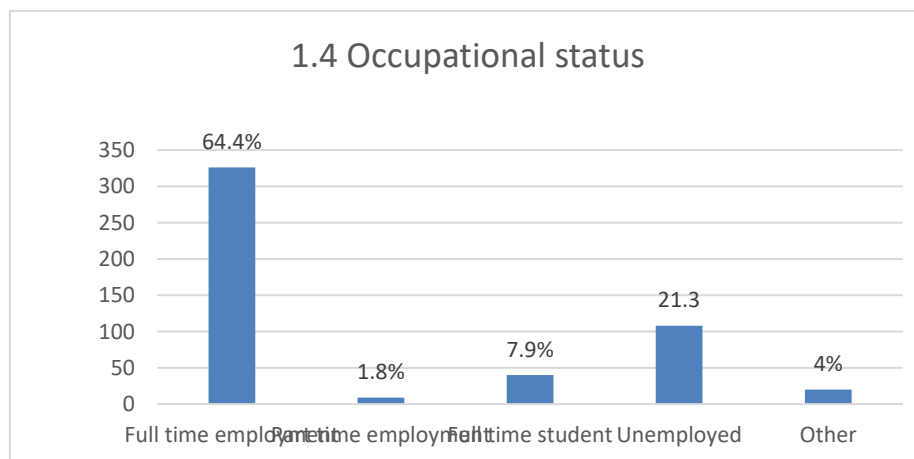


Figure 0.4: Occupational status distribution

5.5.1.5 Marital status

The findings of Table 5.6 indicate that the majority (n = 387) of respondents were married, while 20.4% were single, and 3.0% were divorced (Figure 5.5).

Table 0.6: Marital status frequency distribution

Marital Status	Frequency	Percentages
Single	103	20.4
Married	387	76.5
Divorced	15	3.0

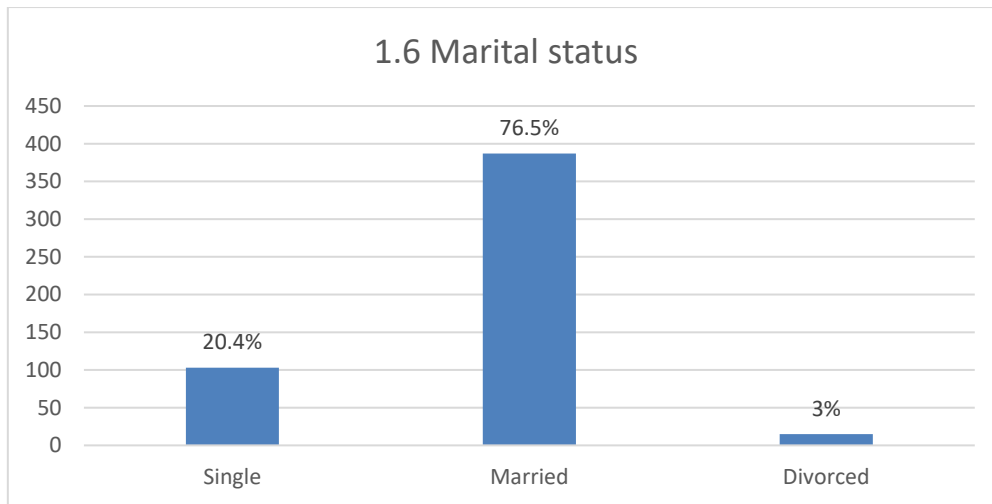


Figure 0.5: Marital status distribution

5.5.1.6 Nationality

As shown in Table 5.7, the vast majority of participants (94.9%) were Saudis, while 5.1% were of different nationalities.

Table 0.7: Nationality frequency distribution

Nationality	Frequency	Percentages
Non-Saudi	26	5.1
Saudi	480	94.9

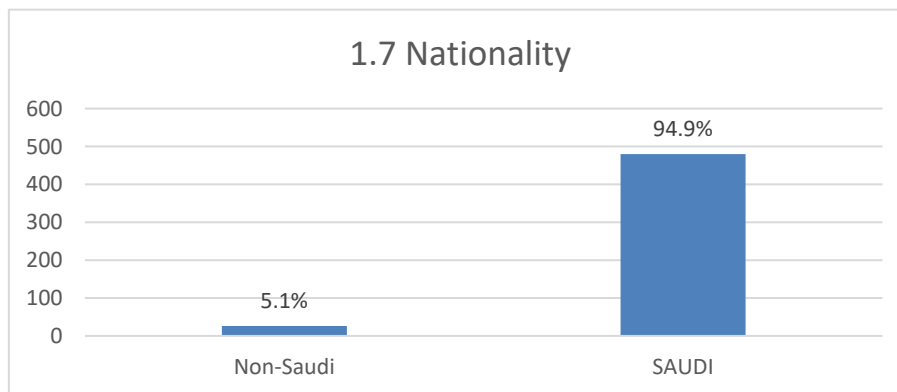


Figure 0.6: Nationality distribution

5.5.1.7 Descriptive analysis

The survey questionnaire used a five-point Likert scale, with responses varying from one to five, where 1 = “strongly disagree”, 2 = “disagree”, 3 = “neutral”, 4 = “disagree”, and 5 = “strongly agree”, as shown in Table 5.8. Likert questions provide adequate support to the researcher in retaining consistency in the research outcomes.

Table 0.8: Likert response outcome scores

Response	Score
1	Strongly disagree
2	Disagree
3	Neutral
4	Agree
5	Strongly agree

Table 5.9 depicts the average values for each of the five Likert scale responses that help decide the direction of question responses. The mean value quantifies participants' degree of agreement or disagreement with the questionnaire statements[114].

Table 0.9: Likert response mean values

Response	Mean value
1	1 to 1.79
2	1.8 to 2.59
3	2.6 to 3.39
4	3.4 to 4.19
5	4.2 to 5

The descriptive analysis utilises several approaches such as frequency, percentile, cross-tabulation, trend analysis, and graphical analysis methods. In the current study, frequencies and percentages corresponding to each of the research variables are presented and interpreted according to the most highlighted responses.

Table 5.10 demonstrates the results of descriptive statistics corresponding to demographic variables such as age, gender, occupational status, nationality, marital status, and last or current level of education (L/CLE). As indicated in Table 5.10, male respondents accounted for 73.9%, whereas female participants only contribute to 26.1%. Regarding the age variable, most respondents were above 41 years old (33.2%), followed by those aged 27-35 years (29.2%). Around three quarters (76.5%) of the respondents are married, and the rest are either single or divorced. A large proportion (94.9%) of respondents in the survey are Saudis, with the remainder being expatriates. Additionally, 64.4% of the respondents are in full-time employment in terms of occupational status, representing the majority of survey participants. Table 5.10 also indicates that around half of the respondents have pursued a bachelor's degree, and only 8.1% have done their PhD.

Table 0.10: Descriptive statistics for demographic variables

Variables	Category	Frequency	Percentage
Gender	Male	374	73.9
	Female	132	26.1
Occupational status	Full-time employment	326	64.4
	Part-time employment	9	1.8
	Full-time student	40	7.9
	Unemployed	108	21.3
	Other	20	4.0
Nationality	Non-Saudi	26	5.1
	Saudi	480	94.9
Last or current level of education (L/CLE)	Secondary school or less	66	13.0
	Diploma	53	10.5
	Bachelor	260	51.4
	Master	85	16.8
	PhD	41	8.1
Marital status	Single	103	20.4
	Married	387	76.5
	Divorced	15	3.0
Age	Under 18	3	0.6
	18- 22	26	5.1
	23-26	39	7.7
	27-35	148	29.2
	36-40	122	24.1
	Over 41	168	33.2

5.5.2 Part B - E-Recruitment

Percentage (%) of the implementation challenges of e-recruitment

Table 5.11 indicates participants' responses to the ten elements of the e-recruitment process. The results show that more than 84% *agree* and *strongly agree* with the statements, and the mean of response value corresponding to each component included in the study is more than 3.4 according to the Likert scale; thus, the direction of decision regarding each element is either *agree* or *strongly agree*. The mean value corresponding EREC1 is the highest among all items, demonstrating a higher agreement level among the participants regarding the statement that e-recruitment helps HR managers reach people located in varied locations. Moreover, the results also show that the e-recruitment process helps employers get to a large group of prospective candidates 24 hours a day and seven days a week.

Table 0.11: Survey responses – E-recruitment

Question	1	2	3	4	5	Mean	Direction
EREC1	6(1.2)	7(1.4)	16(3.2)	223(44.1)	254(50.2)	4.407	5
EREC2	12(2.4)	51(10.1)	87(17.2)	246(48.6)	110(21.7)	3.773	4
EREC3	6(1.2)	12(2.4)	26(5.1)	271(53.6)	191(37.7)	4.243	5
EREC4	4(0.8)	24(4.7)	38(7.5)	247(48.8)	193(38.1)	4.188	4
EREC5	19(3.8)	71(14)	67(13.2)	225(44.5)	124(24.5)	3.719	4
EREC6	6(1.2)	16(3.2)	42(8.3)	248(49)	194(38.3)	4.202	5
EREC7	3(0.6)	30(5.9)	63(12.5)	257(50.8)	153(30.2)	4.042	4
EREC8	3(0.6)	11(2.2)	31(6.1)	238(47)	223(44.1)	4.318	5
EREC9	2(0.4)	28(5.5)	31(6.1)	266(52.6)	179(35.4)	4.17	4
EREC10	4(0.8)	24(4.7)	48(9.5)	266(52.6)	164(32.4)	4.111	4

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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5.5.3 Part C - E-Recruitment System

Percentage (%) of the challenges of implementing e-recruitment system

Table 5.12 illustrates that most survey respondents agree to the e-recruitment system questionnaire items. Over 89% of the respondents *agree* and *strongly agree* with the e-recruitment system having different interface features; they agreed with all elements mentioned in the e-recruitment system with a mean of 3.4 on the Likert scale.

Table 0.12: Survey responses – E-recruitment system

Question	1	2	3	4	5	Mean	Direction
SYS1	2(0.4)	3(0.6)	15(3)	170(33.6)	316(62.5)	4.571	5
SYS2	3(0.6)	14(2.8)	32(6.3)	193(38.1)	264(52.2)	4.385	5
SYS3	0(0)	7(1.4)	16(3.2)	176(34.8)	307(60.7)	4.547	5
SYS4	2(0.4)	5(1)	4(0.8)	165(32.6)	330(65.2)	4.613	5
SYS5	4(0.8)	12(2.4)	29(5.7)	227(44.9)	234(46.2)	4.334	5
SYS6	14(2.8)	45(8.9)	79(15.6)	193(38.1)	175(34.6)	3.929	4
SYS7	20(4)	74(14.6)	70(13.8)	200(39.5)	142(28.1)	3.731	4
SYS8	0(0)	5(1)	25(4.9)	230(45.5)	246(48.6)	4.417	5
SYS9	5(1)	8(1.6)	39(7.7)	251(49.6)	203(40.1)	4.263	5
SYS10	3(0.6)	11(2.2)	21(4.2)	249(49.2)	222(43.9)	4.336	5
SYS11	1(0.2)	7(1.4)	31(6.1)	215(42.5)	252(49.8)	4.403	5
SYS12	5(1)	4(0.8)	16(3.2)	234(46.2)	247(48.8)	4.411	5
SYS13	3(0.6)	9(1.8)	33(6.5)	201(39.7)	260(51.4)	4.395	5
SYS14	1(0.2)	6(1.2)	26(5.1)	223(44.1)	250(49.4)	4.413	5

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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5.5.4 Part D - E-Recruitment Process

Percentage (%) of the implementation challenges of e-recruitment process

According to the results in Table 5.13, most of the respondents *agree* and *strongly agree* with the statements concerning the e-recruitment process questionnaire. It is identified that more than 90% of the respondents think that the e-recruitment system should announce, accept, shortlist the job application, and keep a record of applications for future jobs. Regarding this, maximum scores were obtained regarding process 5, with which more than 90% of the respondents *strongly agree*.

Table 0.13: Survey responses – E-recruitment process

Question	1	2	3	4	5	Mean	Direction
PROSS1	6(1.2)	8(1.6)	24(4.7)	217(42.9)	251(49.6)	4.381	5
PROSS2	6(1.2)	11(2.2)	48(9.5)	245(48.4)	196(38.7)	4.213	5
PROSS3	4(0.8)	13(2.6)	42(8.3)	260(51.4)	187(37)	4.211	5
PROSS4	9(1.8)	28(5.5)	44(8.7)	243(48)	182(36)	4.109	4
PROSS5	2(0.4)	4(0.8)	19(3.8)	219(43.3)	262(51.8)	4.453	5
PROSS6	8(1.6)	17(3.4)	34(6.7)	208(41.1)	239(47.2)	4.291	5
PROSS7	1(0.2)	13(2.6)	32(6.3)	217(42.9)	243(48)	4.36	5

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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5.5.5 Part E – UTAUT

Percentage (%) of the implementation challenges of UTAUT

Table 5.14 depicts the responses regarding the questionnaire elements constructed according to UTAUT. It includes multiple constructs such as performance expectancy, which scored more than 90% *agree* to *strongly agree*, whereas effort expectancy had more than 83% scoring *agree* to and *strongly agree*. For social influence, more than 78% reported *agree* and *strongly agree* for system design. For facilitating conditions, more than 82% *agree* and *strongly agree*. For behavioural intention, more than 90% *agree* and *strongly agree*. The responses of participants were gathered on each construct and analysed based on the reported data in the table. Respondents positively responded to each of the questions mentioned in the UTAUT questionnaire from the mean response rate.

Table 0.14: Survey responses – UTAUT

Question	1	2	3	4	5	Mean	Direction
Performance expectancy1	6(1.2)	15(3)	39(7.7)	220(43.5)	226(44.7)	4.275	5
Performance expectancy2	1(0.2)	7(1.4)	31(6.1)	237(46.8)	230(45.5)	4.36	5
Performance expectancy3	4(0.8)	5(1)	26(5.1)	225(44.5)	246(48.6)	4.391	5
Performance expectancy4	4(0.8)	8(1.6)	49(9.7)	236(46.6)	209(41.3)	4.261	5
Effort Expectancy1	4(0.8)	12(2.4)	62(12.3)	244(48.2)	184(36.4)	4.17	4
Effort Expectancy2	4(0.8)	12(2.4)	66(13)	250(49.4)	174(34.4)	4.142	4
Effort Expectancy3	2(0.4)	7(1.4)	84(16.6)	237(46.8)	176(34.8)	4.142	4
Effort Expectancy4	10(2)	19(3.8)	63(12.5)	250(49.4)	164(32.4)	4.065	4
Social influence1	13(2.6)	16(3.2)	71(14)	254(50.2)	152(30)	4.02	4
Social influence2	8(1.6)	23(4.5)	82(16.2)	247(48.8)	146(28.9)	3.988	4
Social influence3	6(1.2)	19(3.8)	90(17.8)	249(49.2)	142(28.1)	3.992	4
Facilitating conditions1	5(1)	21(4.2)	79(15.6)	253(50)	148(29.2)	4.024	4
Facilitating conditions2	7(1.4)	21(4.2)	62(12.3)	250(49.4)	166(32.8)	4.081	4
Facilitating conditions3	4(0.8)	15(3)	85(16.8)	245(48.4)	157(31)	4.059	4
Facilitating conditions4	0(0)	11(2.2)	48(9.5)	276(54.5)	171(33.8)	4.2	5
Behavioural intention1	3(0.6)	9(1.8)	39(7.7)	270(53.4)	185(36.6)	4.235	5
Behavioural intention2	3(0.6)	7(1.4)	46(9.1)	266(52.6)	184(36.4)	4.227	5
Behavioural intention3	2(0.4)	5(1)	44(8.7)	280(55.3)	175(34.6)	4.227	5

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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5.5.6 Part F – Quality

Percentage of the challenges of implementing quality

Table 5.15 describes the responses of participants regarding the quality aspects of the e-recruitment process. The results show that more than 80% of the respondents *agree* on this category, but only one respondent *strongly agreed*. The maximum average response value attained corresponded to QUAL7, which posits that e-recruitment helps employers attract otherwise inaccessible candidates.

Table 0.15: Survey responses – Quality

Question	1	2	3	4	5	Mean	Direction
QUAL1	8(1.6)	15(3)	61(12.1)	258(51)	164(32.4)	4.097	4
QUAL2	8(1.6)	11(2.2)	59(11.7)	258(51)	170(33.6)	4.128	4
QUAL3	9(1.8)	20(4)	72(14.2)	239(47.2)	166(32.8)	4.053	4
QUAL4	6(1.2)	9(1.8)	58(11.5)	271(53.6)	162(32)	4.134	4
QUAL5	17(3.4)	29(5.7)	69(13.6)	234(46.2)	157(31)	3.958	4
QUAL6	12(2.4)	33(6.5)	83(16.4)	232(45.8)	146(28.9)	3.923	4
QUAL7	10(2)	6(1.2)	40(7.9)	256(50.6)	194(38.3)	4.221	5
QUAL8	16(3.2)	49(9.7)	97(19.2)	207(40.9)	137(27.1)	3.791	4
QUAL9	7(1.4)	11(2.2)	53(10.5)	276(54.5)	159(31.4)	4.125	4

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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5.5.7 Part G- Artificial Intelligence

Percentage of the implementation challenges of AI

Table 5.16 depicts participants' responses regarding the impact of AI on e-recruitment process decision-making. The results show that more than 66% of participants provided a positive response regarding each element mentioned in the AI process. Thus, the outcomes observed indicate that AI helps reduce the average time to fill the job vacancies, improve the selection process, and reduce the recruitment cost. Table 5.17 indicates the awareness of professionals who have used or who are using AI systems, and whether would they recommend its use in the e-recruitment system. The results show more than 60% agree and recommend the use of AI in the e-recruitment system.

Table 0.16: Survey responses – AI

Question	1	2	3	4	5	Mean	Direction
AI1	33(6.5)	69(13.6)	132(26.1)	167(33)	105(20.8)	3.478	4
AI2	18(3.6)	54(10.7)	157(31)	167(33)	110(21.7)	3.587	4
AI3	25(4.9)	74(14.6)	151(29.8)	181(35.8)	75(14.8)	3.409	4
AI4	14(2.8)	20(4)	93(18.4)	215(42.5)	164(32.4)	3.978	4
AI5	11(2.2)	25(4.9)	115(22.7)	216(42.7)	139(27.5)	3.883	4
AI6	11(2.2)	13(2.6)	73(14.4)	248(49)	161(31.8)	4.057	4
AI7	35(6.9)	72(14.2)	110(21.7)	172(34)	117(23.1)	3.522	4
AI8	10(2)	18(3.6)	88(17.4)	237(46.8)	153(30.2)	3.998	4
AI9	17(3.4)	30(5.9)	124(24.5)	221(43.7)	114(22.5)	3.761	4
AI10	9(1.8)	28(5.5)	113(22.3)	223(44.1)	133(26.3)	3.875	4
AI11	11(2.2)	27(5.3)	110(21.7)	212(41.9)	146(28.9)	3.899	4

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
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Table 0.17: Survey responses – AI (yes/no)

Question	No	Yes
	Count (%)	Count (%)
AI Yes/No1	258(51)	248(49)
AI Yes/No2	272(53.8)	234(46.2)
AI Yes/No3	96(19)	410(81)
AI Yes/No4	172(34)	334(66)

5.6 Inferential Analysis

Inferential analysis was utilised to analyse the relationship among various study variables. One-way ANOVA and independent sample t-test used to analyse the difference in different demographic variables regarding the e-recruitment strategy in the current study. This section presents the results of statistical tests to analyse participants' perceptions of e-recruitment in Saudi universities, Saudi companies and public sector employers as well as job seekers.

5.6.1 Perceptions by Age

To test the statistical association between different age groups and constructs of e-recruitment, one-way ANOVA tests were utilised. The results indicate that P-values are greater than the level of significance (0.05) for the 12 cases presented in Table 5.18. Therefore, there

is no statistically significant relationship between age and the various constructs of the e-recruitment process.

Table 0.18: One-way ANOVA – Age

X	Y	One Way ANOVA (Age)	
		F	P-Value
1	MEAN_Erecruitment	1.112	0.353
2	MEAN_System	1.535	0.177
3	MEAN_Process	0.288	0.920
4	MEAN_Performance expectancy	0.823	0.534
5	MEAN_Effort Expectancy	0.634	0.674
6	MEAN_Social influence	1.283	0.270
7	MEAN_Facilitating conditions	1.507	0.186
8	MEAN_Behavioral Intention	1.134	0.341
9	MEAN_Quality	0.860	0.508
10	MEAN_AI Yes/No	0.703	0.621
11	MEAN_Artificial Intelligence	1.788	0.114
12	UTAUT	0.850	0.515

5.6.2 Perceptions by Gender

Table 5.19 displays the results of the independent sample t-test used to analyse the difference in the opinion of male and female respondents towards the e-recruitment process. The statistics presented indicate that P-values corresponding to the variables MEAN_PE, MEAN_EE, MEAN_SI, MEAN_FC, MEAN_BI, MEAN_QUAL, MEAN_AIYN, and Theory are less than 0.05; thus, these variables are considered as significant, and a statistical difference regarding the perception of males and females exists corresponding to these variables.

Table 0.19: Independent sample t-test – Gender

	Male	Female	Independent sample t-test	
	Mean (SD)	Mean (SD)	t	P-Value
MEAN_EREC	4.14(0.56)	4.05(0.52)	1.713	0.087
MEAN_Sys	4.43(0.47)	4.39(0.45)	0.875	0.382
MEAN_PROSS	4.32(0.55)	4.19(0.64)	2.194	0.029
MEAN_PE	4.37(0.61)	4.19(0.67)	2.797	0.005
MEAN_EE	4.19(0.68)	3.95(0.77)	3.406	0.001
MEAN_SI	4.05(0.75)	3.85(0.79)	2.62	0.009
MEAN_FC	4.14(0.64)	3.95(0.69)	2.784	0.006
MEAN_BI	4.28(0.62)	4.09(0.67)	2.943	0.003
MEAN_QUAL	4.11(0.65)	3.92(0.6)	3.14	0.002
MEAN_AIYN	0.62(0.29)	0.58(0.33)	1.174	0.242
MEAN_AI	3.83(0.77)	3.73(0.72)	1.303	0.194
Theory	4.21(0.53)	4.01(0.61)	3.548	0.001

5.7 Factor Analysis

Factor analysis was used to extract maximum common variance from all variables and put them into a standard score as an index of all variables. The Cronbach's alpha values for the internal consistency of the scale and the items were all above standard agreed measures for factor analysis. To analyse the internal consistency for the questionnaire items, Cronbach's alpha coefficient values were retrieved from SPSS. According to [114] the item's internal consistency achieved if Cronbach's alpha is more than 70. Hence, the .07 threshold is considered an acceptable cut off point among the social sciences researchers. Measurements that reflected low reliability were not further investigated, as the items reached the standard of convergent validity. Table 5.20 indicates that all scores are more than 0.70, exhibiting high reliability for all items, which means that the construct satisfies the requirement of convergent validity. The following sections explain different rotated solutions for the analysed factors.

Table 0.20: Factor analysis

Variable	Cronbach's Alpha	N of Items
E-recruitment	0.88	10
System	0.94	12
Process	0.94	7
UTAUT	0.96	18
UTAUT-PE	0.84	4
UTAUT-EE	0.88	4
UTAUT-FC	0.84	4
UTAUT-SI	0.92	3
UTAUT-BI	0.95	3
Quality	0.94	9
AI	0.91	10

5.7.1 E-Recruitment Factor Analysis

Table 5.21 demonstrates factor analysis outcomes computed on the recruitment process. The test results depict that all the ten items listed in the e-recruitment questionnaire grouped into one component, due to the high correlation of these items with one component.

Table 0.21: Factor analysis – Recruitment

Component Matrix	
	Component
	1
EREC1	0.667
EREC2	0.551
EREC3	0.692
EREC4	0.649
EREC5	0.558
EREC6	0.726
EREC7	0.682
EREC8	0.608
EREC9	0.721
EREC10	0.706

5.7.2 E-Recruitment System Factor Analysis

The Table 5.22 indicates that 12 variables listed in the e-recruitment system questionnaire reduced to three components based on the association of these items with the element itself.

Table 0.22: Factor analysis – E-recruitment system

Component Matrix			
	Component		
	1	2	3
SYS1	0.651	-0.411	0.034
SYS2	0.617	-0.231	0.240
SYS3	0.742	-0.288	0.063
SYS4	0.649	-0.474	-0.036
SYS5	0.652	-0.221	0.287
SYS6	0.721	-0.040	0.021
SYS7	0.575	0.168	0.027
SYS8	0.708	0.264	-0.115
SYS9	0.699	0.287	-0.351
SYS10	0.679	0.035	-0.250
SYS11	0.641	0.228	-0.333
SYS12	0.668	0.210	-0.215
SYS11	0.631	0.220	-0.332
SYS12	0.628	0.240	-0.211
Extraction method: principal component analysis			
a. Three components extracted			

5.7.3 E-Recruitment Process Factor Analysis

Table 5.23 represents the result of factor analysis corresponding to the e-recruitment process. The table outcomes show the factor loadings of seven variables under the one factor extracted. As a higher value of the factor loading as more, it contributes to the variable. Based on the table, only one variable was extracted; thus, the seven items grouped into one factor. This table contains the rotated component matrix loadings for the e-recruitment process, which represent both how the variables are weighted for each factor and the correlation between the variables and the factor.

Table 0.23: Factor analysis – Process

Component Matrix	
	Component
	1
PROSS1	0.810
PROSS2	0.775
PROSS3	0.736
PROSS4	0.651
PROSS5	0.792
PROSS6	0.703
PROSS7	0.746
Extraction method: principal component analysis	
a. One component extracted	

5.7.4 UTAUT Factor Analysis

Table 5.24 describes four factors extracted on the 18 items of the UTAUT questionnaire, which depicts 18 items divided into four variables according to the most critical items with a similar response in component 1, and similarly for components 2, 3, and 4.

Table 0.24: Factor analysis – UTAUT

Component Matrix				
	Component			
	1	2	3	4
Performance expectancy1	0.672	-0.480	0.082	-0.044
Performance expectancy2	0.677	-0.490	0.037	-0.151
Performance expectancy3	0.705	-0.377	0.173	-0.199
Performance expectancy4	0.725	-0.315	-0.135	-0.141
Effort Expectancy1	0.734	0.003	-0.411	-0.111
Effort Expectancy2	0.784	0.013	-0.402	-0.121
Effort Expectancy3	0.793	0.103	-0.403	-0.083
Effort Expectancy4	0.733	0.169	-0.416	-0.080
Social influence1	0.699	-0.123	-0.122	0.545
Social influence2	0.689	-0.016	0.063	0.578
Social influence3	0.678	0.063	0.024	0.478
Facilitating conditions1	0.670	0.537	0.072	-0.089
Facilitating conditions2	0.659	0.526	0.135	-0.095
Facilitating conditions3	0.686	0.449	0.156	-0.128
Facilitating conditions4	0.620	0.075	0.365	0.007
BEHAVIORAL INTENTION1	0.756	-0.001	0.408	-0.070
BEHAVIORAL INTENTION2	0.809	-0.041	0.263	-0.117
BEHAVIORAL INTENTION3	0.776	-0.055	0.220	-0.096
Extraction method: principal component analysis				
a. Four components extracted				

5.7.5 Count and Percentage Values

Table 5.25 shows the count and percentage values for demographic characteristics (OS, nationality, last or current level of education, MS, and age). These variables are discussed individually below.

Table 0.25: Count and percentage values for each group

Variables	Categorical	Frequency	Percent
Occupational status (OS)	Full-time employment	326	64.4
	Part-time employment	9	1.8
	Full-time student	40	7.9
	Unemployed	108	21.3
	Other	20	4.0
Nationality	Non-Saudi	26	5.1
	Saudi	480	94.9
Last or current level of education (L/CLE)	Secondary school or less	66	13.0
	Diploma	53	10.5
	Bachelor	260	51.4
	Master	85	16.8
	PhD	41	8.1
Marital status (MS)	Single	103	20.4
	Married	387	76.5
	Divorced	15	3.0
Age	Under 18	3	.6
	18- 22	26	5.1
	23-26	39	7.7
	27-35	148	29.2
	36-40	122	24.1
	Over 41	168	33.2

5.7.5.1 Age

Q1- Is there a difference between (Age Groups) in their mean pairs?

A1- One-way ANOVA was used to determine any statistically significant differences between the means of two or more independent groups.

Table 0.26: Count and percentage values – Age groups

	One Way ANOVA (Age)	
	F	P-Value
MEAN_EREC	1.112	0.353
MeanSys_Without67	1.535	0.177
MEAN_PROSS	0.288	0.920
MEAN_PE	0.823	0.534
MEAN_EE	.634	0.674
MEAN_SI	1.283	0.270
MEAN_FC	1.507	0.186
MEAN_BI	1.134	0.341
MEAN_QUAL	0.860	0.508
MEAN_AIYN	0.703	0.621
MeanAI_Without3	1.788	0.114
Theory	0.850	0.515

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

5.7.5.2 Marital status (MS)

Q2- Is there a difference between (MS Groups) in their mean pairs?

A2- One-way ANOVA was used to determine any statistically significant differences between the means of two or more independent groups.

Table 0.27: Count and percentage values – MS groups

	One Way ANOVA (MS)	
	F	P-Value
MEAN_EREC	2.222	0.110
MeanSys_Without67	0.778	0.460
MEAN_PROSS	2.649	0.072
MEAN_PE	0.983	0.375
MEAN_EE	0.488	0.614
MEAN_SI	0.087	0.917
MEAN_FC	1.476	0.230
MEAN_BI	0.280	0.756
MEAN_QUAL	0.579	0.561
MEAN_AIYN	0.066	0.936
MeanAI_Without3	1.406	0.246
Theory	0.281	0.755

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

5.7.5.3 Latest/ current level of education (L/CLE)

Q3- Is there a difference between (L/CLE Groups) in their mean pairs?

A3- One-way ANOVA was used to determine any statistically significant differences between the means of two or more independent groups.

Table 0.28: Count and percentage values – L/CLE groups

	One Way ANOVA (L/CLE)	
	F	P-Value
MEAN_EREC	2.438	0.046
Mean_Sys	4.710	0.001
MEAN_PROSS	1.060	0.376
MEAN_PE	1.445	0.218
MEAN_EE	2.564	0.038
MEAN_SI	1.916	0.107
MEAN_FC	1.999	0.094
MEAN_BI	1.757	0.136
MEAN_QUAL	1.703	0.148
MEAN_AIYN	1.157	0.329
Mean_AI	2.761	0.027
Theory	2.555	0.038

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

Table 5.29 shows that the people who have [(Diploma) & (PhD)] had higher agreement than the group [(Master) & (Secondary school or less)] according to mean value.

Table 0.29: Duncan^{a,b} test – L/CLE groups with EREC

EREC	L/CLE	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Secondary school or less	66	4.0258	NA
	Master	85	4.0600	NA
	Bachelor	260	4.1077	4.1077
	PhD	41	NA	4.2610
	Diploma	53	NA	4.2679
	Sig.		0.415	0.108

Table 5.30 shows that the people who have [(Diploma) & (PhD) & (Master) & (Bachelor)] had higher agreement than the group [(Secondary school or less)] according to mean value.

Table 0.30: Duncan^{a,b} test – L/CLE groups with SYS

Sys	L/CLE	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Secondary school or less	66	4.2449	NA
	Bachelor	260	NA	4.4167
	Master	85	NA	4.4412
	PhD	41	NA	4.5528
	Diploma	53	NA	4.5645
	Sig.		1.000	0.084

Table 5.31 shows that the people who have [(Diploma) & (PhD)] had higher agreement than the group [(Secondary school or less)] according to mean value.

Table 0.31: Duncan^{a,b} test – L/CLE groups with EE

EE	L/CLE	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Secondary school or less	66	4.0038	NA
	Bachelor	260	4.0913	4.0913
	Master	85	4.1294	4.1294
	Diploma	53	NA	4.3113
	PhD	41	NA	4.3476
	Sig.		0.334	0.054

Table 5.32 shows that the people who have [(Diploma) & (PhD) & (Secondary school or less)] had higher agreement than the group [(Master)] according to mean value

Table 0.32: Duncan^{a,b} test – L/CLE groups with AI

AI	L/CLE	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Master	85	3.5929	NA
	Bachelor	260	3.7992	3.7992
	Secondary school or less	66	NA	3.8833
	PhD	41	NA	3.9390
	Diploma	53	NA	3.9585
	Sig.		.111	.267

Table 5.33 shows that the people who have [(Diploma) & (PhD)] had higher agreement than the group [(Secondary school or less)] according to mean value

Table 0.33: Duncan^{a,b} test – L/CLE groups with UTAUT

Theory	L/CLE	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Secondary school or less	66	4.0303	NA
	Bachelor	260	4.1421	4.1421
	Master	85	4.1510	4.1510
	Diploma	53	NA	4.3040
	PhD	41	NA	4.3062
	Sig.		.238	.120

5.7.5.4 Occupational status (OS)

Q4- Is there a difference between (OS Groups) in their pair of means?

A4- One-way ANOVA was used to determine any statistically significant differences between the means of two or more independent groups.

Table 0.34: Count and percentage values – OS groups

	One Way ANOVA (OS)	
	F	P-Value
MEAN_EREC	1.267	0.282
MeanSys_Without67	1.272	0.280
MEAN_PROSS	1.189	0.315
MEAN_PE	2.299	0.058
MEAN_EE	1.091	0.360
MEAN_SI	2.654	0.032
MEAN_FC	1.606	0.172
MEAN_BI	1.719	0.145
MEAN_QUAL	1.694	0.150
MEAN_AIYN	1.668	0.156
MeanAI_Without3	.455	0.769
Theory	2.185	0.070

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

Table 5.35 shows that the people who have [(Part-time employment)] had higher agreement than the group [(Unemployed)] according to mean value.

Table 0.35: Duncan^{a,b} test – OS groups with UTAUT

Theory	OS	N	Subset for alpha = 0.05	
			1	2
Duncan ^{a,b}	Unemployed	108	3.7994	NA
	Full time student	40	3.9750	3.9750
	Full-time employment	326	4.0532	4.0532
	Other	20	4.1667	4.1667
	Part-time employment	9	NA	4.1852
	Sig.		0.111	0.111

5.7.5.5 Gender

Q5- Is there a difference between (Female & Male) in their pair of means?

A5- Independent t-test was used to determine any statistically significant differences between the two groups.

Table 0.36: Count and percentage values – Gender

	Male	Female	Independent sample t-test	
	Mean (SD)	Mean (SD)	t	P-Value
MEAN_EREC	4.14(0.56)	4.05(0.52)	1.713	0.087
Mean_Sys	4.43(0.47)	4.39(0.45)	0.875	0.382
MEAN_PROSS	4.32(0.55)	4.19(0.64)	2.194	0.029
MEAN_PE	4.37(0.61)	4.19(0.67)	2.797	0.005
MEAN_EE	4.19(0.68)	3.95(0.77)	3.406	0.001
MEAN_SI	4.05(0.75)	3.85(0.79)	2.62	0.009
MEAN_FC	4.14(0.64)	3.95(0.69)	2.784	0.006
MEAN_BI	4.28(0.62)	4.09(0.67)	2.943	0.003
MEAN_QUAL	4.11(0.65)	3.92(0.6)	3.14	0.002
MEAN_AIYN	0.62(0.29)	0.58(0.33)	1.174	0.242
Mean_AI	3.83(0.77)	3.73(0.72)	1.303	0.194
Theory	4.21(0.53)	4.01(0.61)	3.548	0.001

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

5.7.5.6 Nationality

Q6- is there a difference between (Saudi & Non-Saudi) in their pair of means?

A6- Independent t-test was used to determine any statistically significant differences between the two groups.

Table 0.37: Count and percentage values – Nationality

	Non-Saudi	Saudi	Independent sample t-test	
	Mean (SD)	Mean (SD)	t	P-Value
MEAN_EREC	4.16(0.46)	4.11(0.55)	0.423	0.673
MeanSys_Without67	4.39(0.36)	4.43(0.47)	-0.43	0.67
MEAN_PROSS	4.28(0.54)	4.29(0.58)	-0.073	0.942
MEAN_PE	4.35(0.56)	4.32(0.63)	0.205	0.838
MEAN_EE	4.04(0.79)	4.13(0.71)	-0.674	0.501
MEAN_SI	3.79(0.59)	4.01(0.77)	-1.406	0.16
MEAN_FC	4.12(0.56)	4.09(0.66)	0.194	0.846
MEAN_BI	4.14(0.53)	4.23(0.64)	-0.873	0.39
MEAN_QUAL	4.04(0.74)	4.06(0.63)	-0.166	0.868
MEAN_AIYN	4.39(0.36)	4.43(0.47)	-0.43	0.67
MeanAI_Without3	3.67(0.75)	3.81(0.76)	-0.961	0.337
Theory	4.1(0.48)	4.16(0.56)	-0.546	0.586

NOTE: P-value > 0.05 = no statistical difference between groups; P-value < 0.05 = statistical significance.

5.7.6 Quality Factor Analysis

The Table 5.38 is from the factor analysis program shown above. It is included here to show how different the rotated solutions can be for the quality dimension of e-recruitment. It shows the result of factor analysis conducted on the response collected on the e-recruitment quality questionnaire items. The outcomes of factor analysis show that all items are highly correlated with component one, so the above nine items are grouped into one factor.

Table 0.38: Quality factor analysis

Component Matrix	
	Component
	1
QUAL1	0.753
QUAL2	0.805
QUAL3	0.823
QUAL4	0.759
QUAL5	0.727
QUAL6	0.725
QUAL7	0.670
QUAL8	0.626
QUAL9	0.710
Extraction method: principal component analysis	
a. One component extracted	

5.7.7 Artificial Intelligence Factor Analysis

The Table 5.39 is from the factor analysis program shown above. It is included here to show how different the rotated solutions can be for AI. It demonstrates the results of factor analysis corresponding to the AI questionnaire. Two components were extracted, which means that ten items mentioned in the AI quality questionnaire grouped into two segments according to their correlation with each element.

Table 0.39: AI factor analysis

Component Matrix		
	Component	
	1	2
AI1	0.744	-0.309
AI2	0.802	-0.269
AI3	0.697	0.010
A4	0.827	-0.119
AI5	0.766	0.145
AI6	0.654	0.111
AI7	0.800	0.139
AI8	0.642	0.445
AI9	0.867	0.027
AI10	0.844	-0.029
Extraction method: principal component analysis		
a. Two components extracted		

5.8 Summary

It has been summarised that there are many practical steps through which organisations in Saudi Arabia can be improved in terms of private and public sector employment service facilitators. In this case, there are varieties of methods utilised to conduct research, such as qualitative and quantitative. The research methods which are used in the chapter to conduct the research are surveys, case study research, experimental research, a systematic review of literature, and interviews. Quantitative analysis was applied for structured surveys. Moreover, statistical data analysis is also conducted by analysing the variable in a descriptive way; the questions which are utilised in the study are based on demographics and technology, for instance, the familiarity with AI and the process of e-recruitment being fully automated or not.

The Cronbach's alpha coefficients for items indicated validity (e.g., e-recruitment estimated at 0.84, system at 0.868, and so on). In the survey, the questionnaires consist of 506 questions considering the SHRDF. In the survey, the gender which was dominant was male; around 372 respondents were male, and 132 were female who had actively participated in the survey. Moreover, most of the people who participated in the survey were employed bachelor's graduates. Most participants were full-time employed, and 108 respondents (21.3%) were unemployed. Moreover, with the help of inferential analysis, the relationship among study

variables was examined; ANOVA and independent sample t-test utilised to analyse the difference in demographic variables in the e-recruitment process.

Chapter 6

Systems Implementation

6.1 Introduction

Based on the generated results and the framework designed in the previous chapter, and the functionality presented and tested based on an intelligent system (AIRec), this chapter presents the system design and constructor. AIRec plays a vital role in assessing candidates' qualifications, experience, and suitability while applying for specific jobs. It provides an information base regarding the candidates who applied for careers in a private and public sector and stated the categories in which the candidates got selected. The candidates provided particular points on each categorised variable which help in shortlisting the best candidates.

The system needs to examine the job requirements and match the skills to shortlist the best candidate, along with improvising the usefulness. A detailed description of the architectural design and process model of AIRec is presented in this chapter, including a review of existing systems, followed by presentation of informational, functional, and non-functional r. The subsequent section described the architecture of the AIRec system, followed by its database model and development. The use of CodeIgniter is explained, then the interfaces and modules, and chapter summary.

6.2 Existing Systems Review

This section reviews literature on existing e-recruitment systems, their history and development, and their impacts.

6.2.1 Jobberman

Jobberman is a prominent e-recruitment website that brings job seekers and recruiters to the same avenue. The recruiter uploads the specification of the nature and qualification of candidates they are looking for. At the same time, the job seekers also upload their credentials to the platform, and the robust system helps in the findings of the apt jobs related to the certificate posted and jobs available on the site. Jobberman provides a profound and diversified network of distinct people and organisations in Africa, intending to reduce unemployment issues in the country and have created wider job avenues for the people over the years. The company is operating for more than seven years in the country and still setting standards for other recruiting agencies of Nigeria and Africa.



Figure 0.1: User interface for Jobberman [115]

6.2.2 Glassdoor

Glassdoor is a prominent recruitment site that links job seekers with the rights jobs that suit them. The company co-founded by Robert Hohman, who is presently the CEO, and Rich Barton, Company Chairman, in 2007. The concept introduced as an outcome of comprehensive brainstorming. In 2008, Glassdoor founded a website to rate job vacancies. The website collects company reviews and views anonymously, including the salaries of staff members of large corporations, for all the signed members of the site.

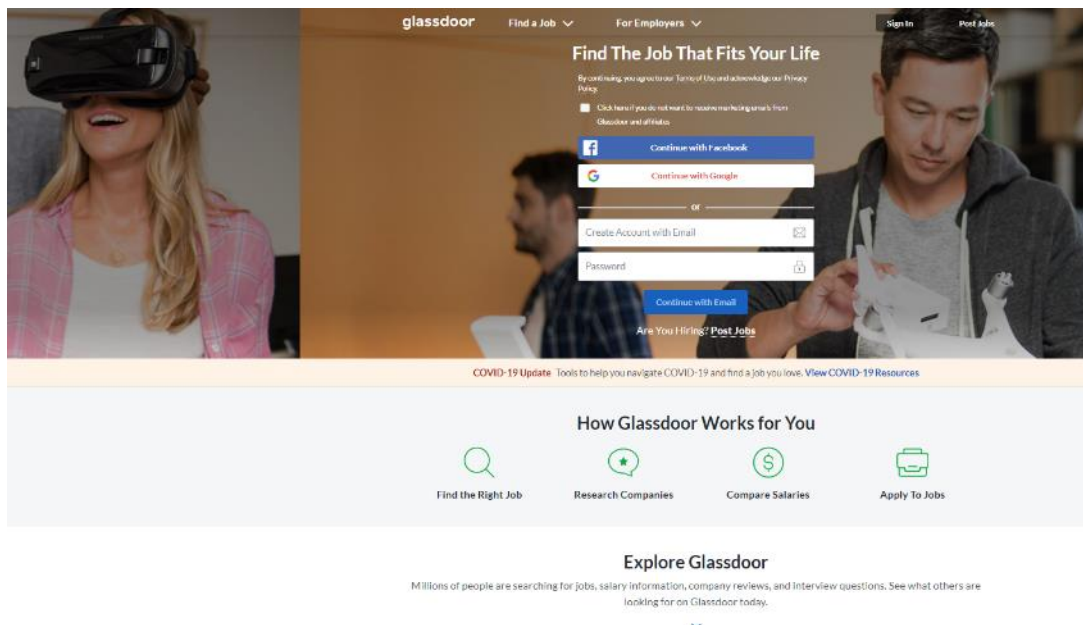


Figure 0.2: User interface for Glassdoor [116]

6.2.3 Job Advisor

This e-recruitment website was launched in March 2012. Job Advisor in an Australian website that provides a review of employers based on the opportunities provided by them to the

employees. The website helps in improving the online branding of the employers and the company. All the submission to the website or grades made against the organisations has remained anonymous to all the organisations. Job Advisor integrates employers, to utilise the feedback gained from the site as a crucial tool of employee satisfaction, leveraging encouragement among potential applicants.

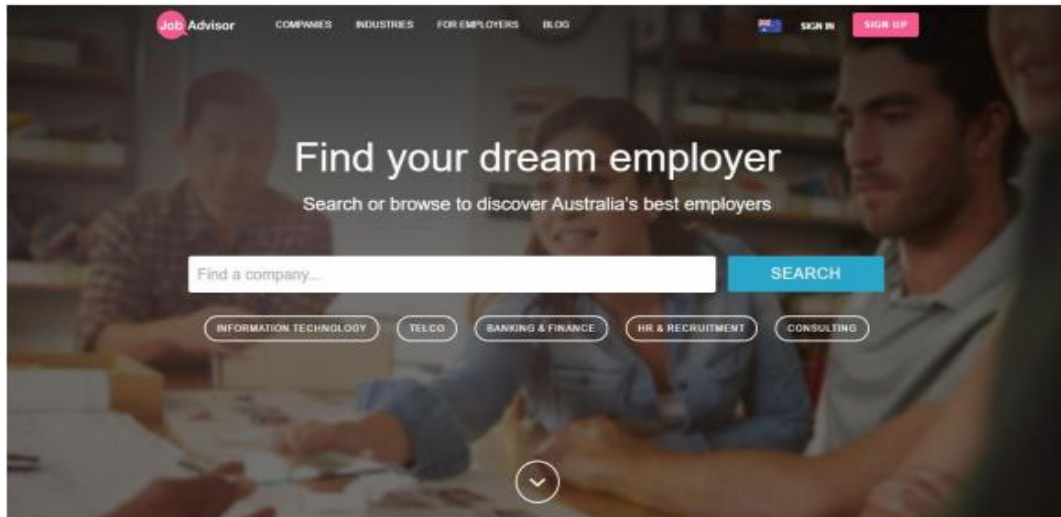


Figure 0.3: User interface for Job Advisor [117]

6.2.4 Indeed

Indeed is a job search engine providing wider job opportunities, accessibility, and benefits. It compiles vacancy postings from other job sites, including Monster, Journalism Jobs, CareerBuilder, and others. Individuals can search jobs by city, state, or zip code. It has additional filters of job type, title, salary, and others, and enables users to save searches for later access. Along with this, to provide a more advanced search, the recruitment site uses keyword progression, which helps in refining the examination more effectively. The mobile software and application of the site provide a handy experience of searching and applying for jobs, and providing an effective option for uploading CVs to find recruiters easily online.

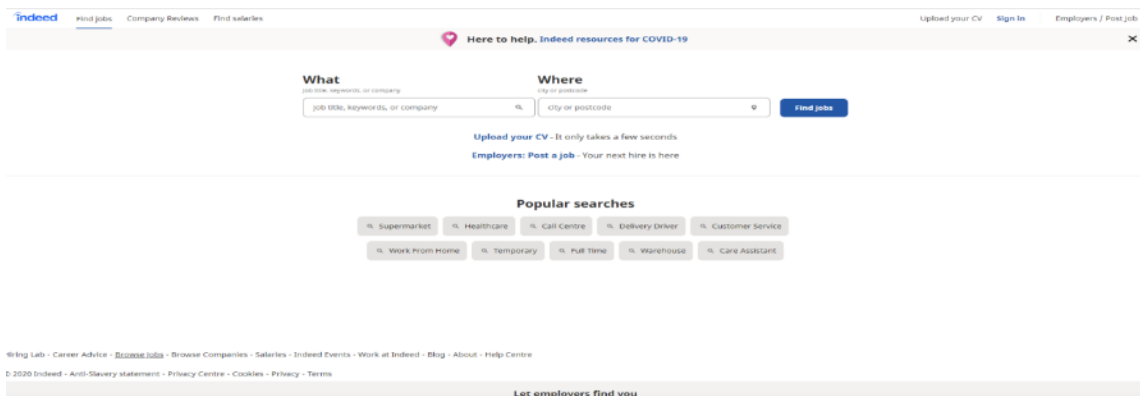


Figure 0.4: User interface for Indeed [118]

6.2.5 LinkUP

LinkUp provides exclusive job listings from the career web pages of companies. LinkUp acts like Google in providing a crucial aspect of indexing company websites, wherein it transports the most up-to-date data and pertinent job information. This aspect helps avoid scams and duplicate job listings, by pulling data from original sources (i.e., employing companies).

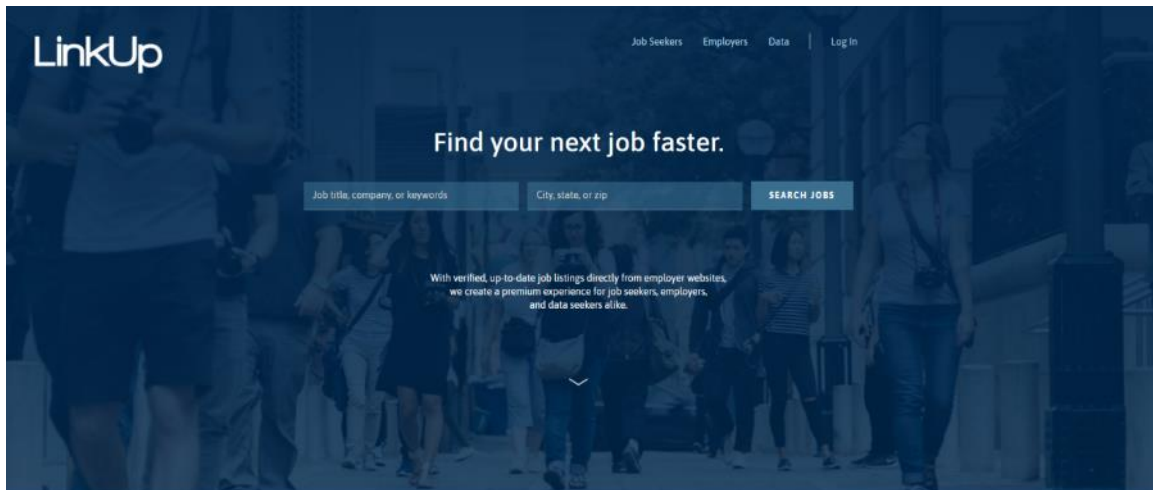


Figure 0.5: User interface for LinkUp [119]

6.2.6 SimplyHired

The e-recruitment site SimplyHired integrates some smooth features that similar job search engines do not have. The site provides a significant pool of jobs by pulling broader job listing around the web, involving social-media avenues. It has an impressive mobile app, and has flawlessly integrated the web version to save and keep track of the previous search, no matter the situation. The mobile software of the site allows one to make a quick application for jobs via the mobile devices and prepopulated fields in the résumé and profile options.

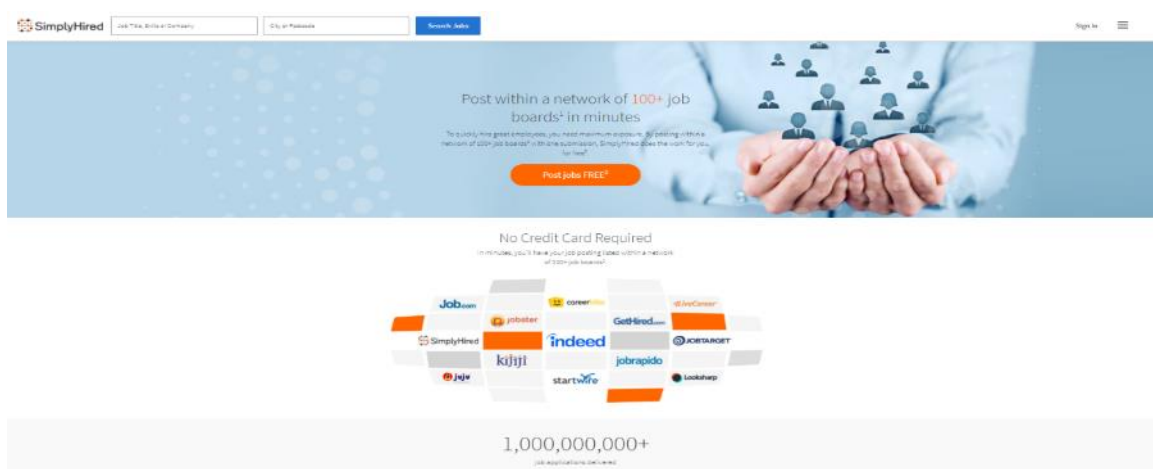


Figure 0.6: User interface for Simplyhired [120]

6.2.7 Snagajob

Snagajob.com is the nation's primary and largest employment network by revealing it as the top choice for recruiters to upload the job openings freely. By utilising Snagajob.com, one can locate the jobs available on an hourly basis in the preferred areas by putting industry, company, and area filters. This e-recruitment site enables the connection of job seekers with the recruiters and offers valuable tips and tools for résumé renovation.

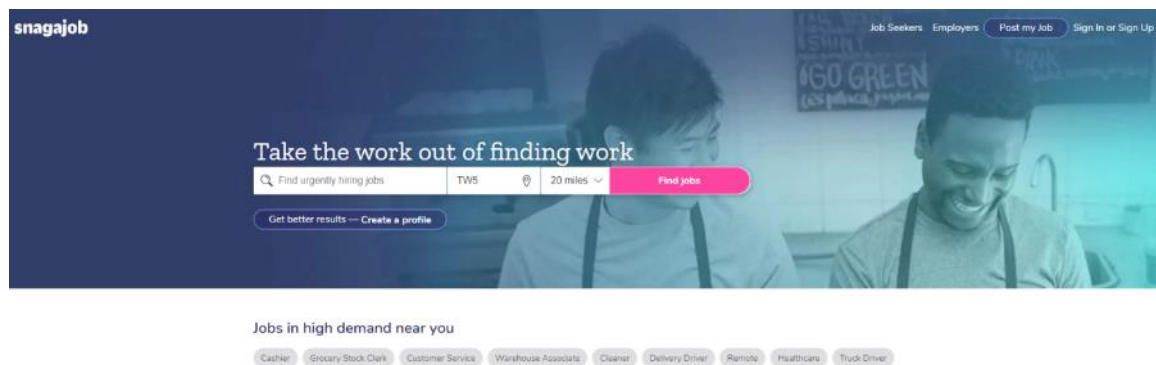


Figure 0.7: User interface for Snagajob [121]

6.3 Presentation of Informational, Functional, and Non-Functional Requirements

6.3.1 Information Requirements

The present research project aims at developing an AIRec system to empower users, including senior management, departmental heads, job seekers, job providers, random users, and distinct other users with a wide array of information to undertake quality decisions.

6.3.2 Requirement Analysis

To illustrate the detailed information of the e-recruitment system's functions and constraints, a well-structured document required for the provided analysis helps display precisely the aspects that need an implementation.

6.3.3 Functional Requirements

AIRec system functional requirements depend on the nature of the software produced, with the regular software users and the general methodology integrated by the organisation on composing needs. At the point where user requirements are communicated to users, the conditions are presented generally in a genuinely theoretical manner, including system requirements to depict the system capacity in the subtle elements, inputs, yields and exceptional cases [122]. The non-functional requirements are generally upheld by functional requirements, which entails imperatives for implementation and design.

Apart from this, the functional requirements under the system can be broken further into user requirements and software requirements. User requirements are explained as the statement available in natural language, backed with service diagrams of the services provided by systems, and the operational constraints mentioned for customers. Inability to fulfil user requirements is acknowledged as failure for the system. System requirements can be explained as a structured document detailing necessary services, functions, and operational constraints of the developed system. For the present research, the functional requirements are as follows:

- The designed system should ensure a comprehensive understanding of the job vacancies to the applicants.
- The system must differentiate precisely the job applicants/seekers with job providers.
- The developed intelligent system should assess candidates' experience, qualifications, and suitability for specific job applications in organisations.
- The system should analyse job requirements and match employee skills, selecting the best candidates for shortlisting.

6.3.4 Non-Functional Requirements

These requirements are not explicitly related to the functions conveyed by the system, including system properties such as reaction time, dependability, and storage capabilities. Non-functional requirements might impose functional limitations on the system, for instance in terms of I/O gadgets abilities, and the information representation used as an element of system interfaces. Non-functional requirements connected with the features of the individual system may indicate or compel the crucial system properties. Eventually, all these requirements determine the security, system execution, and other properties, which depict that the system is regularly more basis than the requirements of individual function. System clients work as the rule explorer approaches that work around a capacity system, which generally does not report the issues. Hence, neglect of non-functional requirements can render the entire system unusable. The non-functional requirements of this study include the following:

- *Speed*: The system should have the power to generate quick results for users for the options selected.
- *Size*: The developed system must not take a lot of memory of user systems.
- *Ease of use*: An explicit user interface should be provided for user comfort.
- *Reliability*: The system must take less time and generate minor percentage errors.
- *Robustness*: The developed system should recover rapidly and efficiently from all system failures.

- *Scalability*: The system should work efficiently, even with growing size.
- *Portability*: The system must function properly across a wide range of devices.

6.3.5 MySQL and SQL Server

MySQL and SQL server are both prominent and widely used back-end stores of data, which have similar characteristics concerning storage systems and data retrieval. They also partially support XML language; however, there are differences between them concerning performance, security, and licensing costs:

- SQL server integrates a fast storage engine, in contrast to MySQL, which incorporates open storage engine.
- Compared to the MySQL server, MySQL integrates fewer foreign keys, which makes fewer relational databases than SQL server. Along with this, MySQL has no stored procedures support, and the MyISAM engine does not support the transaction [123].
- MySQL is cheaper than SQL, but the latter is licensed by purchasing Microsoft Office Developer or Visual Studio Developer versions for development only.
- MySQL has better performance than SQL Server because of its compactness on the disk, low memory usage, and CPU requirements. Along with this, MySQL has fewer features than SQL Server, which brings greater complexity, memory, and disk storage requirements, hence causing poor performance. However, by integrating powerful hardware and an effective trained SQL Server, better understanding can be attained with all added features [123].
- MySQL helps keep SQL Statement log information in binary, which replicates quickly and usefully for heavy database queries. On SQL server, every statement is recorded and presented among the database servers for keeping the data in a synchronised manner. For skilled training experts, the mechanism of data replication becomes very easy [123].
- Regarding security, both database packages have a similar range of default security methods, with regular security patch updates. Both SQL and MySQL allow one to alter the default ports in communication.
- For recovery, MySQL has the advantages of facilities like recovery convenience and failsafe for the database. In case of an interrupted supply of power, the MySQL database may get entirely corrupted without any option of recovery for the data entries. The data process followed in the SQL server ensures that it goes through multiple checkpoints, even in unplanned shut-down situations [123]. Moreover, in the service hierarchy of .NET, the SQL server is evident to come along with the version of Visual

Studio 2010 and ensure significant synchronisation of learner’s course material and profile data across distinct platforms, with good database management.

In this context, the current project requires multiple data tables and entries, having one relationship with diverse others for working and management of profile data of users and job seekers. Consequently, MySQL was selected for this project, which provides varied new and improved features.

6.4 Architecture of Present System

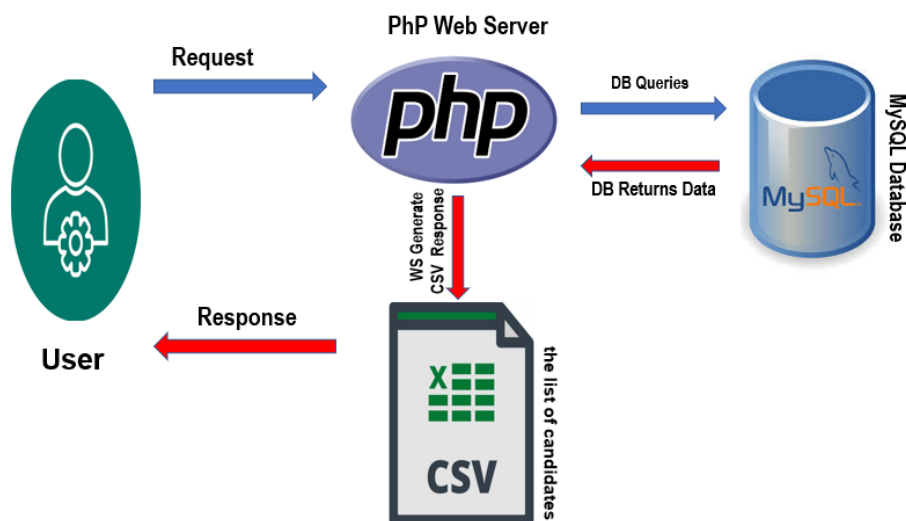


Figure 0.8: AIRec architecture

6.4.1 Database and Database Server

In hosting securely, the AIRec database server hosts play a vital role, providing substantial storage of information regarding AIRec entities. Regarding recruiting news, the server stores Metadata, which is stored deeply in the PhpMyAdmin. A straightforward design of the database is depicted in Figure 6.9.

6.4.2 PHP Web Server:

The AIRec system combines different files developed in ASP.Net, CSS theme, CodeIgniter framework, and JavaScript files. It is the system hosted on the webserver.

6.4.3 File CSV format:

The file CSV format denotes the list of candidates’ names regarding a specific job, arranged in a synchronised manner from best to the poor-performer candidates. A director requested until the best candidate is selected for the job interview.

6.4.4 Users

The requirement to access the AIRec system is crucial for users, whereby the application architecture must enable users to edit, add, delete, and submit request for job vacancies from the available database, helping in ranking CVs for shortlisting.

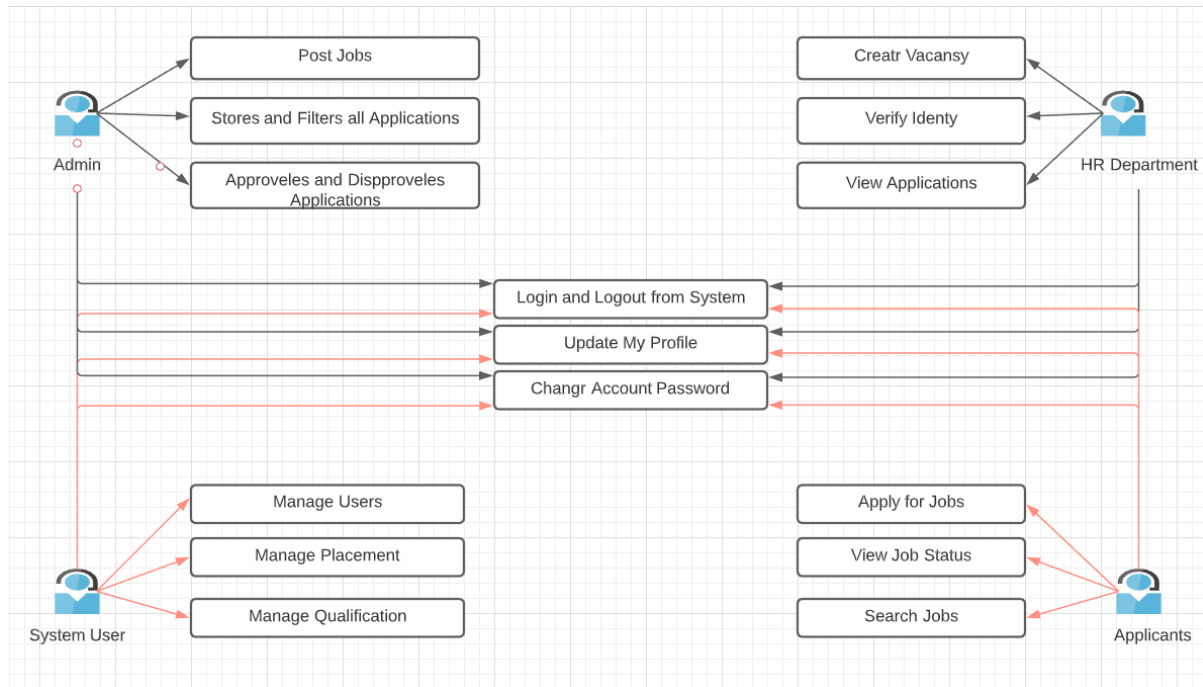


Figure 0.9: AIRec process model

6.4.4.1 Administrator

A system administrator requires to authenticate at this level to ensure access to the AIRec system. In this regard, setting up the initial information, the administrator needs to follow a detailed process to configure the AIRec system, which is detailed below:

1. Post jobs: This process helps create new job vacancies on the website of a company or design an advertisement for attracting job applicants.
2. Stores and filters applications: This involves the process that helps rank topic candidates in order, from best to worst.
3. Approve and disapprove of applications: The system provides authority to make final decisions for approving or rejecting a candidate's application.
4. Logout and login from the system: The system provides adequate access to the system, comprising username and password for logout or login.
5. Update profile: This depicts the process of updating the profile information.
6. Change password of account: A regular or timely change of password is often provided as a crucial security tip to users.

6.4.4.2 *System user*

Another critical requirement to access the AIRec system is the need for the service user to authenticate. To represent software and servers, which makes the API calls for owned or managed assets by a business manager compelling, the following process is mapped out for the process model shown in Figure 6.10.

1. **Manage users:** In this process, the users are allowed to create and delete their profiles. Various access granted to the users, including administrator rights or legal rights to access, delete, edit, and audit files, with a commensurate user log.
2. **Manage placement:** This process allows users over administrative action using an admin system, such as assigning permission, as the process holds most approvals.
3. **Manage qualification:** This process implies aligning a job requirement with the capabilities of the candidate.
4. **Login and logout from the system:** The system provides adequate access to the system by enabling a username and password for login.
5. **Update profile:** This involves the process to update the profile information.
6. **Change account password:** The password provides a security tip to the users for changing their passwords regularly.

6.4.4.3 *HR department*

For accessing the AIRec system, an HR manager needs to be authenticated. In this regard, to ensure the hiring, administration, and training of staff members properly, the following processes are mapped out in the process model illustrated in Figure 6.10.

1. **Create job vacancy:** This involves creating the new listings for employment posts, triggered by employers' active recruitment steps to launch a further range of actions for finding a suitable candidate.
2. **Verifying identity:** This involves implementing the necessary process, which helps in ensuring the identity of a person matches the supposed identity.
3. **View applications:** This focuses on ensuring access for viewing the application made. If the employer decides to interview an individual, accessing the application an enable direct contact with candidates, with further information found in the search results.
4. **Login and logout aspects of the system:** The system ensures adequate access to users by enabling a username and password for login or logout.
5. **Update profile:** This process updates profile information.
6. **Change account password:** The process provides a crucial security tip to users to change regularly the password.

6.4.4.4 Applicants

An applicant must authenticate the access to AIRec system, which is essential to obtain a unique number provided to a job seeker who registers with a provider of employment services. For this, an ID is provided to job seekers registered, followed in the process model depicted in Figure 6.10.

1. Applying for the job: a link to an online form where the applicants have to fill regarding the work history. These forms are generally completed online for the job.
2. Check job status: This process provides access to check the status for the job, depicting that the position is still open and applications are accepted, and enabling checking whether the résumé has been reviewed. It also collects more résumés before deciding to whom to reach out.
3. Search jobs: This involves the process of searching for employment opportunities.
4. Login and logout from the system: Enables access to a user by providing a username and password for login or logout.
5. Update profile: This provides a process for updating the profile information.
6. Change password of account: One security tip provided to users to regularly change password.

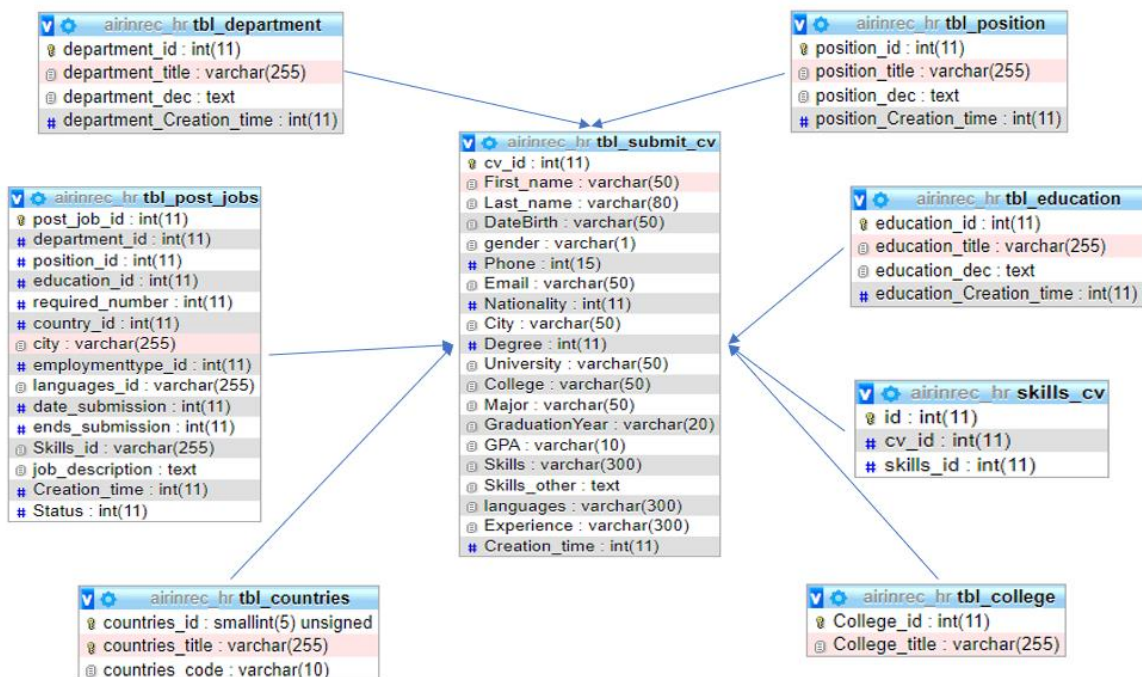


Figure 0.10: AIRec entity relationship diagram

6.5 Database Model

Figure 6.10 depicts the AIRec database Entity-Relationship Model (ERD). The database was normalised and developed in the MS SQL Server, with an exact name and description of the entities made below. The following tables show the information specification for university (Table 6.1), college (Table 6.2), country (Table 6.3), department (Table 6.4), education (Table 6.5), employment type (Table 6.6), job languages (Table 6.7), languages (Table 6.8), skills (CV) (Table 6.9), job skills (Table 6.10), position (Table 6.11), API (Table 6.12), skills (Table 6.13), submit CV (Table 6.14), and post-job (Table 6.15), and user information (Table 6.16). 1

Table 0.1: University information

Attribute	Type	Comments
University_id	Integer	Primary Key
University_name	Varchar (250)	

2

Table 0.2: College information

Attribute	Type	Comments
College_id	Integer	Primary Key
College_name	Varchar (250)	

3

Table 0.3: Country information

Attribute	Type	Comments
Countries_id	Integer	Primary Key
Countries_name	Varchar (250)	
Countries_code	Varchar (10)	

4

Table 0.4: Department information

Attribute	Type	Comments
Department_id	Integer	Primary Key
Department_name	Varchar (250)	
Department_dec	text	

5

Table 0.5: Education information

Attribute	Type	Comments
Education_id	Integer	Primary Key
Education_name	Varchar (250)	
Education_dec	text	

6

Table 0.6: Employment-type information

Attribute	Type	Comments
Employmenttype_id	Integer	Primary Key
Employmenttype_name	Varchar (250)	
Employmenttype_dec	text	

7

Table 0.7: Job languages information

Attribute	Type	Comments
Job_languages_id	Integer	Primary Key
Post_job_id	Int (11)	
languages_id	Int (11)	

Table 0.8: Languages information

Attribute	Type	Comments
languages_id	Integer	Primary Key
languages_name	Varchar (250)	
languages_dec	text	

Table 0.9: Skills_CV information

Attribute	Type	Comments
Skills_CV_id	Integer	Primary Key
CV_id	Int (11)	
Skills_id	Int (11)	

8

Table 0.10: Job_skill information

Attribute	Type	Comments
Job_skill_id	Integer	Primary Key
Job_id	Int (11)	
skill_id	Int (11)	

9

Table 0.11: Position information

Attribute	Type	Comments
Position_id	Integer	Primary Key
Position_name	Varchar (250)	
Position_dec	text	

10

Table 0.12: API information

Attribute	Type	Comments
API_id	Integer	Primary Key
API_username	Varchar (250)	
API_password	Varchar (200)	
API_status	Int (11)	

11

Table 0.13: Skills information

Attribute	Type	Comments
Skill_id	Integer	Primary Key
Skill_name	Varchar (250)	
Skill_dec	text	

Table 0.14: Submit_CV information

Attribute	Type	Comments
Submit_CV_id	Integer	Primary Key
First_name	Varchar (250)	
Last_name	Varchar (200)	
DateBirth	Varchar (200)	
Gender	Varchar (50)	
Phone	Int (15)	
Email	Varchar (50)	
Nationality	Int (15)	
City	Varchar (50)	
Degree	Int (15)	
University	Varchar (50)	
College	Varchar (50)	
Major	Varchar (50)	
GraduationYear	Varchar (50)	
GPA	Varchar (50)	
Skills	Varchar (50)	
Skills_other	text	
languages	varchar (300)	
Experience	varchar (300)	
Creation_time	int (11)	

Table 0.15: Post-job information

Attribute	Type	Comments
Post_job_id	Integer	Primary Key
Department_id	Int (15)	
Position_id	Int (15)	
Education_id	Int (15)	
Required_number	Int (15)	
Country_id	Int (15)	
City	Varchar (255)	
Employmenttype_id	Int (15)	
Languages_id	Varchar (255)	
Date_submission	Int (15)	
Ends_submission	Int (15)	
Skills_id	Varchar (255)	
Job_description	Text	

12

Table 0.16: Users information

Attribute	Type	Comments
Users_id	Integer	Primary Key
user_email	Varchar (50)	
user_name	Varchar (50)	
user_password	Varchar (50)	
user_group	Varchar (50)	

6.6 AIRec Development

AIRec development involves developing a web-based application by providing the ability to access the required information remotely via the Internet. In this regard, Figure 6.8 presents the system architecture of AIRec[124].

6.6.1 Hardware and Software System Requirements

These requirements involve the representation of system capabilities, operational imperatives, and administrative functions, and may deviate from the theoretical explanation of the abnormal state of a system to imperative, pragmatic, functional specifications, based on numbers. The fundamental system prerequisites are hardware and software requirements. Hardware system requirements are linked with a physical computer component, required for effective software operations. Software requirements focus on characterising software requirements and

essentials, which should introduce in the PC to provide a great deal of application working. These requirements are stated in Table 6.17.

Table 0.17: Server hardware and software requirements

Requirements	Parameters
Processor	16 CPU
Primary Memory (RAM)	32 GB of RAM
Storage HD	1 TB Hard Disk Space or higher
Bandwidth	Unlimited
CPU Architecture	x64 (64 Bit)
Database Management System	MySQL 5.7
Programming Languages	PHP, HTML, CSS, JavaScript, JQuery
Operating System	Linux, Apache Server, 7.4 PH
Transfer Technology to the Web	FTB
Firewall	FTP, SHH, MySql, XSS

In the initial stage, the first trust boundary exists between the remote web server and the end-user. The user's identity is verified under the authentication process, and then the user is directed to the application resource, where the logging details and password commonly employed for authenticating users and verifying their identities are applied. The second trust boundary subsists amid the database server and the webserver. Moreover, there is a need for secure authentication to access the database for the web application, hosted on the particular web server platform.

6.6.2 Implementation Tools

- **Hyper-Text Markup Language (HTML)**, a standard markup or code dialect commonly used for developing website pages. HTML is used along with JavaScript and CSS for preparing user interfaces for web browsers and web applications.
- **MySQL**, deemed to be the leading relational database management systems, it is considered the best open source and free RDBMS, especially for web applications.
- **Phpstorm**, extensively adopted for PHP programming. Also known as an integrated development environment (IDE), this cross-platform IDE is designed and developed by JetBrains, a Czech organisation. This IDE serves as an editor for JavaScript and PHP concerning Mac OS X, Linux and Windows.
- **CodeIgniter**, a robust PHP framework that web developers widely adopt to create web applications rapidly and in an effortless manner. Also, it offers the facilities of sending

emails, managing sessions and uploading files concerning databases. It is explained in detail in the following section.

- **Firewall**, which serves as an obstacle or barrier amid an untrusted and trusted network.

6.7 Use of CodeIgniter

CodeIgniter offers numerous libraries for linking with for database and performs different operations such as sending emails and managing sessions. CodeIgniter was developed in the context of the Model-View-Controller (MVC) development pattern, a software approach that distinguishes presentation from application logic. In practice, it allows the user's web pages to use minimal scripting, because the PHP scripting is separated from the display. The following are the instrumental components:

- The Model signifies users' data structures, and typically the Model classes will encompass functions that enable individuals to insert, retrieve and update data in the database.
- MVC View is data or information presented to users; typically, a web page, in the case of CodeIgniter it can be a header or footer (i.e., page fragment). Apart from this, it can be other types of pages, or RDF Site Summary.
- The Controller in the MVC framework is an intermediary amid the View, Model and other resources required for processing HTTP request and generating a web page.

CodeIgniter has a flexible approach to the MVC framework, as there is no need for Models. Suppose individuals designing web applications do not require any separation, and perceive that maintaining models comprise complications; in that case, they can ignore Models and develop the application solely using Views and Controllers. CodeIgniter facilitates integrating its own existing script and creating core libraries, allowing individuals to work simply and efficiently. MVC options are shown in Figure 6.11.

Model View Controller (MVC) Arch Passive Pattern

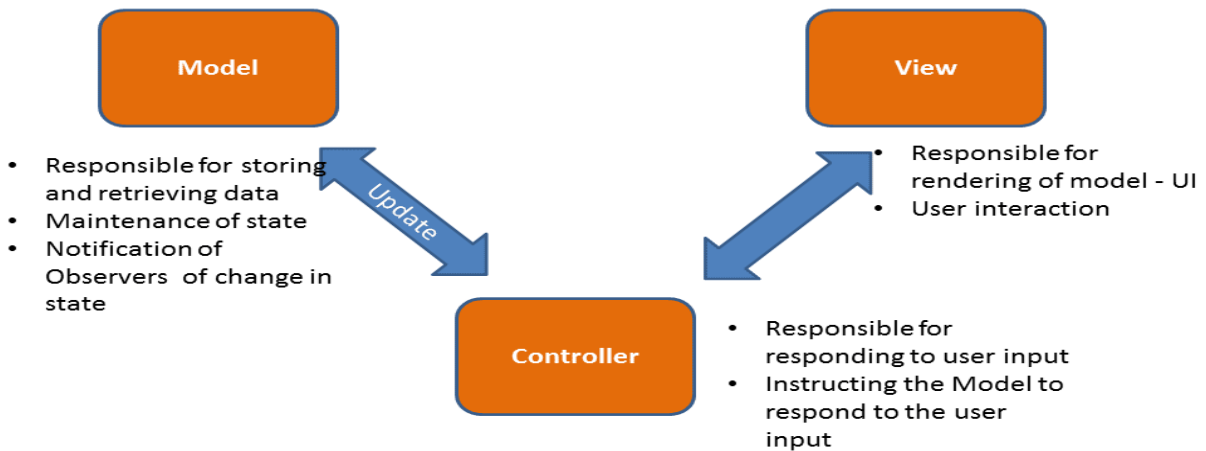


Figure 0.11: MVC options

6.7.1 Advantages of using CodeIgniter Concerning Web Development

- Efficient error handling and easy reporting of bugs.
- Customizability feature. This is one of the core benefits of CodeIgniter, as it allows developers to customize or simplify or design the website and application as per their specific needs.
- High-security feature and a user-friendly interface improve user experience and also minimise the risks of third-party access.
- Hassle-free migration and rapid development of application or website enhance user experience, and allow web developers to add features flexibly.
- It is an MVC-Based System in which the Models part is eliminated. It also has efficient Search Engine Optimisation.
- It has the advantage of community support, which helps handle complex situations in website building. It is a test-driven platform on which websites can be effectively tested and developed.

6.8 Interfaces and Modules

This section illustrates numerous modules, interfaces and sub-modules relating to the web application.

6.8.1 Landing Page

The landing page is the first page shown when the users access the website, and it demonstrated the variety of services provided by the application.

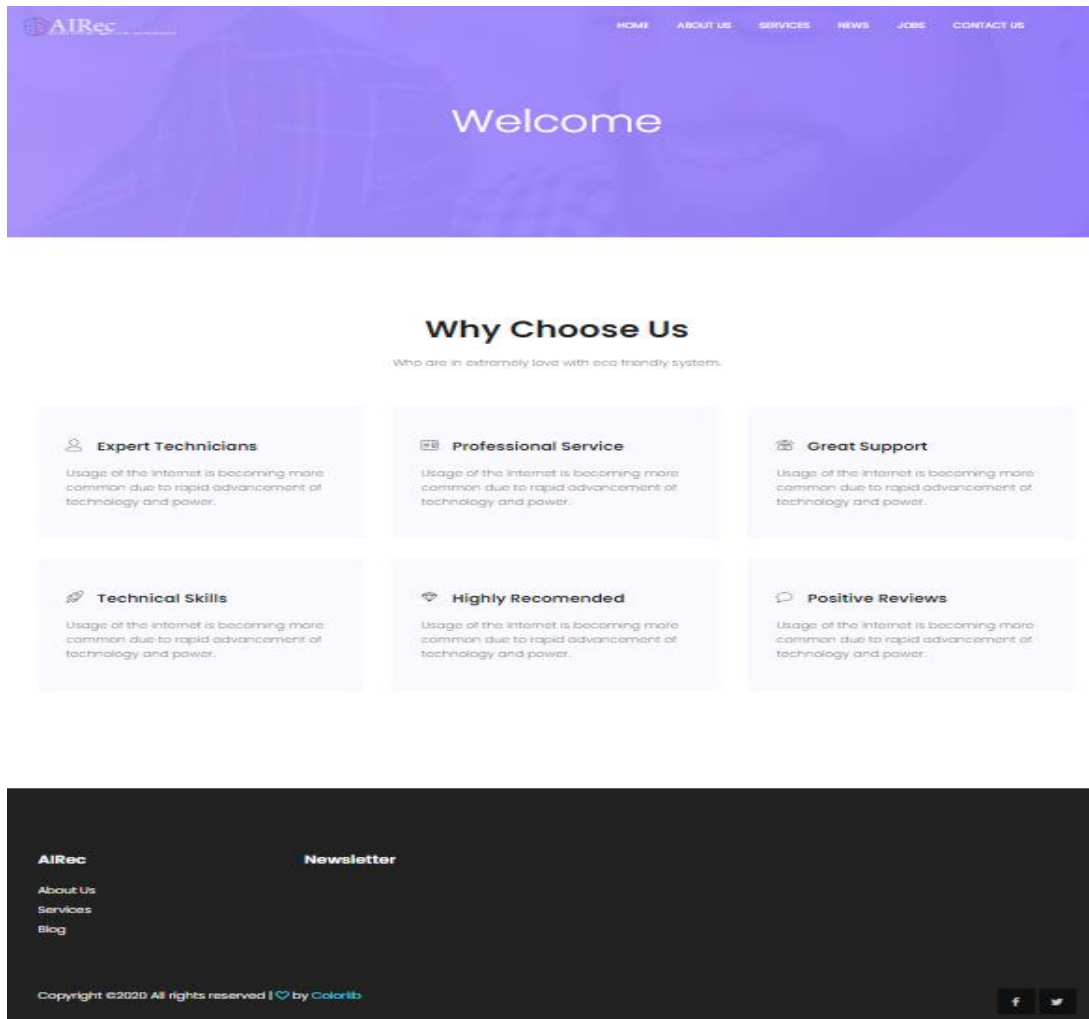


Figure 0.12: Landing page concerning job searching [124]

6.8.2 Login Page

The login page requires users to either make a new account or, in the case of existing accounts, requires them to enter their password and username. A range of functions or activities take place on this page, including:

- Immediate user verification in the case of an existing account on the site.
- Verification of the account type, to know whether it is an organisation or a candidate.
- In the next step, the website redirects the user to the home page regarding the account type and platform.

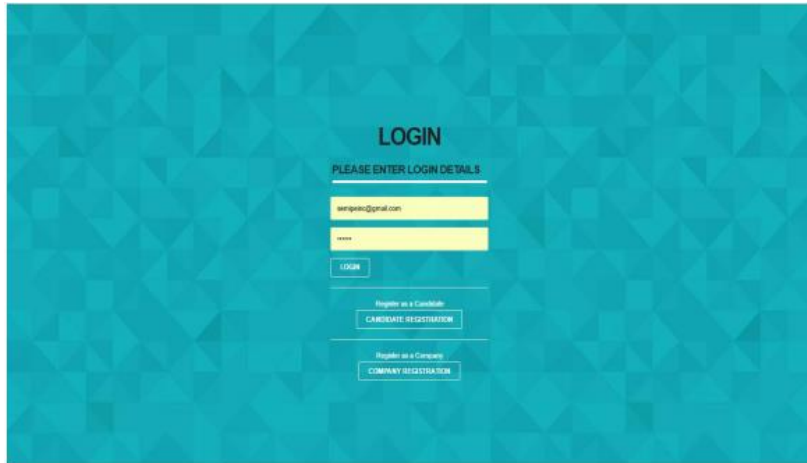
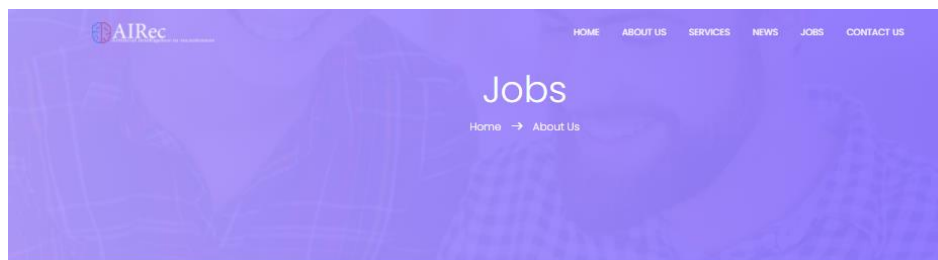


Figure 0.13: Login page [124]

6.8.3 Candidate Homepage

After making an account on the website and successful authentication on the login page, the user is directed to the application’s homepage, which shows relevant and recent jobs to users posted on the page. Also, there is a “contact us” tab on this page.



Featured Positions

Position :Operations manager APPLY

Department IT

Languages : English

Skills : Adobe FrameMaker,API Testing,ASP.NET,C# Suite,C#,Cloud,Data Management,Microsoft Windows administration,System documentation,TCP/IP,WebDrive

Job Nature: Full-time

Job description : The System Administrator is responsible for effective provisioning, installation/configuration, operation, and maintenance of systems hardware and software and related infrastructure, based on Microsoft Windows Server technologies Role & Responsibilities: • Install new/rebuild existing servers and configure hardware, peripherals, services, settings, directories, storage, etc. in accordance with standards and project/operational requirements. • Perform daily backup operations, ensuring all required file systems and system data are successfully backed up to the appropriate media, recovery tapes or disks are created, and media is sent off site as necessary. Create, modify, and delete domain user accounts per request. • Repair and recover from hardware or software failures. Coordinate and communicate with impacted users. • Apply and manage deployment for OS patches and upgrades for servers and desktops on a regular basis, and upgrade administrative tools and utilities. Configure/add new services as necessary. • Perform regular security monitoring to identify any possible intrusions. • Develop and maintain installation and configuration procedures. • Perform ongoing performance tuning, hardware upgrades, and resource optimization as required. Configure CPU, memory, and disk partitions as required. • Assist in developing, implementing, testing and maintaining server level disaster recovery plans. • Provides 24/7 on-call support for the servers and e-mail environment and Participates in weekend maintenance activities, as required. iqama transferable is preferred Driving Licenses is required

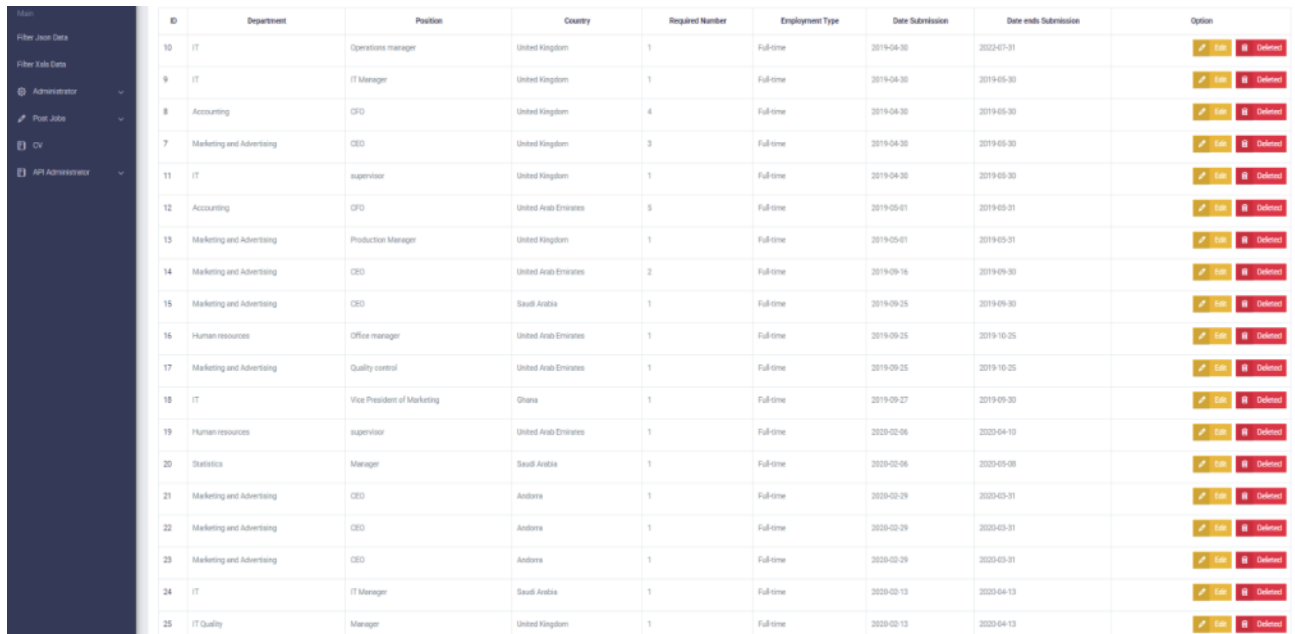
End Submission : 2022-07-31

United Kingdom , London

Figure 0.14: Candidates’ homepage [124]

6.8.4 Posting Job Page

This page contains job profiles viewed by candidates, accessed by organisations registered with the website or platform who possess valid login details to access the forum.

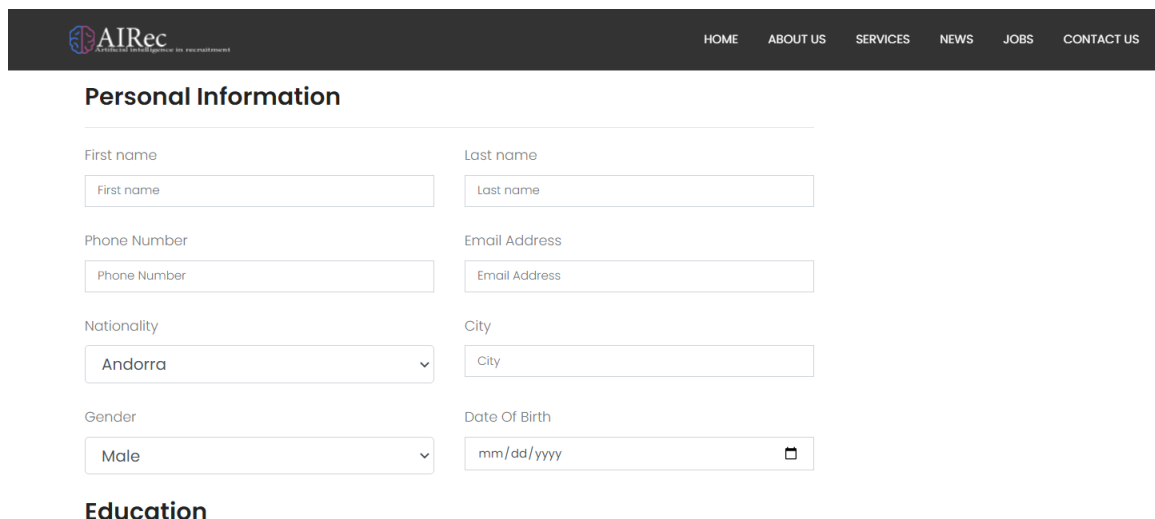


ID	Department	Position	Country	Required Number	Employment Type	Date Submission	Date ends Submission	Option
10	IT	Operations manager	United Kingdom	1	Full-time	2019-04-30	2022-07-31	
9	IT	IT Manager	United Kingdom	1	Full-time	2019-04-30	2019-05-30	
8	Accounting	CFO	United Kingdom	4	Full-time	2019-04-30	2019-05-30	
7	Marketing and Advertising	CEO	United Kingdom	3	Full-time	2019-04-30	2019-05-30	
11	IT	supervisor	United Kingdom	1	Full-time	2019-04-30	2019-05-30	
12	Accounting	CFO	United Arab Emirates	5	Full-time	2019-05-01	2019-05-01	
13	Marketing and Advertising	Production Manager	United Kingdom	1	Full-time	2019-05-01	2019-05-01	
14	Marketing and Advertising	CEO	United Arab Emirates	2	Full-time	2019-09-16	2019-09-30	
15	Marketing and Advertising	CEO	Saudi Arabia	1	Full-time	2019-09-25	2019-09-30	
16	Human resources	Office manager	United Arab Emirates	1	Full-time	2019-09-25	2019-10-25	
17	Marketing and Advertising	Quality control	United Arab Emirates	1	Full-time	2019-09-25	2019-10-25	
18	IT	Vice President of Marketing	Ghana	1	Full-time	2019-09-27	2019-09-30	
19	Human resources	supervisor	United Arab Emirates	1	Full-time	2020-02-06	2020-04-10	
20	Statistics	Manager	Saudi Arabia	1	Full-time	2020-02-06	2020-05-08	
21	Marketing and Advertising	CEO	Andorra	1	Full-time	2020-02-29	2020-03-31	
22	Marketing and Advertising	CEO	Andorra	1	Full-time	2020-02-29	2020-03-31	
23	Marketing and Advertising	CEO	Andorra	1	Full-time	2020-02-29	2020-03-31	
24	IT	IT Manager	Saudi Arabia	1	Full-time	2020-02-13	2020-04-13	
25	IT Quality	Manager	United Kingdom	1	Full-time	2020-02-13	2020-04-13	

Figure 0.15: Job posting page [124]

6.8.5 Registration Pages

Registration pages allow job seekers and companies to register on the platform and join the forum. This page enables users to register via their official email IDs and set their preferred password to visit the website, and insert their login details to access the website.



AIRec Artificial Intelligence in recruitment HOME ABOUT US SERVICES NEWS JOBS CONTACT US

Personal Information

First name Last name

Phone Number Email Address

Nationality City

Gender Date Of Birth

Education

Figure 0.16: Candidate registration page [124]

6.8.6 Other Modules

Other modules regarding a job seeking application or website are the profile page of candidates, upload page, job experience and education page, profile updating page and search result page.

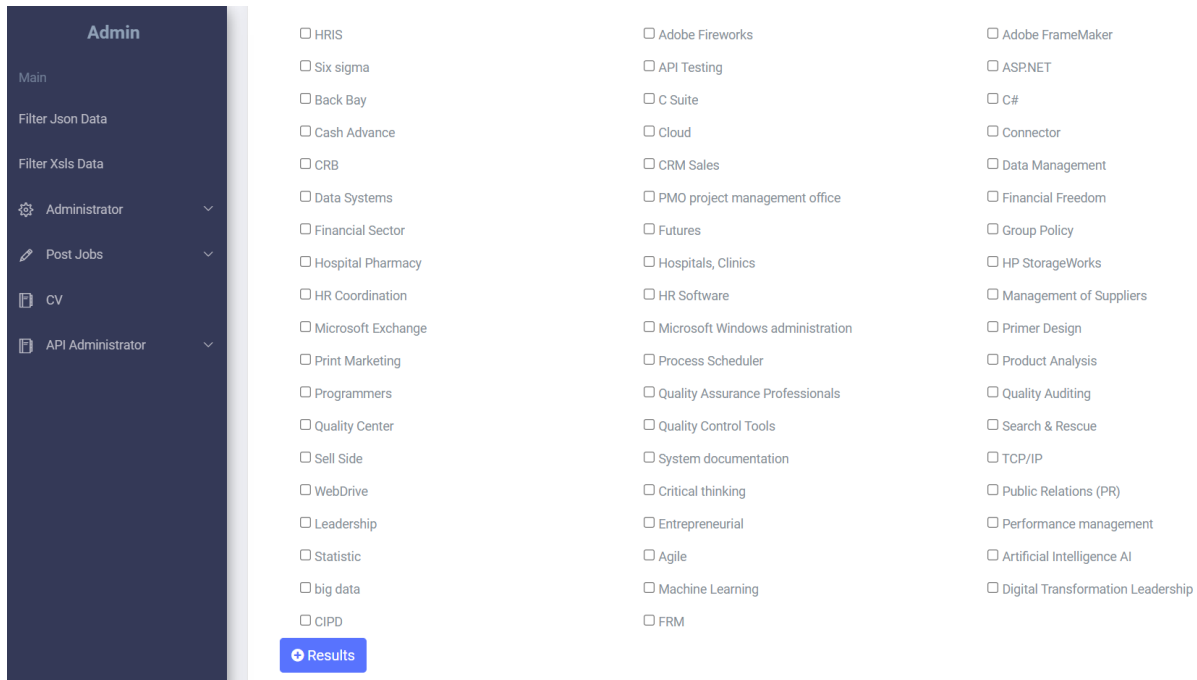


Figure 0.17: Company registration page [124]

6.8.7 Ranking candidates

The system must assess and find the most suitable candidates for the jobs posted on the website, wherein shortlisting is done in the Excel sheet with a focus on seven variables. All variables provided with specific points add to make a total of a hundred points in the ends.

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	cv_id	First_name -	Phone	Email	countries	City	education	College	Gra	GPA	Skills	\$languages	Experience
2	21743	Darin Flicker	700000000	example@gmail.com	United Kingdom	londn	Ph.D.	IT	2010	4	Machine Learning	English,Spain	10 Years
3	21744	Randy Dollard	2147483647	example@email.com	United States	londn	Master	IT	2011	3.9	Machine Learning	English,French	9 Years
4	21745	Peter Kimes	700000000	ex@gmail.com	United States	New York	Master	IT	2012	3.85	Machine Learning	English,Spain	8 Years
5	21746	Nicky Gillman	700000000	example@email.com	United Kingdom	londn	Master	IT	2013	3.75	Machine Learning	English,Spain	7 Years
6	21747	Jonathan Nickols	2147483647	example@gmail.com	United Kingdom	londn	Master	IT	2014	3.7	Machine Learning	English,French	6 Years
7	21748	Harvey Maes	2147483647	example@email.com	United Kingdom	londn	Master	IT	2015	3.65	Machine Learning	English,Spain	5 Years
8	21749	Russell Struck	2147483647	ex@gmail.com	United Kingdom	londn	Bachelor	IT	2016	3.6	Machine Learning	English,Spain	4 Years
9	21750	Frances Deibert	2147483647	example@gmail.com	United Kingdom	londn	Bachelor	IT	2017	3.55	Machine Learning	English,Spain	4 Years
10	21751	Bill Greenwell	2147483647	example@gmail.com	United Kingdom	londn	Bachelor	IT	2018	3.5	Machine Learning	English,Spain	2 Years
11	21752	Lloyd Lisk	2147483647	example@gmail.com	United Kingdom	londn	Bachelor	IT	2019	3.45	Machine Learning	English	1 Year
12	21753	Javier Marasco	2147483647	example@gmail.com	United Kingdom	londn	Bachelor	IT	2020	3.25	Machine Learning	English	None

Figure 0.18: Ranking page [124]

6.8.8 Database page

phpMyAdmin is utilised as a database due to the intuitive web interface features, and compatibility with MySQL attributes, such as tables, views, browse databases, fields, drop

databases, alter databases, rename databases, and creation of indexes and expand. The data sets encompass data relating to candidates' job applications for different job profiles.

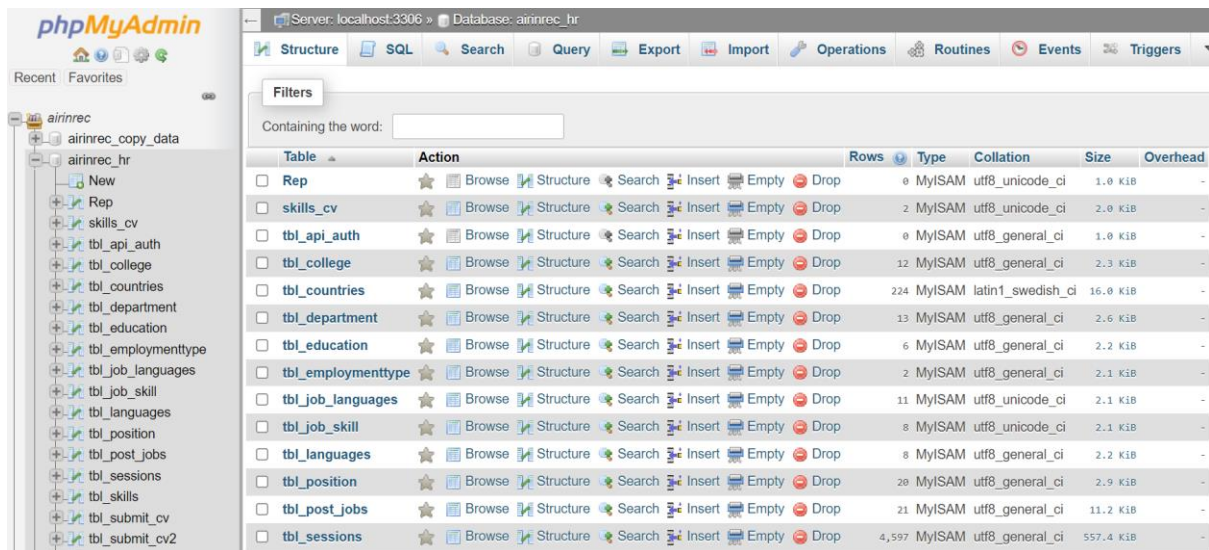


Figure 0.19: Database page [124]

6.9 Summary

The research project entitled “Design and Implementation of e-Recruitment Management System for Academics in Saudi Universities” consists of developing an intelligent system for helping organisations to design and manage their hiring processes. AIRec implementation in the project was carried out with PHP, JavaScript, HTML, and CSS, primarily with a view to visual appeal. MySQL was integrated into the project as a backend program in the database. The project illustrates the growth, history, and societal impact of e-recruitment systems.

Chapter 7

E-Recruitment Modelling-Based AI

7.1 Introduction

Global organisational activities are increasingly digital. For business success, employees must be selected based on different qualities and skills. Therefore, each organisation must employ a very effective strategy to select the best candidates for the published job out of very high skilled candidates. AI is involved everywhere to improve business operational efficiency. AI is based on machine learning algorithms which make it possible for organisations to eliminate squandered labour and other costs in the selection process, to speed up the process of selection and at the same time selecting the best candidates for the published job [125]. Many techniques exist for machine learning include:

- Support Vector Machine (SVM): a machine learning technique for classification and regression analysis that examines data and learns by example to assign labels to objects [126].
- Deep learning: is a machine learning technique that teaches computers to do what comes naturally to humans: learn by example. Deep learning is a key technology behind driverless cars, enabling them to recognize a stop sign, or to distinguish a pedestrian from a lamppost [127].
- Fuzzy Logic (FL): is an approach to variable processing that allows for multiple possible truth values to be processed through the same variable. Fuzzy logic attempts to solve problems with an open, imprecise spectrum of data and heuristics that makes it possible to obtain an array of accurate conclusions [128].

In addition, there are the types of algorithms that been used for ranking the data such as, Linear Regression, Genetic Algorithm Optimisation, Particle Swarm Optimisation and Artificial Neural Networks what will be detailed in section 7.2.

The success of AIRec electronic recruitment platform depends solely on the type of algorithms used to analyse the data of the candidates and the selection of the best candidates for the job. This study provides a detailed algorithm modelling to be used in the AIRec system. Random data were generated in the Excel sheet whereby the highest-ranking candidate is taken as a reference for all the jobs that will be published. This reference refers to the highest amount of points out of 100 points achieved across the seven input variables. The reference is taken to be coded in MATLAB so that three types of algorithms will run to analyse and select the best candidate for the job. However, the specific application for the AIRec which is based

on ranking to the top four types of algorithms been examined and the best theme has been selected. The algorithms of the Neural Network will run random examinations for all candidates with their input variables, to rank the candidates from most to least suitable. The algorithms are examined to select the best candidate based on the minimum Root Mean Square Error (RMSE):

1. Linear Regression
2. Genetic Algorithm Optimisation
3. Particle Swarm Optimisation
4. Artificial Neural Networks

Out of the four algorithm types, the ANN is found to be the best type of algorithm with the lowest RMSE (0.0513 and 0.0457 for the trained and tested data, respectively). ANN was also found to be more successful than the other algorithms in terms of including all candidate data, speed, and accuracy.

7.2 AI TECHNIQUES

7.2.1 Linear Regression (LA)

It is critical to obtain the correlation between the input data and the output in order to examine the effects of each input variable on the output, and to determine whether the input parameter classifications are valid or need to be updated. The impact for each input parameter on the output is described using the following linear equation to examine the impact of overall output, which can also be used to represent a linear relationship:

$$Y = \theta_0 + \theta_1 x$$

where Y is the overall output for the input parameters, θ_0 is the weight for each input, and x is the predictor or the input variable.

Additionally, regression is used for the testing and applications of different types of algorithms, such as GA, PSO, and NN, which are more advanced than Linear Regression (LR), and most of their data are non-linear. In this case study, the model should be able to deal with more complex data regardless of the degree of the polynomial. The polynomial equation for the regression of degree n is represented as follows:

$$Y = \theta_0 + \theta_1 x + \theta_2 x^2 + \theta_3 x^3 + \dots + \theta_n x^n$$

where Y is the overall output for the input parameters, θ_0 is the bias, $\theta_1, \theta_2, \theta_3, \dots$ are the weight for each input, and X is the predictor or input variable.

7.2.2 Genetic Algorithm (GA)

GA is one of the methods used to solve issues related to the selection of different solutions, and it helps to estimate the best solution possible [129]. GA approximates and optimises search issues through the iteration process, to filter out the best solution. The following five steps, depicted in Figure 7.1, are used for the process:

1. Initial population: The process begins with a set of individuals which called population. An individual is classified by a set of parameters knows as genes, which are joined together into a string to form a chromosome.
2. Fitness function: Used to determine how fit an individual is to compete with other individual.
3. Selection: Used to select the fittest individuals and let them be passed to the next generation.
4. Crossover: The most significant GA phase in which each pair of parents is mated by choosing a random crossover from within the genes. The generated child is called the offspring.
5. Mutation: The new offspring genes are subject to changes with low random on probability. The new generated population will be tested against the fitness function. The best individual will be selected and process starts again until the optimal results are achieved.

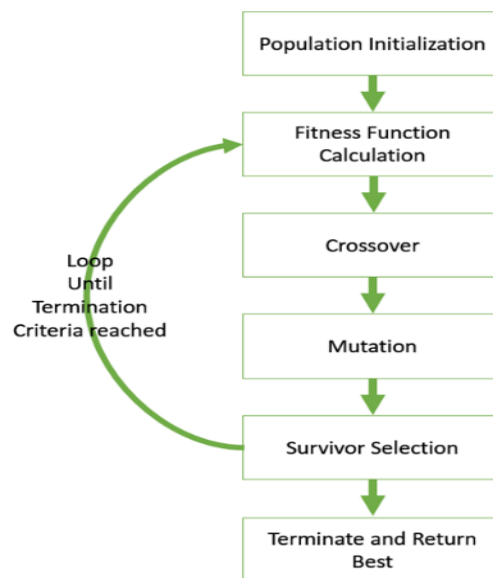


Figure 0.1: Flowchart of GA algorithm

7.2.3 Particle Swarm Optimisation (PSO)

The theory behind PSO goes back to Kennedy and Eberhart, as they were inspired by the social behaviour of birds, such as in finding a safe point to land, based on which they proposed

an algorithm to mimic such behaviour using swarm intelligence, capable of solving complex mathematical issues in engineering. PSO has a high level of mathematical optimisation, as it is very important to have to deal with more complex mathematical issues. PSO has fewer parameters to adjust comparing with other types of algorithms [130]. As shown in Figure 7.2, the PSO flowchart starts by calculating the local (pBest) and global (gBest) fit values for the whole swarm. Each particle velocity and speed will be adjusted according to the gBest and pBest speed and direction. The particles compare themselves to the next neighbour until the whole swarm becomes fully connected and move towards the global solution.

The algorithm keeps track of the following global variables:

- Each particle has a position in the search space.
- Each particle has a velocity and individual best position.
- In addition, the swarm maintains its global best position.

The PSO steps are as follows:

- Calculate the fitness for each particle.
- Update individual and global best.
- Update velocity and position.

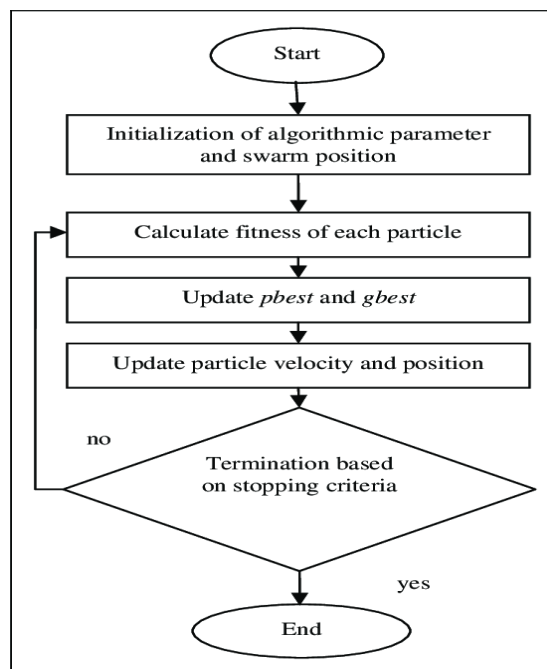


Figure 0.2: Flowchart of PSO algorithm

The code is used to run the PSO algorithm in order to train and test the model to find the minimum MSE value, which eventually result in the selection of the best candidate. As shown in Figure 7.2, the algorithm keeps track of three global variables.

7.2.4 Artificial Neural Network (ANN)

Since the features cannot be related directly to the output and the linear regression cannot be obtained, more features can be added manually, however in this case, an ANN is needed to create its features directly, and combine what is needed to create features in the hidden layers, to let the model find the non-linear way to interpolate and map the input to the output.

Using the special function (FITNET) in MATLAB to train an ANN, this function can take different inputs at the same time, but in this case, only the number of neurons in the hidden layer. First, a Simple Neural Network (SNN) is trained, with seven input variables inserted into the FITNET function to produce only one output, while the function is in the process is having some neurons or new features in the hidden layers which the model is creating, to combine all the features in certain ways and predict the output of the model.

Differences Between Statistical and AI Modelling

In statistical modelling, the data used as a guidance to select a stochastic model, which serves as the abstraction for making probabilistic statements about questions of interest, such as hypotheses, predictions, and forecasts.

In classical machine learning, the data drive the selection of the analytic technique to best perform the task at hand. The data trains the algorithms. In modern machine learning, the data drive systems are based on neural nets that self-determine the regularities in the data to learn a task. The process of training the neural network on the data learns the task. As someone put it, "The data does the programming."

Table 0.1 The Differences Between Statistical and AI Modelling

Statistics	Machine Learning
Finds Population Inference from the sample	Finds generalizable predictive pattern in large & wide datasets
$N > P$. The data is often smaller.	Suitable for large & small dataset
Assumptions about data generating process	No such assumptions
Data gathered from careful control designed	No such emphasis
Designed for few dozen variables	ML is very different when data is of high dimension
Probabilistic model, P-Score, Confidence interval	Emphasis is on prediction accuracy through cross validation

7.3 Model Development

7.3.1 Data Generation

The data sets contain information about candidates who applied for different jobs, and the categories in which these candidates were selected were based on seven different categories. All categories are given certain points so that all points will add up to a hundred as follows:

- Skills
- Major
- University
- Languages
- Experience
- Qualifications
- Grade Point Average (GPA)

The main aim is to create a model to evaluate and predict the best candidates for the job, so that the best and optimal decision will be taken in matching jobs for which candidates apply. Different algorithm models are created and the data is simulated in MATLAB, and the model is trained to predict the outcome of each candidate as specified in the total scores column as described below.

7.3.2 Importing data into MATLAB

Data was imported from the Excel sheet named with a (job.xlsx) with seven variables in seven columns, as mentioned above, with an additional column for the candidate's total score. The input data was assigned as variable X, which includes the first seven columns where the seven specifications were selected to optimise the total scores for the candidates. The output data was assigned to the variable Y, which takes all the columns outcome into the eighth column, and the number of observations was assigned to the letter M.

7.3.3 Initial Data Visualization for Output

Initial visualization of the output predicted data showing and confirming the entries of the categories where the prediction is from zero to 100.

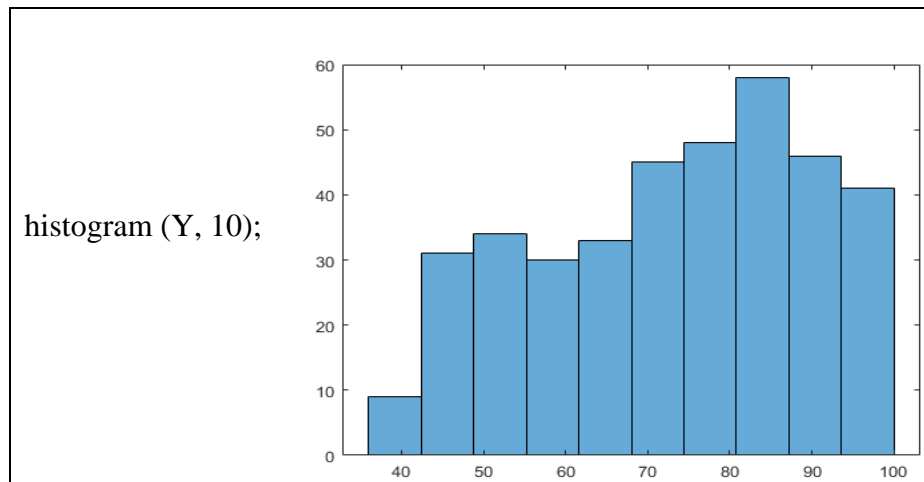


Figure 0.3: Initial output data visualization

7.3.4 Updated Output

Normalising the features and transforming the output value is undertaken to avoid having an output variable that is so centred around zero, and to have fewer output variables around the higher parameters. Therefore, a new output variable is created by taking the log of one plus the output value, since the output could be zero. The log of zero is avoided by adding 1 to the output.

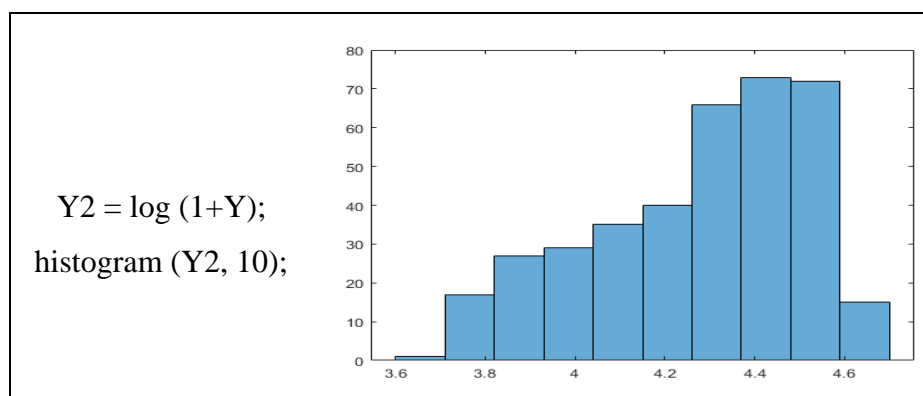
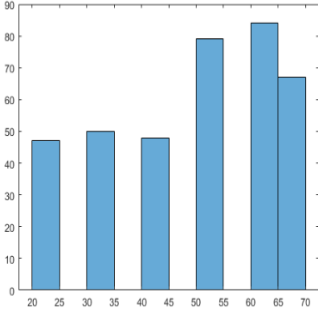
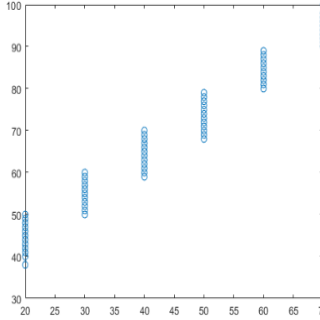
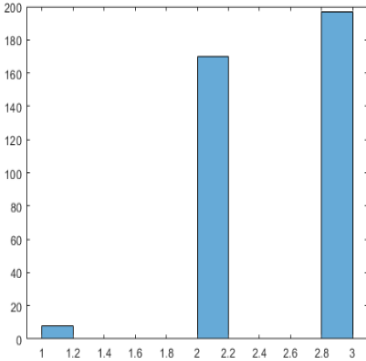
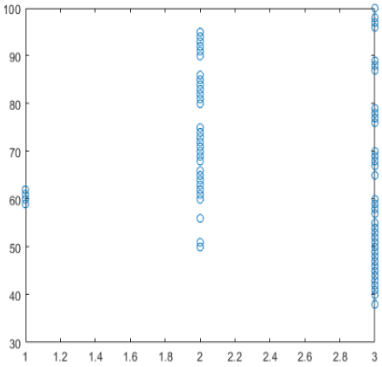


Figure 0.4: Updated output

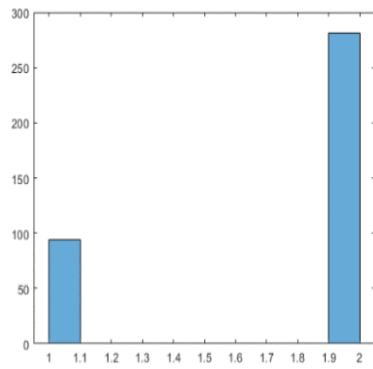
7.3.5 Relationship Between Input Data and Output

It is significant to get the relationship between the input data and the output to see the impact of each input variable on the output, and to see whether the categories of the input variables are valid or yet to change. The overall relationship between all the variables from the input and the output is difficult to be determined at this stage because of the change of all of the input variables and the high variation of their feature at the same time compared to the output. Since all of the input variables are changing at the same time, a machine learning model is created to be trained. Because of this, since the input variables are multiple, the relationship between each input variable and the output is examined and evaluated separately, as shown

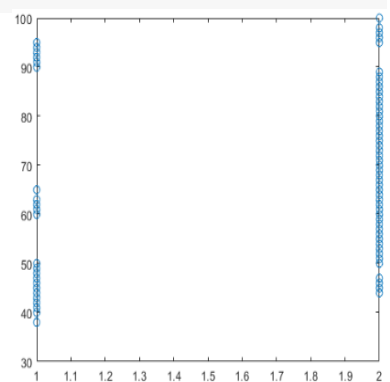
in the following figures. It can be seen that the relationship between the input variables and the output is very difficult to define, and the impact is hard to identify. To overcome this issue, a transformation for the output from (Y) to (Y2) is applied to normalise all the input variables and their features, to make sure all the input variables have the same weight, and to accelerate the training of the model.

INPUT DATA	RELATIONSHIP TO THE OUTPUT
<p>Qualifications:</p> <p>histogram(X(:,1), 10);</p> 	<p>histogram(X(:,7), 10);</p> <p>plot (X(:,1),Y,'o')</p> 
<p>University:</p> <p>histogram(X(:,2), 10);</p> 	<p>histogram(X(:,7), 10);</p> <p>plot (X(:,2),Y,'o')</p> 
<p>Major:</p>	<p>histogram(X(:,7), 10);</p>

histogram(X(:,3), 10);

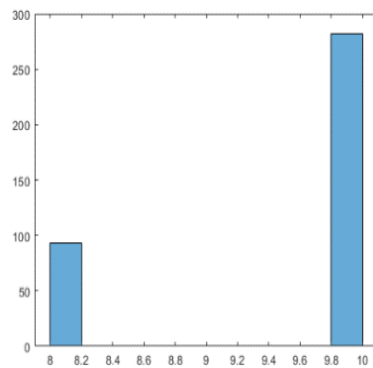


plot(X(:,3),Y,'o')



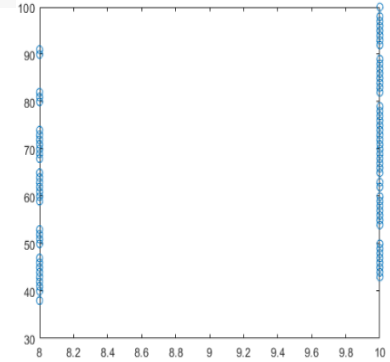
GPA:

histogram(X(:,4), 10);



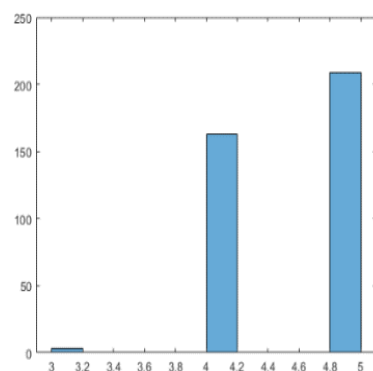
histogram(X(:,7), 10);

plot(X(:,4),Y,'o')



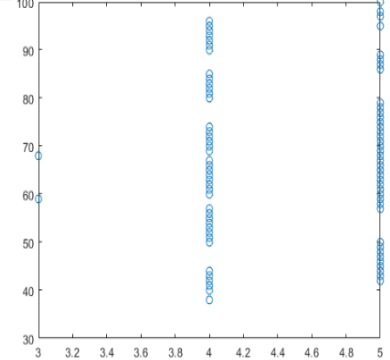
Skills:

histogram(X(:,5), 10);



histogram(X(:,7), 10);

plot(X(:,5),Y,'o')



Languages:

histogram(X(:,7), 10);

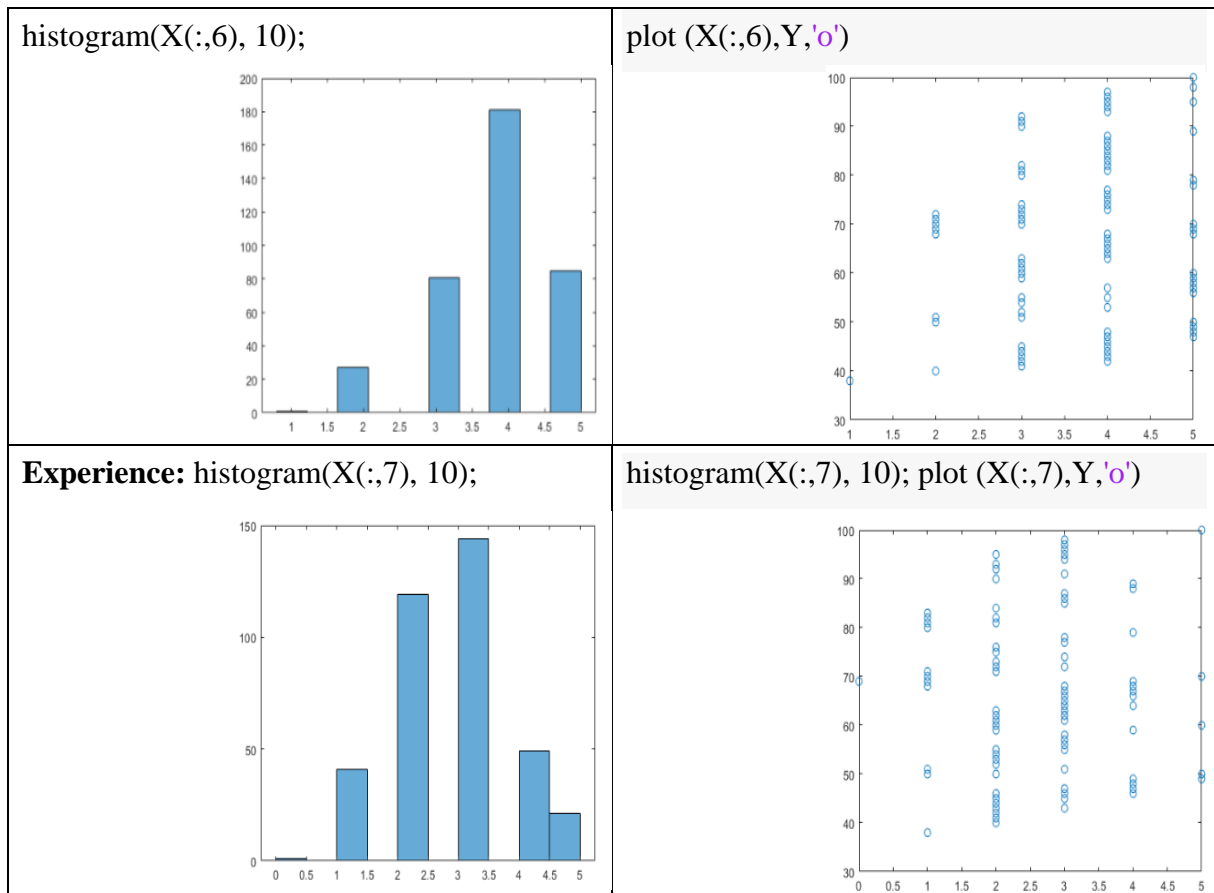


Figure 0.5: Relationship between input data and output – Variables

7.3.6 Normalising the Input Variables

A loop is created for each input by removing the minimum value for each input, so that the input variable starts at zero, then dividing by the range (the maximum value) of the input minus the minimum value of the input. The new normalisation (X2) of the input is then stored.

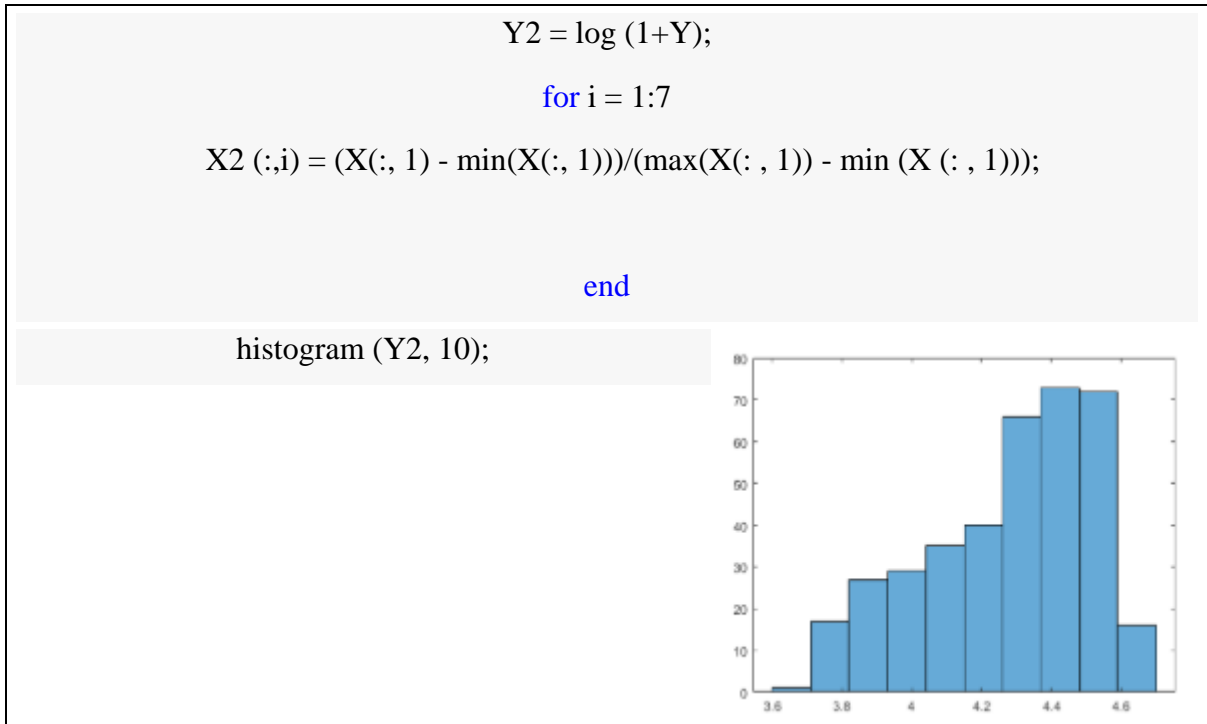
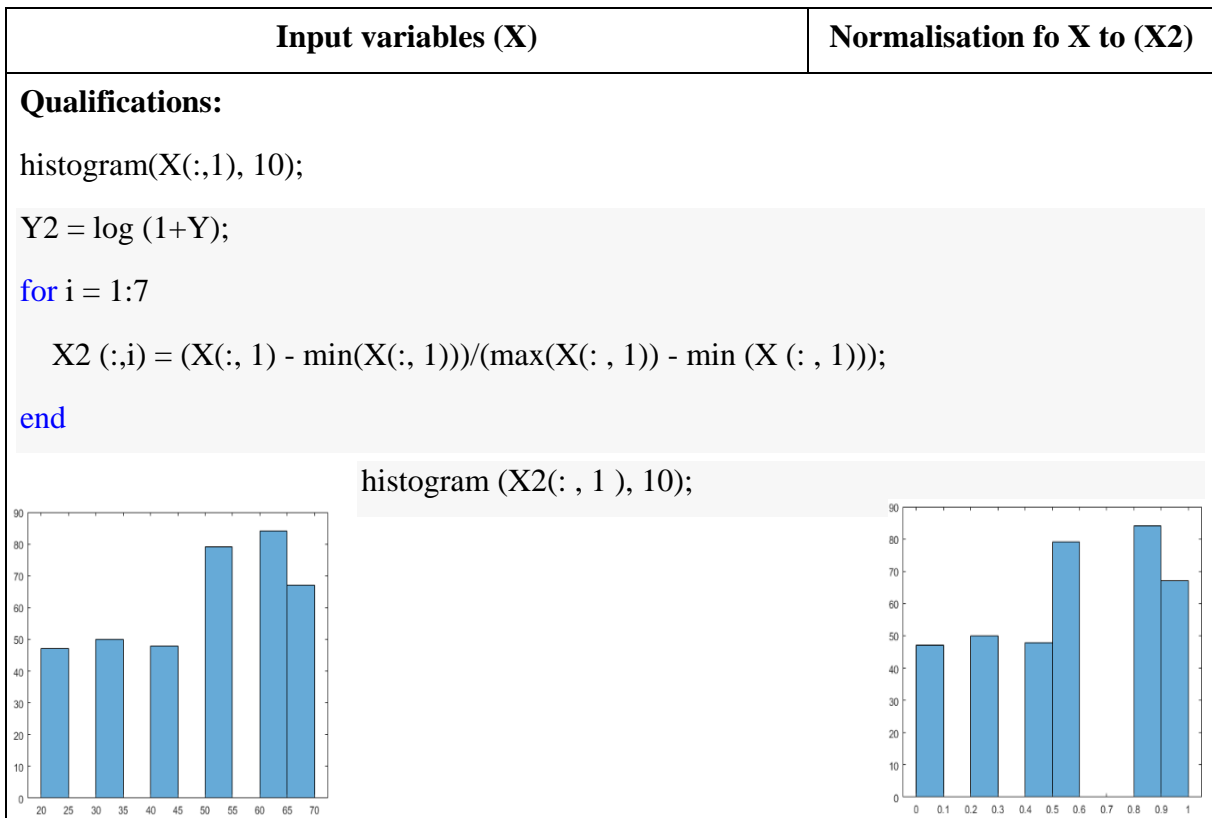


Figure 0.6: Normalising the input variables

In this case, the output does not need to be normalised and the transformation of the new output is the same ($Y2 = \log (1+Y)$). However, the input variables are the variables that need to be normalised between zero to 10, so the new normalisation of the input variable will be as shown in the following figures.



University:

```
histogram(X(:,2), 10);
```

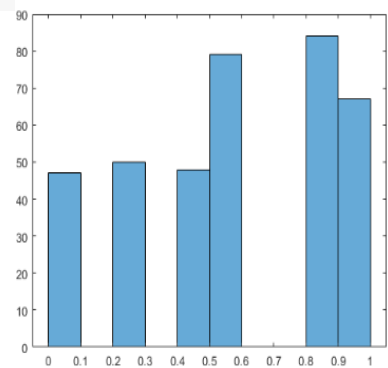
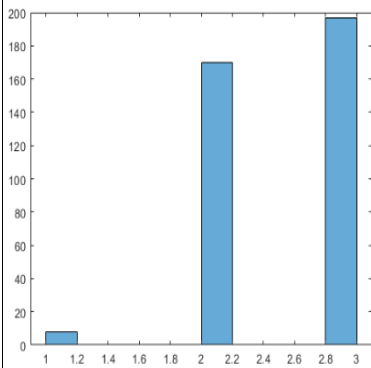
```
Y2 = log (1+Y);
```

```
for i = 1:7
```

```
    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min (X(:, 1)));
```

```
end
```

```
histogram (X2(:, 2 ), 10);
```



Major:

```
histogram(X(:,3), 10);
```

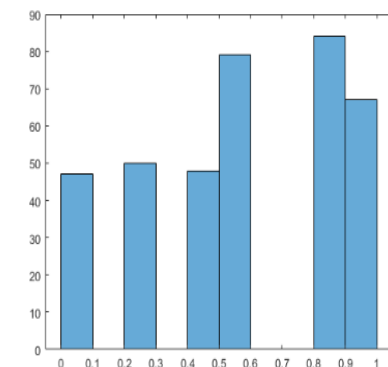
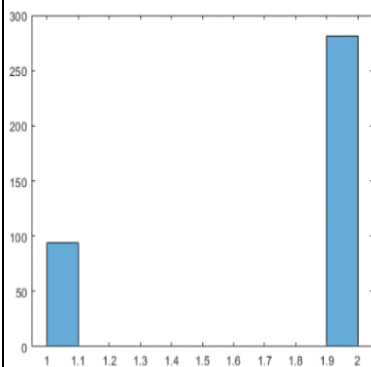
```
Y2 = log (1+Y);
```

```
for i = 1:7
```

```
    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min (X(:, 1)));
```

```
end
```

```
histogram (X2(:, 3 ), 10);
```



GPA:

```
histogram(X(:,4), 10);
```

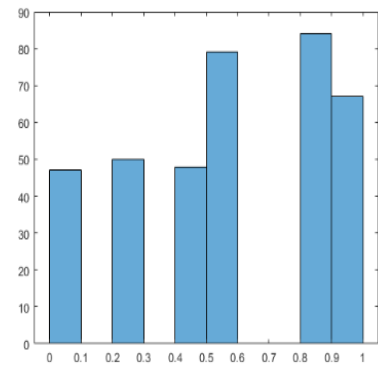
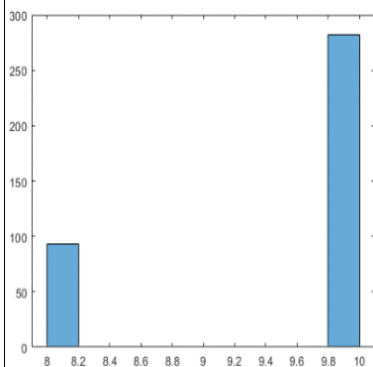
```
Y2 = log (1+Y);
```

```
for i = 1:7
```

```
    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min (X(:, 1)));
```

```
end
```

```
histogram (X2(:, 4), 10);
```



Skills:

```
histogram(X(:,5), 10);
```

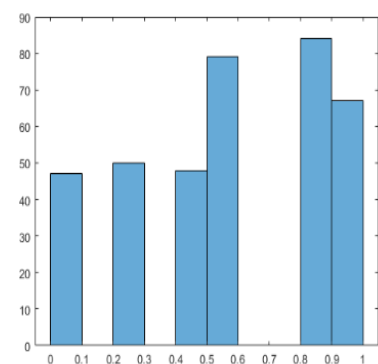
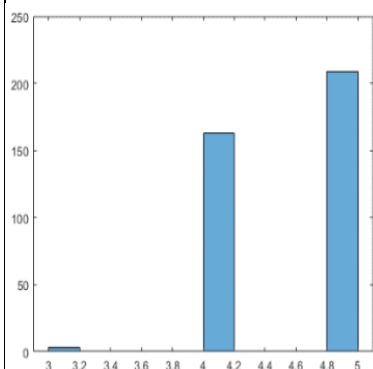
```
Y2 = log (1+Y);
```

```
for i = 1:7
```

```
    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min (X(:, 1)));
```

```
end
```

```
histogram (X2(:, 5), 10);
```



Languages:

```
histogram(X(:,6), 10);
```

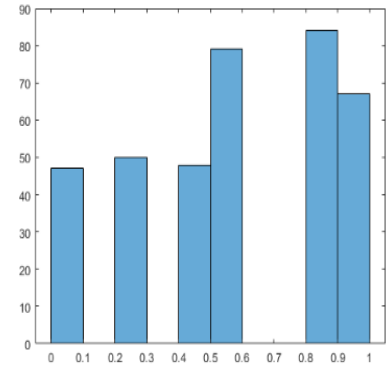
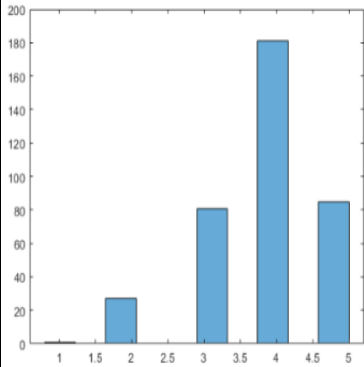
```
Y2 = log (1+Y);
```



```

for i = 1:7
    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min(X(:, 1)));
end
histogram(X2(:, 6), 10);

```



Experience:

```

histogram(X(:,7), 10);

```

```

Y2 = log(1+Y);

```

```

for i = 1:7

```

```

    X2(:,i) = (X(:, 1) - min(X(:, 1)))/(max(X(:, 1)) - min(X(:, 1)));

```

```

end

```

```

histogram(X2(:, 7), 10);

```

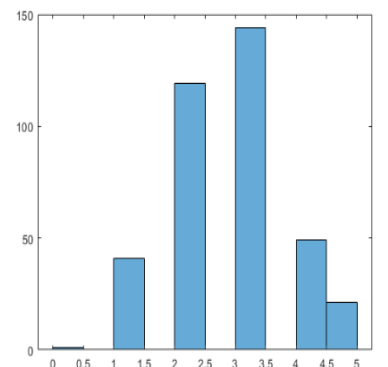
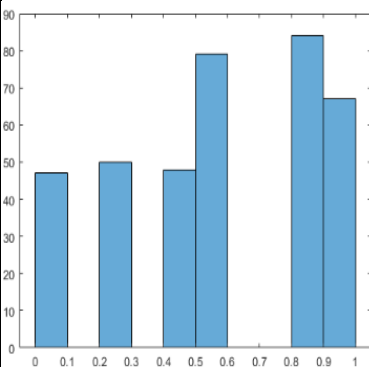


Figure 0.7: New normalisation of the input variable

7.3.7 Boundaries Conditions for The Data (Volume of The Data Divisions)

7.3.7.1 *Size of training set*

The training set is only used to optimise the model parameters, which are the weights of the connections between the neurons and the value of the bias. In this stage, the network is exposed to the data in the training set to learn the optimal values for the parameters.

7.3.7.2 *Size of validation set*

The main aim of this process is to see how well the model is behaving for new data, and not the full testing of the data sets. This process is used to optimise the hyperparameters, like the internal parameters or architecture of the model, to minimise error for the validation set. In this case, the internal parameters can be the regularisation. These parameters do not impact the relationship between the input and the output. The hyperparameters could be the number of neurons in the hidden layer and the number of the hidden layers. At the end of this process, the best values of the hyperparameters are chosen.

7.3.7.3 *Test set*

To see how well the model performs on totally unknown data after the selection of the best values of the hyperparameters, this process is carried out by keeping a fraction of the assets (data sets) left after the validation to use as a test. Since the validation sets are used to optimise the hyperparameters, the dataset is no longer valid to be reused again, and for this reason, the test set is used to evaluate the accuracy of the model.

7.3.8 ANN Topology

To make sure the right number of neurons is selected in the hidden layer, a loop is created for the different number of neurons and the model is trained for it, then the RMS for the validation set is examined as a function of the new selected number of neurons. The selected number of neurons gives the lowest RMS for the validation set. The selected numbers of neurons will vary between one and sixty. However, this time the model is trained as the numbers of neurons are substituted as (i), which varies between 1: 60. The network is defined, and the fractions of the sets (train, validate, and test) are identified (75, 15, and 10), respectively. The RMSE is stored (rmse_train (i)) to be plotted later as several neurons. The following code shows how to optimise the number of neurons of the hidden layer. The new architecture shows that the number of neurons in the hidden layer is gradually increasing until it reaches 60, as shown in the following Figure 7.8.

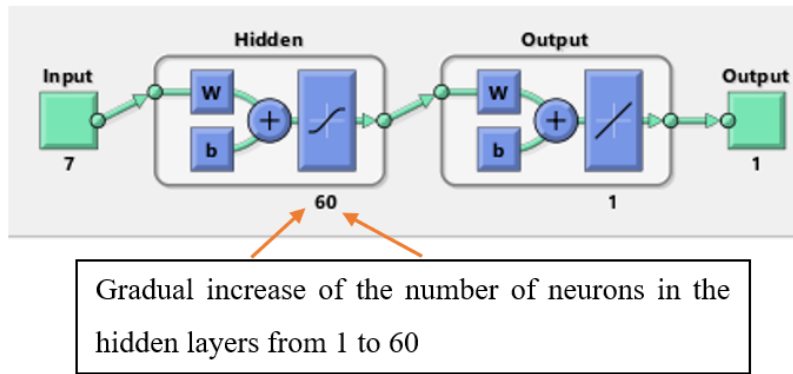


Figure 0.8: New architecture for neuron optimisation

7.3.9 Selecting the Optimal Number of Neurons

Selecting the optimal number of neurons in the hidden layer, Figure 7.9 shows the features of the over- and under-fitted layers. From zero to 20, the model is under-fitted because of the very few hidden layers, meaning the model is too simple and will have a high bias. By increasing the number of neurons, the model is becoming more complex from 45 to 60, meaning the model is having a very high variance, which means the model is not behaving well for the unknown validation and testing data. However, the model is generalising very well for the training data and remains consistent over the change of the number of neurons.

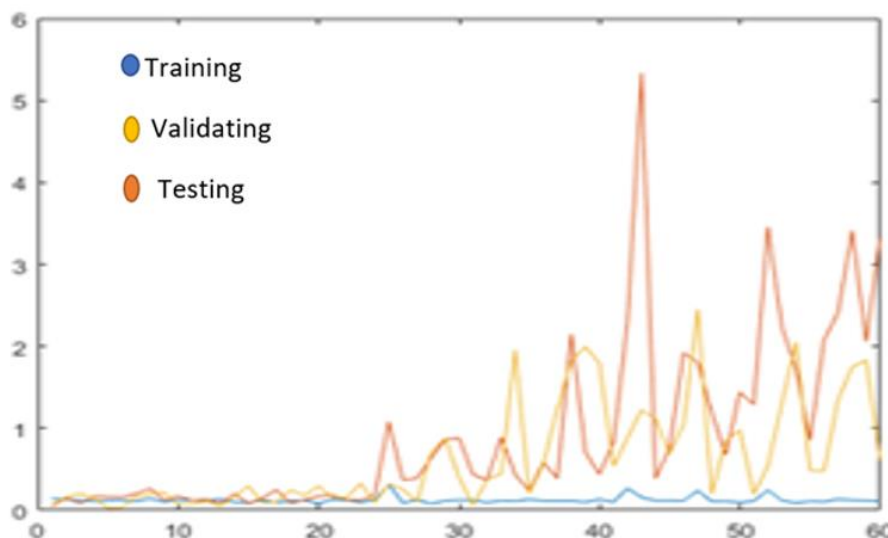


Figure 0.8: Selecting optimal neuron number

7.4 Results and Discussion

7.4.1 GA Testing

Although the graph (Figure 7.10) shows a linear relation, some of the solutions are missing. The graph shows that the GA is not guaranteed to find the global minimum optimum solution

for the best selection issue. As the results show, there is a big difference between the trained and tested RMS (Table 7.2). This means that GA is not the perfect method to use to model the data for the selection of the best candidate. GA is a general tool that uses specific techniques for solving particular issues, which likely to out-perform GAs in both speed and accuracy of the final result.

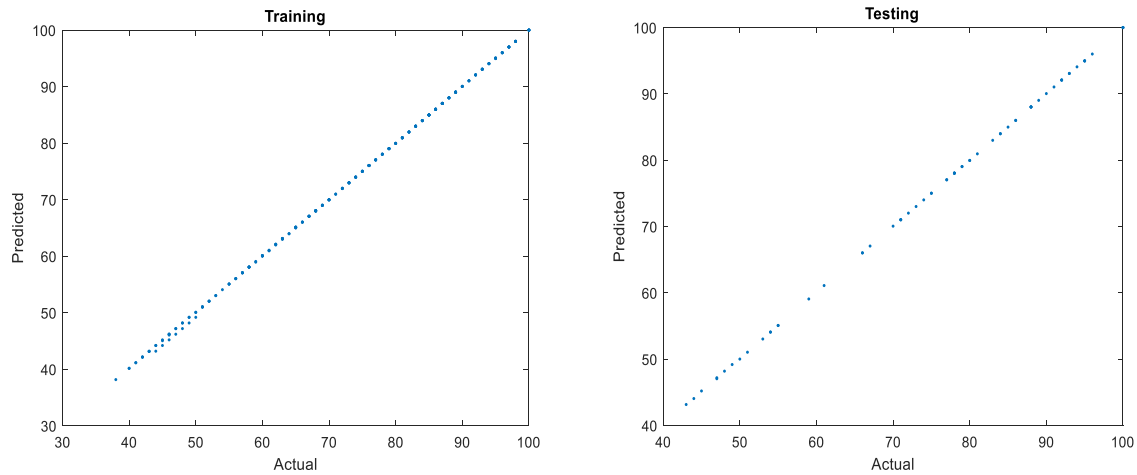


Figure 0.10: GA training and testing

Table 0.2: GA results

GA model	Trained RMS	Tested RMS
	0.1485	0.0590

7.4.2 PSO Testing

Although Figure 7.11 shows a linear relation, some of the solutions are still missing. The graph shows that the PSO is not guaranteed to find the global best optimum solution to the selection issue. Table 7.3 shows an improved and promising result compared to GA. However, the PSO results show there is a big difference between the trained and tested RMS. Even though the difference is smaller than the difference in GA, PSO is still not the perfect method to use to model the data for the selection of the best candidate.

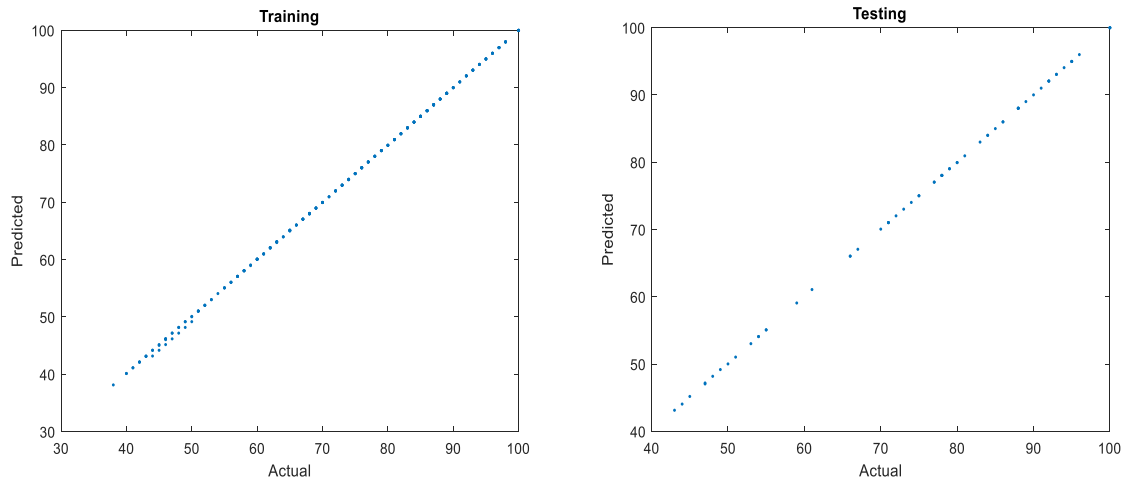


Figure 0.11: PSO training and testing

Table 0.3: PSO results

PSO model	Trained RMS	Tested RMS
	0.1838	0.0956

7.4.3 ANN Model Testing

MATLAB does not recognise the column for the function FITNET, therefore the data set must be transformed into rows. This is done by transforming the data set into matrices, by taking the transpose of the matrix columns. The current size of X2 is 375 rows and 7 columns; when transposed, it becomes 7 rows and 375 columns. Therefore, there is a new X2' and Y2'.

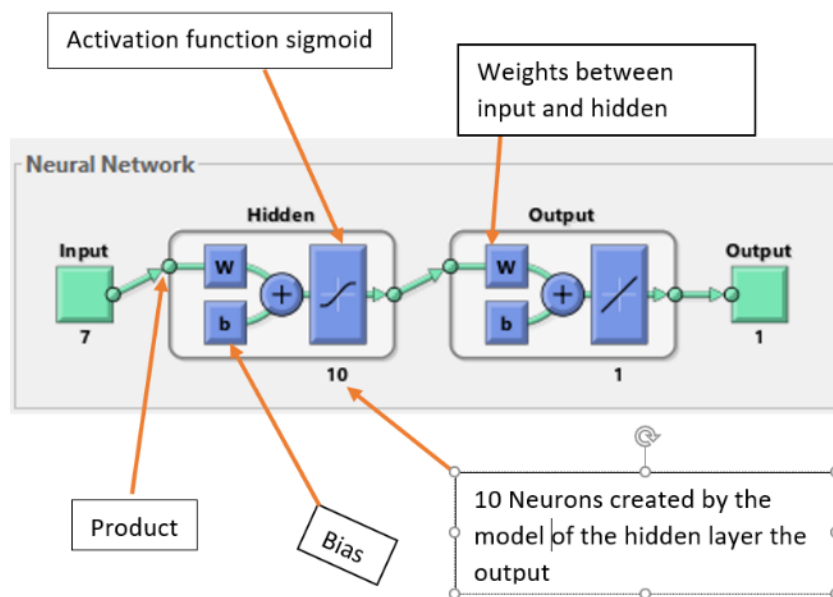


Figure 0.9: FITNET function (hidden-layer-size)

7.4.3.1 Impact of number of neurons in hidden layer

Using only one single hidden layer (shallow model) is expedient to examine the parameter's impact of the number of neurons in the hidden layer (rather than using a deep learning model). Providing a variable for the FITNET function (hidden-layer-size), which is equal to the number of neurons in the hidden layer, the architecture of the model is as follows:

- 7 neurons in the input layer.
- 10 neurons in the hidden layer.
- 1 neuron in the output layer.

Figure 7.25 shows that the function FITNET is responsible for the creation of the network, which is stored in the object NET. At this stage, the ANN is created and trained and is ready to take any values of the input and make a prediction as output. To evaluate the prediction of the ANN with the true values of the output for the three sets (size, validate, and test), the examination of the performance takes place, examining only for the lines that correspond to the training, validation, and test sets.

To predict the Y2 value for the output for the training set, the model uses the new NET function and inserts the value of the features (neurons), whereby the NET function transfers the features to output. The values of the features of the training sets (X2t) are provided, but only 75% of X2t data is provided, alongside 15% of X2V validated data, and 10% of X2S test data.

The (tr) contains a lot of information needed, like the number of the lines and also the index for the validation set as well as the test set. However, if we want to calculate the root mean square value (RMS), the results produced by ANN (Table 7.4) must be compared with the true values of the training, validating, and testing sets. To get the true values, the predicted values must be converted back by taking the exponential of the predicted values minus one.

Table 0.4: ANN results – Training and validation

ANN	Training	Validation	Testing
	0.3848	0.4018	0.3936

7.4.3.2 Validation of ANN model accuracy

At this stage, the best architecture for this model can be defined based on the outcome above, where the RMSE is minimum. Returning to the training ANN, seven neurons are selected in the hidden layer instead of ten, and the model is retrained. As shown in Figure 7.25, the new performance can be calculated; however, the model needs to be trained several times to have a more accurate result, as shown in Table 7.5.

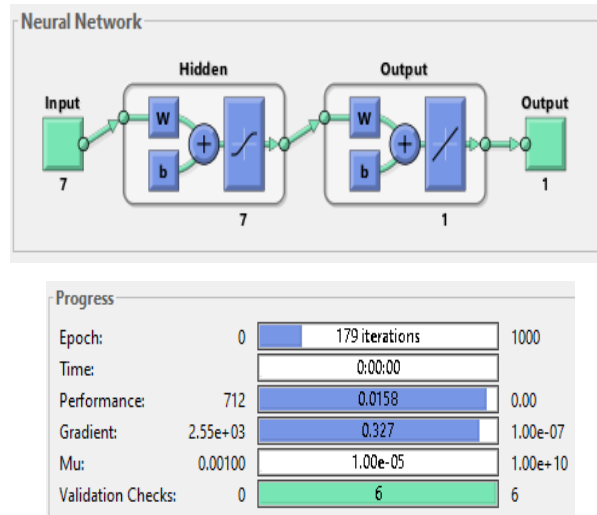


Figure 0.13: Validation of ANN model accuracy

Table 0.5: ANN revised results

ANN	Training	Testing
	0.0513	0.0457

The prediction outcome values are compared with the true values. The accuracy of the model depends on how the predicted values match the true values. In this case, the output cannot be plotted as a function of the input, because the model is multi-dimensional due to the seven input parameters. However, to visualise the model performance, the predicted output is plotted and compared against the true output. Therefore, plotting the predicted output as a function of the true output, the X-axis is the true value of the output, which is the true value of having the job, and the predicted value is the Y-axis using the code plot.

As shown in Figure 7.14, the values predicted by the model fit exactly with the true values, which validates the model as a perfect for the prediction and selection of the best candidates for the job. The figure shows the perfect linear relationship between the predicted values and the true ones. At this stage, the linear regression can confidently be examined. The figure shows the best fit to the linear relation with confidence, with no missing data, and it is proven from these results (Table 7.6) that the minimum RMS can be obtained.

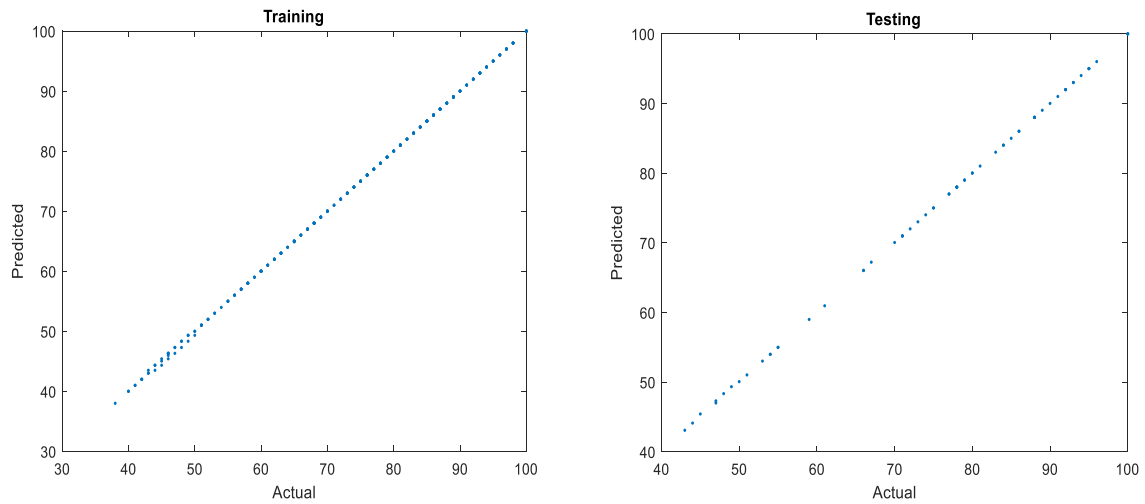


Figure 0.14: Linear relationship between predicted and true values

Table 0.6: System modelling accuracy results

Algorithm model	EDU	UNI	College	GPA	Skills	LANG	EXP	Trained RMS	Tested RMS
Regression	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2.9141e-13	1.5355e-13
GA	0.9978	1.0260	0.9098	1.0242	1.0040	0.9958	0.9973	0.1485	0.0590
PSO	0.9963	1.0179	0.8714	1.0378	1.0104	0.9950	1.0057	0.1838	0.0956
ANN	0.3731	0.2310	0.2837	0.1918	0.2103	0.3459	0.2813	0.0513	0.0457

7.4.3.3 Linear regression

Linear regression is a statistical modelling technique used to easily interpret and quickly fit and evaluate non-linear complex models. The linear regression of the complex relationship between the input data and the output shows the perfect fit and performance of the model, over all of the training, validation, and testing sets, with $R = 0.99986$, indicating the high reliability of the model (Figure 7.15).

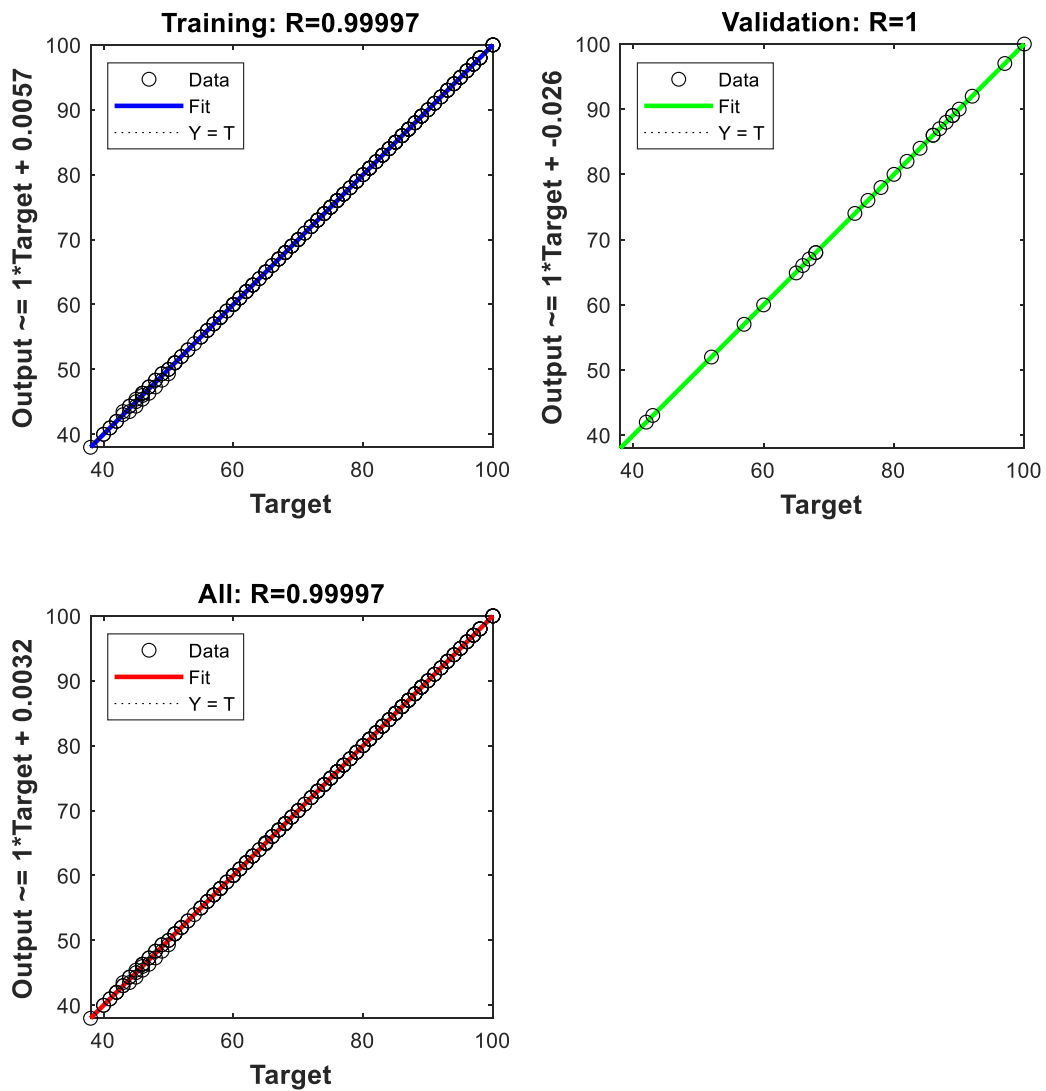


Figure 0.15: Linear regression over all data

7.4.3.4 Validation performance

Figure 7.16 shows the best performance of the ANN model of 37.68 of the training aligned with three epochs. The mean square error of logs up to 10×10^6 on the Y-axis vs six epochs on the X-axis for the validation and test data both have the best fit, exactly in the middle (indicated where they cross the green circle).

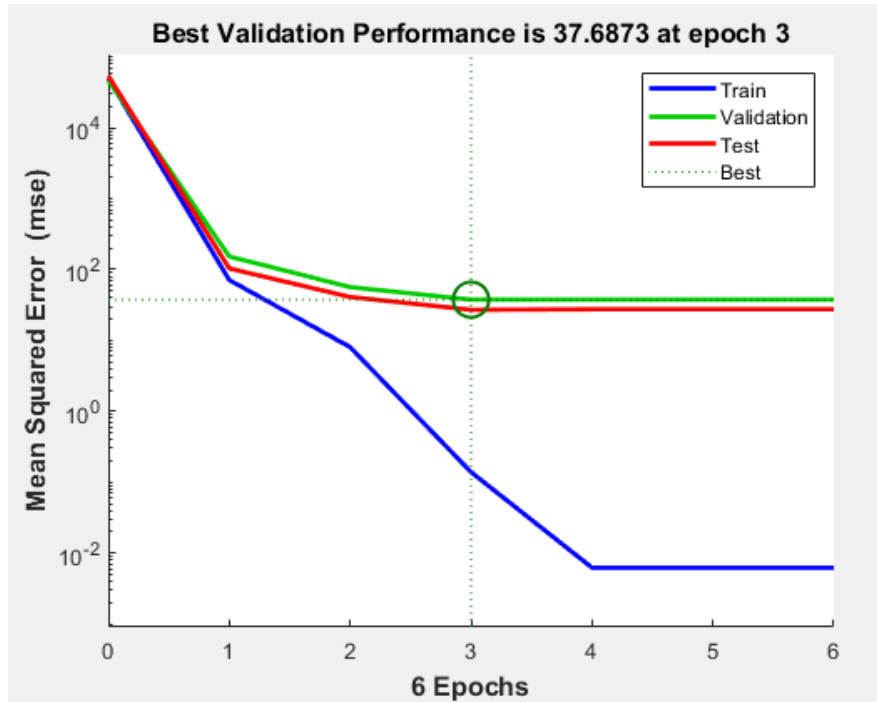


Figure 0.16: ANN model validation

7.5 Integrating ANN Model into the AIRec System

Based on the results achieved from the ANN model, validated through the above results to be the best model out of the three tested models (GA, PSO, and ANN), the ANN model is selected to run into the AIRec system. For the web version of the AIRec software system to recognize the ANN model, which is based on C++ code (MATLAB), the C++ code must be converted to a code that is readable by the web version. The PHP language is selected as it is one of the most successful languages been implemented and used for web languages. The C++ code has been converted to PHP language and implemented into the AIRec software system. The AIRec system has been tested based on the converted PHP language to select the best candidate for the right job, which resulted in the best selections of candidates, as shown in Figure 7.17.

```

20 <?php
21 $independent = array(0.0,0.0,0.0,1.0,0.0,0.0,0.0);
22
23 $ranking = ann_predictor($independent);
24 print("Ranking is: %" . $ranking);
25
26
27 function ann_predictor($independent_var){
28     $no_inputs = 7;
29     $no_hidden = 10;
30     $no_output = 1;
31     $h_neuron = array(0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0, 0.0);
32     $output_neuron = 0.0;
33     $input_offset = array(20.0, 1.0, 1.0, 8.0, 3.0, 1.0, 0.0);
34     $input_gain = array(0.04, 1.0, 2.0, 1.0, 1.0, 0.5, 0.4);
35     $ymin = -1.0;
36     $scaled_inputs = array(null, null, null, null, null, null, null);
37     $active_neuron = array(null, null, null, null, null, null, null, null, null, null);
38     $layer2_inputs = array(null, null, null, null, null, null, null, null, null, null);
39     $layer1_inputs = null;
40     $b2 = null;
41     $output_gain = null;
42     $output_offset = null;
43     $prediction = null;
44
45     // scale the input variable to unity
46     for ($i = 0; $i < $no_inputs; $i++) {
47         $scaled_inputs[$i] = ($independent_var[$i] - $input_offset[$i]) * $input_gain[$i];
48         $scaled_inputs[$i] = $scaled_inputs[$i] + $ymin;
49     }
50     // Hidden Layer - 10 neurons, b1 is the biasing, and IW1 are the weights 5inputs x 10 weights
51     $b1 = array(2.0779539557695798635, -0.28431828948737963847, 1.2741733227448615029, -1.2451304110735901265,
52

```

```

input
int main()
{
    cout<<"Hello World";
    return 0;
}
Ranking is: %11.794944760035
...Program finished with exit code 0
Press ENTER to exit console.

```

Figure 0.17: Integrating ANN model into the AIRec system [124]

The AIRec system was then deployed for external testing and was surveyed by HR experts, which resulted in excellent feedback, as explained in the following section.

7.6 System Usability Scale

The SUS is a well-known process worldwide, defined by ISO 9241. The SUS was developed by John Brooke [131] to measure the effectiveness, efficiency, and satisfaction of the use of the system. A survey was created for the system used in this study in the form of a questionnaire (Appendix C) with 10 categories, aligned with the Likert Scale to decide the direction of the questions (as explained in Chapter 4).

7.6.1 Reliability and Validity

The reliability of the survey for the AIRec system was tested using Cronbach's alpha coefficient values. Alpha reliability is achieved when the benchmark is above 70. Forty members of the HR departments in a recognized public Saudi university a diverse group of officials in the SHRDF, and some owners of the enterprises have participated to test the AIRec system and based on their satisfaction with it. They answered the provided survey and the

Cronbach's alpha result was very high (0.974), as shown in Table 7.7, indicating the high validity and usability of the system, based on the measurement of the questionnaire.

Table 0.7: Reliability statistics

Cronbach's Alpha	No. of Items
0.974	10

Table 7.8 shows the [Count] & Percent (%) values for each question for attitude [Mean Values] and direction. It indicates the participants' responses to the 10 elements of the questionnaire. It has been analysed that the mean response value corresponding to each element included in the survey is 4.6 overall, which shows the high need of the system compared with the minimum of 3.4 based on the Likert scale. SUS1 and SUS10 achieved the highest mean values, which show the high frequency and confidence in using the AIRec system (respectively). Adding to the frequency and confidence, the rest of the mean values concerning ease of use, and the various functions included with the interface of the system indicate that the system is more user friendly. All of these advantages resulted in high demand for the integration of the system within the HR departments for all levels of industries.

Table 0.8: System usability scale results

Question	1	2	3	4	5	Mean	Direction
	Count (%)	Count (%)	Count (%)	Count (%)	Count (%)		
SUS1	0(0)	0(0)	3(7.5)	8(20.0)	29(72.5)	4.65	5
SUS2	0(0)	0(0)	4(10.0)	7(17.5)	29(72.5)	4.62	5
SUS3	0(0)	0(0)	4(10.0)	7(17.5)	29(72.5)	4.62	5
SUS4	0(0)	0(0)	4(10.0)	10(25.0)	26(65.0)	4.55	5
SUS5	0(0)	0(0)	4(10.0)	7(17.5)	29(72.5)	4.62	5
SUS6	0(0)	0(0)	4(10.0)	7(17.5)	29(72.5)	4.57	5
SUS7	0(0)	0(0)	4(10.0)	7(17.5)	29(72.5)	4.57	5
SUS8	0(0)	0(0)	4(10.0)	11(27.5)	25(62.5)	4.52	5
SUS9	0(0)	0(0)	4(10.0)	11(27.5)	25(62.5)	4.52	5
SUS10	0(0)	0(0)	3(7.5)	8(20.0)	29(72.5)	4.65	5

Key

1 = Strongly disagree	2 = Disagree	3 = Neutral	4 = Agree	5 = Strongly agree
-----------------------	--------------	-------------	-----------	--------------------

7.7 Summary

By examining different algorithms through GA, PSO, and ANN, the latter was found to give the best results, thus it was used to identify the best and the highest-ranking candidates, taken as a reference for all the jobs published. This reference refers to the highest amount of points out of 100 achieved out of the seven input variables. The reference is taken to be coded in MATLAB so that the algorithms of the ANN can run random examinations for all candidates with their input variables, to rank candidates from the most to least suitable for roles.

Chapter 8

Discussion

8.1 Main Findings

The Saudi Ministry of Human Resources and Social Development (MHRSD) coordinates recruitment with both public and private sector employment providers; it works on translating human resource development policies and Vision 2030 into effective programs that support the national economy with a qualified workforce. It aims to create a high-quality digital job market to develop the competitiveness of the Saudi workforce, empower job seekers, and enhance the level of native employment among the workforce, in line with private sector growth and national economic diversification. The Masar platform is among the services launched by the MHRSD in the field of digital transformation and electronic effort in the governmental sector, which contains many electronic services seeking to facilitate user operation.

The most prominent operations carried out by Masar include recruitment, retirement, performance management, promotions, transportation, vacations, scholarships, training, job succession, and termination of service. According to the report of the MHRSD's magazine in the fourth quarter of 2020 [132], 486 governmental institutions were involved in this service, with 2,269,327 employment beneficiaries. In April 2020 the SHRDF, through the Nitaqat platform, launched the Employment Support Program to subsidise the employment of male and female Saudis in the private sector. The number of beneficiaries of the Program during the third quarter of 2020 reached 11,717, distributed throughout the Kingdom's regions [133].

E-recruitment has been well-accepted by people in Saudi Arabia in both the public and private sectors. The UTAUT measurement of the extent of people's acceptance of the e-recruitment system indicated that the mean response value corresponding to each element included in the survey was greater than 3.4 (according to the five-point Likert scale used). Thus, the direction of decision regarding each element is either *agree* or *strongly agree*. The largest portion (85%) of participants who responded to the questionnaire confirmed that the public and private sectors are using online recruitment (as explained in Chapter 5). In addition, the comprehensive study conducted by [133] supported the main finding, whereby approximately 17,056,088 visitors to the MHRSD's website to search for a job from the Saudi population had sufficient knowledge of e-recruitment.

8.1.1 Gender

The majority (78%) of survey respondents were men, while over a fifth (22%) were women. The latter were mainly academic staff in universities. A diverse group of professionals were represented in the SHRDF, and some owners of enterprises. A statistical association was found between gender and adoption of e-recruitment in this study. These findings affirm the conclusion of [131] based on the Labour Force Survey, which reported that e-recruitment was associated with reduced unemployment. They reported that the total unemployed population (Saudis and non-Saudis, aged 15 years and above) decreased to 7.4% in the fourth quarter of 2020, compared to 8.5% during the third quarter of the same year. Moreover, the unemployment rate of all Saudis (males and females 15 years and above) decreased to 12.6% in the fourth quarter of 2020, compared to 14.9% during the third quarter of the same year [131].

The results also showed an increase in the labour force participation rate of all Saudis (males and females 15 years and above), to reach 51.2% in the fourth quarter of 2020, compared to 49.0% in the previous quarter, as the labour force participation rate among Saudi males increased to 68.5% compared to 66.0% in the third quarter of the same year, and the labour force participation rate among Saudi females increased to 33.2% compared to 31.3% in the previous quarter [132].

8.1.2 Age

The largest cohort of respondents by age group were aged 41-60 years (33%), while a negligible proportion (0.6%) were aged older than 60 years. A statistical association was found between age and e-recruitment adoption. One-way ANOVA was used to determine whether there were any statistically significant differences between the means of two or more independent groups, as explained in Chapter 5. The P value greater than 0.05 indicates the lack of statistically significant differences between age groups. This corroborates the findings of previous research [134], which confirmed that age does not significantly affect employer perceptions of e-recruitment. This is also commensurate with the fact that the proportion of young people in the country accounts for 60% of the total population, and younger people generally have more readiness for e-services.

8.1.3 Education Level

Over half (n = 260, 51.4%) of participants had Bachelor's degrees, while 16.0% had MSc's in various subjects; 13.0% (n = 66) had secondary school education; and a tenth (n = 53, 10.5%) had a diploma degree. Only 8.1% had a PhD. Analytical studies of academic qualifications and preparatory programs as well as training programs by the MHRSD [124] indicated that 12,633 Saudi citizens were nominated to occupy jobs announced by the Ministry, whether

through preference, competition, or direct employment. Based on the total number of job vacancies (12,633), only 53 jobs were published to candidates where all the candidates are subject to interviews and ranking. However, the rest of the jobs were appointed directly to relatives and close friends, which shows how unfair and biased the system of selection is. The number of diploma holders was 376 men and 55 women, and the number of job candidates with a bachelor's degree reached 6,472 men and 5,593 women. In addition, the number of postgraduate students was 66 men and 18 women. According to the MHRSD's report, the comparison was made for only 53 jobs out of 12,633 vacant jobs, and this indicates the need to develop a smart system that serves the recruitment process and sorts applicants for jobs [135].

8.1.4 Marital Status

The findings in Table 5.6 indicate that the majority of the 506 survey respondents were married (n = 387), whereas 20.4% were single, and 3.0% were divorced (Figure 5.5).

8.1.5 Nationality

The vast majority of participants (n = 480, 94.9%) were Saudi nationals, while the remaining 5.1% were expatriates. The findings of this study affirm statistics reported by a study of Saudi and non-Saudi male and female employees in fixed and approved jobs in the state's general budget, subject to the city retirement system in all government agencies, which reported the following [135]:

- Of 1,177,824 state employees, 703,671 were male, and 474,153 were female.
- Non-Saudi employees comprised 66,987 (6%), including 33,895 males and 33,092 females [136].

8.2 E-Recruitment System

Before starting the process of building the system, some specialists and job seekers were asked about the features they want to add to the site to make it easy to use, to be used as a framework to develop the system. The questions concerned the ease of use of the e-recruitment system interface; the functionality of the system, such as for job postings, descriptions, and start and closing dates; and having an attachment to upload their CVs (or the e-recruitment system containing a CV form). For manually self-filled forms, the e-recruitment system must demonstrate the progress of the application (that is, the completed point and any next point), and announce the final candidate for the interview and final decision.

According to the results presented in Table 5.12, most of the survey respondents agreed with the question statement mentioned concerning the e-recruitment system questionnaire. Out of

506 survey respondents, 62.5% said that they *strongly agree* that the e-recruitment system should have a friendly interface. Furthermore, the outcome of the table indicates those survey respondents agreed with all the stated elements in the e-recruitment system, with an average agreement response greater than 3.4.

8.2.1 E-Recruitment Process

According to the results presented in Table 5.13, the majority of the respondents *strongly agree* with the statement mentioned in the e-recruitment process questionnaire; it is identified from the table that the majority of the respondents think that the e-recruitment system should announce job vacancies in a clear, descriptive and concise manner, accept the applications made by candidates, shortlist the job application, and keep a record of applications for future jobs. In regard to this, maximum scores were obtained regarding the e-recruitment website announcing the times and dates of interview processes (51.8% of the respondents *strongly agreed* and 43.3% *agreed*, while only 0.4% *strongly disagreed* and 0.8% *disagreed*).

8.2.2 UTAUT

This research used UTAUT as a theoretical framework to understand and explore the perceptions of employers and jobseekers concerning using the e-recruitment system for recruiting, under the advanced TAM formulated by Venkatesh et al. [137]. The UTAUT aims to explain user intentions to use an information system and subsequent usage behaviour. The theory holds that there are four key constructs, adumbrated below.

Performance Expectancy

The average value of the corresponding response to the performance expectation of the participants in the questionnaire was analysed. Related questions revolved around the importance of electronic recruitment in selecting candidates, increasing the chances of finding a suitable job, and reducing the time for candidates to search for a job and for employers to choose appropriate candidates. The mean scores were greater than 4.2, thus the direction of decision regarding each question was either *agree* or *strongly agree*. Furthermore, the mean values corresponding to PE1, PE2, PE3, and PE4 demonstrated higher agreement level among the participants regarding the statement that e-recruitment helps HR managers in reaching suitable candidates for the right job.

Effort Expectancy

The average value of the corresponding response to the effort expectation of the participants in the questionnaire was analysed. Related questions revolved around easy use, e-recruitment being clear and understandable, and e-recruitment steps being easy to follow. The mean scores were greater than 3.4, thus the direction of decision regarding each question

was either *agree* or *strongly agree*. Furthermore, the mean values for EE1, EE2, EE3, and EE4 were the highest among all items, demonstrating a higher agreement level among the participants regarding the statement that e-recruitment is easy to use for both HR managers and candidates.

Social Influence

The average value of the corresponding response to the social influence of the participants in the questionnaire was analysed. Related questions included “people who are important to me think that I should use the e-recruitment system to find vacancies for the job”; “people who influence my behaviour think that I should use an e-recruitment system more often”; and “people whose opinions I value prefer that I use the e-recruitment system to select the best candidate”. The mean score was greater than 3.4, thus the direction of decision regarding each question is either *agree* or *strongly agree*. The mean values for SI1, SI2, and SI3 were the highest among all items, demonstrating a higher agreement level among the participants regarding the statement that e-recruitment has a social influence on both the HR managers and the candidates.

Facilitating Conditions

The average value of the corresponding response to the facilitating conditions of the participants in the questionnaire was analysed. The questions revolved around users having the necessary technical resources to use the e-recruitment system to choose appropriate candidates for job vacancies, users having the knowledge needed to use the e-recruitment system, the e-recruitment system being compatible with user browsing technologies, and users being able to access help from others when they experience difficulties using the e-recruitment system for ranking CVs. The mean score was greater than 3.4, thus the direction of decision regarding each question is either *agree* or *strongly agree*. The mean values for FC1, FC2, FC3, and FC4 were the highest among all items, demonstrating a higher agreement level among the participants regarding the statement that e-recruitment has facilitating conditions for the public of beneficiaries of its services, including employees or the beneficiaries of those services, and public and private sector organisations.

Behavioural Intention

The first three items (PE, EE, and SI) were found to be direct determinants of usage intention and behaviour, while the fourth (FC) is a direct determinant of user behaviour. The average value of the corresponding response to the behavioural intention of the participants in the questionnaire was analysed. Questions revolved around user intention to continue using the e-recruitment system in the future when applying for jobs, and employers planning to continue to use the e-recruitment system frequently in the process of searching for new job candidates.

The mean score was greater than 4.2, thus the direction of decision regarding each question is either *agree* or *strongly agree*. The mean value corresponding BI1, BI2 and BI3 are the highest among all items, demonstrating a higher agreement level among the participants regarding the statement that e-recruitment increases behavioural intention among service beneficiaries, whether employees or public and private sector organisations.

One-way ANOVA

As presented in Table 5.18, one-way ANOVA was used to explore differences by age, MS, L/CLE and OS. Age and MS had P-values greater than 0.05, thus there were no statistically significant differences in terms of these variable groups. Since L/CLE had less than 0.05 for EE, there was statistical significance for this variable. Duncan^{a,b} test was used; Table 5.12 shows that the people who have [(Diploma) & (PhD)] had higher agreement than those with [(Master) & (Secondary school or less)] according to mean value scores. In addition, the result of the Duncan^{a,b} test in Table 5.31 for OS showed that people who have [(Part-time employment)] had higher agreement (i.e., mean scores) than the group [(Unemployed)].

8.2.3 Quality

Table 5.15 describes the response of participants regarding the quality aspects of the e-recruitment process. It has been analysed that the mean response of the majority of the respondents lies in the *agree* category; however, only one respondent lies in the *strongly agree* category. The maximum average response value attained corresponded to quality 7, which shows that e-recruitment helps employers to attract candidates who are otherwise inaccessible.

8.2.4 Artificial Intelligence

Further to the survey carried out and outlined in chapter five, the survey's result shows the response of participants regarding the impact of AI on decision-making in the e-recruitment process. Table 5.16 shows that respondents positively responded regarding each element mentioned in context of the AI process. Thus, it can be observed from the survey outcomes that AI helps to reduce the average time to fill the job vacancies, improve the selection process, and reduce recruitment costs. Based on the positive results achieved from the survey, we decided to put three types of AI algorithms to the test, as explained in Chapter 7: GA, PSO, and ANN.

The results for GA show that there is a big difference between the trained and tested MES, with 0.1485 and 0.0590, respectively, which means that the GA is not the perfect method to use to model the data for the selection of the best candidate. GA is a general tool that uses

specific techniques for solving particular issues, which are likely to outperform GAs in both speed and accuracy of the final result.

The PSO results show improved, promising results compared to GA, however they also indicate a big difference between the trained and tested MES, with 0.1838 and 0.0956, respectively. Despite the fact that the difference is smaller than the difference in the GA, the PSO is still not the perfect method to use to model the data for the selection of the best candidate.

At this stage, ANN algorithm was selected to cover the lack in response in GA and PSO. The ANN results (Table 7.8) show that the accuracy of the model is much higher, with almost no differences between the validation and testing data, with 0.0513 and 0.0457 respectively. Figure 7.18 shows the predicted values, whereby the model fits exactly with the true values, validating that the model is perfect for the prediction and the selection of the best candidates for the job. The figure shows the perfect linear relationship between the predicted values and the true ones. The best fit can be reached with no missing data, confidently proving that the minimum MSE can be reached. The overall fitting factor (R²) of the training, validation, and testing of the model is 0.99986, which shows the high reliability of the model. The best-achieved accuracy was the ANN selection, with a rate of 99%.

8.2.5 System Usability Scale

SUS for e-recruitment employed a simple, ten-item Likert-scale attitude tool. The sample included faculty members of Saudi universities with different education levels, a diverse community of officials from the SHRDF, and some business owners who responded to the questionnaire regarding the statement of usability and user satisfaction. The Mean response value corresponding to each element included in the survey is 4.6 overall, which shows the high need for the system, compared with the minimum of 3.4 based on Likert scale. SUS 1 and SUS 10 achieved the highest mean values, which shows the high frequency and confidence respectively in using the AIRec system. Adding to the frequency and the confidence, the rest of the mean values show ease of use, comfort, and user-friendliness (determined by various functions included with the interface of the system). All of these advantages resulted in high demand for the integration of the system within the HR departments for all levels of industries.

8.3 Summary

The above discussion illustrates that the MHRSD is looking for private and public sector employment service facilitators. In addition to this, it is about to work on turning HR development policies along with vision into a programme that can further support the Kingdom by providing a more qualified and skilled workforce. Programmes for employment need to be focused on high-quality digital employment in order to increase the competitiveness among the Saudi workforce, improve the level of nativist employment, and to empower job seekers. The majority of survey respondents (85%) affirmed that both the public and private sectors are utilising the e-recruitment process in order to hire people. Moreover, it is also summarised that the use of the UTAUT theoretical framework was also utilised in the study in order to examine the perception of job seekers and employers using e-recruitment.

In the context of practical use and reality, the e-recruitment process is clearly the future of HR responsibilities, as it is helpful in utilising time more effectively, and reducing the time and other costs otherwise wasted in the traditional recruitment procedure, across the whole process (for both recruiters and job searchers). In addition to this, the quality of e-recruitment is also effective in attracting better and more suited candidates for employment in particular roles. In the survey, the majority of people responded that AI is also a great way to facilitate recruitment, as it expedites the decision-making element of the process.

Chapter 9

Conclusion and Future Work

9.1 Conclusion

E-recruitment processes involved searching the job folders, assessing and shortlisting candidates, the final decision of the recruiting managers, and the quality of hiring through online recruitment. The process has many challenges, such as an increased number of unsuitable job applicants, discrimination and diversity issues, and alignment issues. Although E-recruitment is considered an efficient platform for online hiring of candidates, saving significant resources and time for employers and job seekers and decreases recruitment costs. However, E-recruitment is still not fully automated, allowing for human errors and an increase in challenges.

This thesis identified ways to improve the job search process, reduced the complexities and stress factors involved in job searching and recruiting through the introduced AIRec system. AIRec system is a straightforward process for both employers and job seekers; it is flexible to add more features to accommodate any companies or organisation's needs. The AIRec process involved using the latest AI algorithms to attract and select suitable candidates for vacant jobs. Many advantages of AIRec include reduced recruitment costs, enhanced corporate image, clear communication, broader search, standardisation of recruitment procedures, and broader reach to job candidates.

The methodology used in the study is the quantitative analysis method, which is utilised in the form of structured online surveys to collect data. In addition, it concluded that ANOVA examined the relationship among study variables. Duncan^{a,b} test was used to analyse the difference in demographic variables in the e-recruitment process, with Cronbach's alpha to verify the internal accuracy of the scales; the research tends to use Cronbach's alpha. Furthermore, a few theories were examined: TRA, TPB, TAM, TAM2, DOI, and UTAUT. However, the UTAUT was selected as the best model for this research from the multitude of models and theories. Based on the limitations and applicability of each of the models revealed in the literature, this research utilises UTAUT to study and explore the adoption of e-recruitment in Saudi public and private sector organisations.

The Cronbach's alpha coefficients for items indicated (Table 5.1) validity (e.g., e-recruitment estimated at 0.84, the system at 0.868, and so on). In the survey, the questionnaires consist of 506 questions considering the SHRDF. The dominant gender was male; around 372 respondents were male, and 132 were female who had actively participated in the survey.

Moreover, most of the people who participated in the survey were employed bachelors graduates. Most participants were full-time employed, and 108 respondents (21.3%) were unemployed. Moreover, with the help of inferential analysis, the relationship among study variables was examined; ANOVA and Duncan^{a,b} test were utilised to analyse the difference in demographic variables in the e-recruitment process (Table 5.29 - 33).

Based on the achieved results, the design and implementation of the AIRec System were carried out with PHP, JavaScript, HTML, and CSS, primarily with visual appeal. MySQL was integrated into the project as a backend program in the database. The project illustrates the growth, history, and societal impact of e-recruitment systems (Figure 6.8).

A reference is taken to be a maximum of 100 points for the input data. The input data is coded in MATLAB. Different algorithms were selected to run random examinations for all candidates with their input variables to rank candidates according to their suitability to the vacant jobs and ranked from highest to lowest. The selected algorithms were GA, PSO, and ANN. based on the best-achieved results with the lowest RMS, a further selection between the three algorithms chosen to be integrated into the AIRec system. The system's integration transfers the system to be fully automated and eliminates any human interference. The results are as follows:

Table 0.1: System modelling accuracy results

Algorithm model	EDU	UNI	College	GPA	Skills	LANG	EXP	Trained RMS	Tested RMS
Regression	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	2.9141e-13	1.5355e-13
GA	0.9978	1.0260	0.9098	1.0242	1.0040	0.9958	0.9973	0.1485	0.0590
PSO	0.9963	1.0179	0.8714	1.0378	1.0104	0.9950	1.0057	0.1838	0.0956
ANN	0.3731	0.2310	0.2837	0.1918	0.2103	0.3459	0.2813	0.0513	0.0457

The ANN was found to give the best results; thus, it was integrated into the AIRec system to rank the best suitable candidates for the vacant jobs and enable the system to be fully automated.

This PhD developed a novel integrated Neural Network (NN) platform Artificial Intelligent Recruitment (AIRec), with pioneering accuracy of 99% in e-recruitment platform candidate ranking. The platform can attract suitable candidates, improve corporate image and profile, reduce recruitment costs and overhead costs, employing better tools for the recruitment team, selecting candidates based on sound criteria, and providing a tracking option to both

candidates and employers. Additionally, AIRec is also about changing culture and behaviour within HR and line management.

9.2 Future Work

The work presented here can be used to support future e-recruitment studies that aim to build a dedicated the unified national employment platform possesses all the data of job seekers in the public and private sectors inside Saudi Arabia in order to work to improve and raise the efficiency of special procedures, by receiving and processing all employment requirements for all persons of various categories within the Kingdom. The results of the work represent an important tool in future recruitment decisions in the country. Building such systems and adopting this modern technology is necessary for overcoming the obstacles in e-recruitment adoption and optimising resource accessibility and deployment, in terms of both quantity and quality. To develop on the main themes and findings identified from this thesis, numerous areas for further studies have been identified, namely to:

1. Enhance system functionality by including the public and private sectors in Saudi Arabia with different subjects and specialisations.
2. Extend the use of the system to neighbouring countries, like Kuwait, Qatar, and UAE, which share the same culture and recruitment objectives (in the context of increasing economic integration across the GCC).
3. Extend investigation of the developed system, which is based on a survey carried out in a developing country. The system can be tested in other similar countries in the GCC or elsewhere.
4. Investigate the possible use of the system in other service sectors, such as e-government.
5. Finding a high potential for expansion in services, data and users, and building panels and measurement indicators to achieve support for decision-making.
6. Automate HR operations, contributing to creating a paperless work environment, ensuring access to job data and keeping them up to date while unifying the user experience through a single platform.

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Appendix A: Comparison of Research Paradigms

Table A.1: Comparison of five major research paradigms in business and management research			
Ontology (nature of reality or being)	Epistemology (what constitutes acceptable knowledge)	Axiology (role of values)	Typical methods
Positivism			
Real, external, independent One true reality (universalism) Granular (things) Ordered	Scientific method Observable facts Measurable (numerical) observations Causal explanation, law-like generalisations	Value-free Objective, detached researcher, 3 and independent of researched subject	Typically deductive, highly structured, large samples, measurement, typically quantitative methods of analysis; range of data can be analysed
Critical realism			
Stratified/layered (the empirical, the actual and the real) External, independent Intransient objective structures Causal mechanisms	Epistemological relativism Knowledge historically situated and transient Facts are social constructions Contributes historical causal explanation	Value-laden research Researcher acknowledges bias in world views, cultural experience, and upbringing Researcher tries to minimise bias and errors to be as objective as possible	Reproductive, in-depth historically situated analysis of pre-existing structures and emerging agency. Range of methods and data types to fit the subject matter
Interpretivism			
Complex, rich, socially constructed reality through culture and language Multiple meanings, interpretations, realities Flux of processes, experiences, practices	Theories and concepts too simplistic Focus on narratives, stories, perceptions and interpretations Contributes new understandings and worldviews	Value-bound research Researchers are part of what is researched, subjective Researcher interpretations key to contribution Researcher reflexive	Typically inductive. Small samples, in-depth investigations, qualitative methods of analysis, but a range of data can be interpreted

Table A.1: Comparison of five major research paradigms in business and management research			
Ontology (nature of reality or being)	Epistemology (what constitutes acceptable knowledge)	Axiology (role of values)	Typical methods
Postmodernism			
Nominal complex, rich reality socially constructed through power relations Some meanings, interpretations, realities are dominated and silenced by others Flux of processes, experiences, practices	What counts as 'truth' and 'knowledge' is decided by dominant ideologies Focus on absences, silences and oppressed/ repressed meanings, interpretations and voices Contributes exposure of power relations and challenge of dominant views	Value-constituted research Researcher and research embedded in power relations Some research narratives are repressed and silenced at the expense of others Researcher radically reflexive	Typically deconstructive – reading texts and realities against themselves In-depth investigations of anomalies, silences and absences. Range of data types, typically qualitative methods of analysis
Pragmatism			
Complex, rich, external 'reality' is the practical consequences of ideas The flux of processes, experiences and practices	Practical meaning of knowledge in specific contexts 'True' theories and knowledge enable successful action Focus on problems, practices and relevance Contributes problem-solving and informed future practice	Value-driven research Research initiated and sustained by researcher's doubts and beliefs Researcher reflexive	Following research problem and research question Range of methods: mixed, multiple, qualitative, quantitative, action research. Emphasis on practical solutions and outcomes
Source: Saunders, Lewis and Thornhill (2009)			

Appendix B: Questionnaire Survey

Consent Agreement

The purpose of this study is to explore **e-recruitment**, use of technology and **quality**. You are invited to take part in this research study.

Your participation in this research study is voluntary. If you decide not to participate in this research survey, you may withdraw at any time.

The procedure involves filling an online survey that will take approximately 10 minutes to complete. Your responses will be confidential, and we do not collect identifying information such as your name, email address or IP address. Your answers will be completely anonymous.

All data is stored in a password protected electronic format and encrypted. The survey will not contain information that will identify you personally. The results of this study will be used for scholarly purposes only and will be kept anonymous.

By clicking on 'Next' you agree to participate.

E-Recruitment

Question 1: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

E-recruitment	1	2	3	4	5
E-recruitment helps in reaching candidates in multiple regions					
E-recruitment is useful for organizations whose social network is incomplete					
An organization that enters a new market or location can reach out to candidates through e-recruitment					
E-recruitment is useful for organizations that are beginning new activity					
E-recruitment provides access to a large pool of applicants who require minimum training					
E-recruitment enables a firm to fill vacancies quicker					
E-recruitment help ensure compliance with Equal Employment Opportunity (EEO) standards					
Internet overcomes time challenges by providing access to candidates 24 hours a day and 7 days a week					
E-recruitment provides access to diversely skilled candidates					
Through e-recruiting more than one platform is used to reach out to candidates					

E-Recruitment System

Question 2: To what extent do you personally agree or disagree with the following features that the e-recruitment website should have? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

E-recruitment system	1	2	3	4	5
The e-recruitment system should have a user-friendly interface					
e-recruitment system should have an instruction video to show how to use it					
The e-recruitment system should announce a detailed job description for the vacancies					
The e-recruitment system should show the dates and time (deadlines) for applying for the job					
The e-recruitment system should accept all file format to be uploaded					
The e-recruitment system should engage in exportation of the CV from social media profiles					
The e-recruitment system should have a CV form to fill manually					
The e-recruitment system should show the progress of the application (which point is completed and which one follows)					
The e-recruitment system should respond automatically and instantly to the forms					
The e-recruitment system should announce the candidate after the shortlisting					
The e-recruitment system should announce the final candidate for the interview					
The e-recruitment system should provide individualized response (dates and time of the interview to the shortlisted candidates)					
The e-recruitment system should announce the final decision					
The e-recruitment system should send future jobs to the candidates in the database					

E-Recruitment Process

Question 3: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

E-recruitment process	1	2	3	4	5
The website announces job vacancies in a clear, descriptive and concise manner					
The website accepts the applications made by candidates					
The website shortlists the applications in the individual stages of hiring					
The website announces the candidates to be interviewed in each of the phases as the hiring process advances					
The website announces the time and dates of the interviews					
The website posts a list of the candidates who have been accepted for the job					
The website keeps records of all applications for future jobs					

UTAUT

Question 4: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

UTAUT	1	2	3	4	5
I find e-recruitment useful in applying for a job					
Using e-recruitment increases my chances of finding a job that suits me					
Using e-recruitment helps me to apply for a job more quickly					
Using e-recruitment increases my productivity					
Learning how to use e-recruitment is easy for me					
My interaction with e-recruitment is clear and understandable					
I find e-recruitment easy to use					
It is easy for me to become skilful at using e-recruitment system					
People who are important to me think that I should use e-recruitment system					
People who influence my behaviour think that I should use e-recruitment system more often					
People whose opinions I value prefer that I use e-recruitment system					
I have the necessary resources to use e-recruitment system					
I have the knowledge needed to use e-recruitment system					
The e-recruitment system is compatible with technologies I have					
I can get help from others when I have difficulties using e-recruitment system					
I intend to continue using e-recruitment system in the future					
I will always try to use an e-recruitment system in applying for jobs					
I plan to continue to use e-recruitment systems frequently					

Quality

Question 5: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Quality	1	2	3	4	5
E-recruitment helps in maximizing the job match to ensure a good fit of employees with your company					
E-recruitment helps in locating better candidates					
E-recruitment leads to placing right people in the right job					
Information provided about the organization helps the job searcher to make a better decision about how well they fit					
E-recruitment leads to target applicants becoming interested in a specific industry or profession					
E-recruitment reduces number of less qualified applicants					
E-recruitment leads to attraction of individuals who would otherwise be inaccessible					
E-recruitment mitigates chances of applications being rejected					
E-recruitment facilitates targeting the anticipated applicants					

Artificial Intelligence (AI)

Question 6: Please answer with (YES/NO) to the following questions.

1. Are you familiar with the various applications of AI?

a) Yes

b) No

2. Are you aware of the use of AI in decision-making?

a) Yes

b) No

3. Do you think e-recruitment should be fully automated?

a) Yes

b) No

4. Should a human factor be included in recruitment decisions?

a) Yes

b) No

Question 7: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

Artificial Intelligence (AI)	1	2	3	4	5
AI-based decision-making is more effective and accurate as compared to human decisions					
The AI machine will be fair					
AI will make mistakes					
AI removes the human biases					
AI in recruitment improves the selection process					
Digital recruitment reduces costs and increases the talent reach					
AI will eliminate human interviews					
AI will reduce the average time to fill job vacancies					
AI fits or applies universally in all industries					
AI will impact engagement between job seeker and corporate members					
AI will improve corporate organisation and employer image					
AI will support corporations in tapping into the best talent in the market					

QUESTION 8: Chose the correct answer from your perspective.

Which of the following statements most accurately represent your feelings about AI making the recruitment decisions?

- a) Artificial intelligence will optimise the recruitment process and benefit both employers and job seekers.
- b) Artificial intelligence will improve decision-making but human intervention is critical.
- c) Artificial intelligence-based recruitment decisions will not be as effective as human decisions in meeting recruitment goals.
- d) Artificial intelligence-based decision-making systems will fail in meeting the recruitment objectives.
- e) Other. Please specify.....

How do you feel about Artificial intelligence systems replacing human decision-making in recruitment?

- a) It is an inevitable evolution of technology integration in human resource management.
- b) It will improve recruitment decisions.
- c) It will threaten job security of human resource management professionals.
- d) Human intervention should not be eliminated from the recruitment process owing to the subjective nature of employee interactions.
- e) Other. Please specify.....

Demographics

Nationality

- Saudi
- Non-Saudi. Please specify.....

Gender

- Male
- Female

Age

- Under 18 27-35 Over 60
- 18- 22 36-40
- 23-26 41-60

Marital Status:

- Single Divorced
- Married Widow/er
- Other. Please specify.....

Last or current level of education:

- PhD Diploma
- Master Secondary school or less
- Bachelor
- Other. Please specify.....

Occupational status:

- Full-time employment Full time student
- Part-time employment Unemployed
- Other. Please specify.....

Thank You

Appendix C: Validation Survey

Consent Agreement

The purpose of this study is to explore **e-recruitment**, **System Usability Scale (SUS)**. You are invited to take part in this research study.

Your participation in this research study is voluntary. If you decide not to participate in this research survey, you may withdraw at any time.

The procedure involves filling an online survey that will take approximately 5 minutes to complete. Your responses will be confidential, and we do not collect identifying information such as your name, email address or IP address. Your answers will be completely anonymous.

All data is stored in a password protected electronic format and encrypted. The survey will not contain information that will identify you personally. The results of this study will be used for scholarly purposes only and will be kept anonymous.

If you have any questions, please contact Abdulrhman Aljuaid 1433123@brunel.ac.uk.

By clicking on 'Next' you agree to participate.

System Usability Scale (SUS)

Question: To what extent do you personally agree or disagree with the following general statements? Please select one option in each line, where:

1	2	3	4	5
Strongly disagree	Disagree	Neutral	Agree	Strongly agree

System Usability Scale (SUS)	1	2	3	4	5
I think that I would like to use the AI system frequently to find job vacancies					
I found the AI system unnecessarily complex					
I thought the AI system was easy to use					
I found the AI system select the best person for shortlisting					
I think that I would need the support of a technical person to be able to use the AI system					
I found the various functions in the AI system were integrated and It ranked the CV perfectly					
I found the input functionalities in the AI system were well structured and integrated					
I would use this system for future job application					
The AI system is very user-friendly and does not have inconsistencies					
I think that I would replace the current system with the AI system to remove human biases in the hiring process					
I felt very confident using the AI system					

Appendix D: Ethical Approval



College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London
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Uxbridge
UB8 3PH
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24 August 2018

LETTER OF APPROVAL

Applicant: Mr ABDULRAHMAN ALJUAID

Project Title: E-recruitment

Reference: 11866-LR-Aug/2018- 13994-4

Dear Mr ABDULRAHMAN ALJUAID

The Research Ethics Committee has considered the above application recently submitted by you.

The Chair, acting under delegated authority has agreed that there is no objection on ethical grounds to the proposed study. Approval is given on the understanding that the conditions of approval set out below are followed:

- The agreed protocol must be followed. Any changes to the protocol will require prior approval from the Committee by way of an application for an amendment.

Please note that:

- Research Participant Information Sheets and (where relevant) flyers, posters, and consent forms should include a clear statement that research ethics approval has been obtained from the relevant Research Ethics Committee.
- The Research Participant Information Sheets should include a clear statement that queries should be directed, in the first instance, to the Supervisor (where relevant), or the researcher. Complaints, on the other hand, should be directed, in the first instance, to the Chair of the relevant Research Ethics Committee.
- Approval to proceed with the study is granted subject to receipt by the Committee of satisfactory responses to any conditions that may appear above, in addition to any subsequent changes to the protocol.
- The Research Ethics Committee reserves the right to sample and review documentation, including raw data, relevant to the study.
- You may not undertake any research activity if you are not a registered student of Brunel University or if you cease to become registered, including abeyance or temporary withdrawal. As a deregistered student you would not be insured to undertake research activity. Research activity includes the recruitment of participants, undertaking consent procedures and collection of data. Breach of this requirement constitutes research misconduct and is a disciplinary offence.

A handwritten signature in cursive script, appearing to read 'Hua Zhao'.

Professor Hua Zhao

Chair

College of Engineering, Design and Physical Sciences Research Ethics Committee
Brunel University London