CV ANALYSIS AND OPTIMIZING THE RECRUITMENT PROCESSIN THE IT INDUSTRY USING MACHINE LEARNING TECHNIQUES
2023-098

Project Proposal Report

Maldeniya M.M.D-IT20203726

B.Sc. (Hons) Degree in Information Technology Specializing in Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology
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DECLARATION

I certify that this is our original work, and that this proposal does not include, without citation, any material previously submitted for a degree or diploma at any other university or institute of higher education. Furthermore, to the best of our knowledge and belief, it does not contain any material previously published or written by another person, unless cited in the text.

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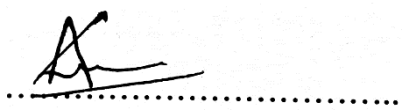

Signature of the supervisor:

(Dr.Anuradha Karunasena)

26/03/2023

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Date

ABSTRACT

Identifying the right individuals is crucial for an organization's success and growth. However, traditional recruitment methods involving manual procedures, such as screening CVs, evaluating academic qualifications, and assessing technical and professional skills, are not only time-consuming but also ineffective. To meet the evolving demands of employers, it is imperative to adopt an efficient and reliable approach to assess the skills and abilities of candidates. We designed our proposed solution to optimize the hiring process in the IT industry by implementing a system that can accurately and effectively find the candidates who are best suited for a given job role. In this research component, the primary objective is to rank candidates by utilizing a job description generated through a structured format. By using a proper job description, the candidate's skills can be easily identified, making the ranking process more efficient. Additionally, to provide recruiters with a better understanding of the candidate, graphical representation will be provided. Overall, this system leverages advanced machine learning algorithms and natural language processing to analyze candidate data and match it with the job description, resulting in a streamlined and objective evaluation process.

Keywords – CV, Machine Learning, Ranking, Natural Language Processing, Job Description, Recruiting

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABREVIATIONS

CV	Curriculum vitae
IT	Information Technology
JD	Job Description
ICT	Information Communication Technology
ICTA	Information and Communication Technology Agency of Sri Lanka
NLP	Natural Language Processing
BERT	Bidirectional Encoder Representations from Transformers
MLM	Machine Learning Model
HR	Human Resources
SDLC	Software Development Life Cycle
IDE	Integrated Development Environment
HTML	Hyper Text Markup Language
CSS	Cascading Style Sheets
DB	Data Base
API	Application Programming Interface
GPU	Graphics Processing Units
TPU	Tensor Processing Units

LIST OF APPENDICES

1 INTRODUCTION

1.1 CV Analyzing and Job Recruitment

Choosing the right candidates is crucial for an organization's success and growth. However, traditional hiring processes are often slow and inefficient, relying on manual steps such as resume and skill evaluation. To better serve employers' needs, a more effective and accurate method for assessing candidates' skills and abilities is necessary. Unfortunately, there is currently no universally accepted way to evaluate personality traits, which can be crucial for a candidate's fit with a company culture or role. This research focuses on the IT sector and aims to streamline the hiring process by integrating machine learning, data extraction, and natural language processing techniques. By evaluating a candidate's technical skills, professional skills, and personality traits, hiring managers can make informed decisions and select the most suitable candidates for available roles. Overall, this approach offers a more efficient and accurate means of candidate evaluation, enhancing the quality of hires and ultimately contributing to an organization's long-term success.

1.2 CV and Job Description

1.2.1 Curriculum Vitae

CV or curriculum vitae is a document that summarizes a person's educational and professional history, skills, accomplishments, and other relevant information. It is commonly used in the job application process to demonstrate a candidate's qualifications and suitability for a particular job. Customizing a CV to the particular job or industry is crucial. that candidates are applying for, emphasizing relevant experience and skills

1.2.2 Job Description

A job description is a written statement that specifies the job responsibilities, duties, necessary skills, qualifications, and any other relevant requirements for an employee working in a specific position or role within an organization. It provides a clear and concise summary of the tasks, expectations, and performance standards that are associated with a job.

1.3 Research Area

Numerous studies have been conducted to assess the skill proficiency of candidates from various perspectives. In particular, researchers have ranked the candidate pool to get the best fit, with a focus on analyzing and evaluating their resumes. Additionally, this study aims to determine if this approach can assist recruiters in identifying top talent more quickly and effectively.

1.4 Component Overview

The main objective of this component is to review candidates' resumes and identify the most qualified individual for a specific job vacancy. The emphasis is on using a well-defined job description to rank the CVs and obtain optimal outcomes. Through this component, a comparison between the job description and the candidate's skills will be presented using a summary representation, making it easy to identify even for those with limited computer literacy.

2. LITERATURE REVIEW

2.1 Background Study

The ICT sector in Sri Lanka is thriving with innovative technological advancements, showcasing the natural intelligence of its people. With the second-highest revenue, Sri Lanka's IT industry significantly contributes to the nation's exports, connecting more than 500 industries with information technology. This responsible and sustainable industry highly values labor laws and environmental regulations. Due to a skilled workforce and cost-effective operations, the IT sector has become incredibly profitable. [1] According to a report by the ICTA, Sri Lanka's IT industry has been growing at a rate of 16% per year. By 2022, [2] it is projected to create more than 200,000 jobs both directly and indirectly. The nation's robust talent pool of IT experts, who have received top-notch education and training, make Sri Lanka competitive in the international IT business. Despite the high demand for IT employment, obstacles exist in selecting the best applicants to fill these positions.

To thrive in today's competitive global market, companies must carefully select the right candidates for IT jobs. The main goal of the hiring process is to find the most qualified candidate for a job in the company, based on their ability to meet the job requirements. This requires a thorough evaluation of various aspects of the applicants, including age, qualifications, skills, and experience, among others.
Ensuring a good match between an employee and a job is crucial, as it directly impacts the quality and quantity of the employee's work, as well as the overall performance and productivity of the organization. Therefore, [1] a meticulous selection process is necessary to identify the best fit candidate for the job.

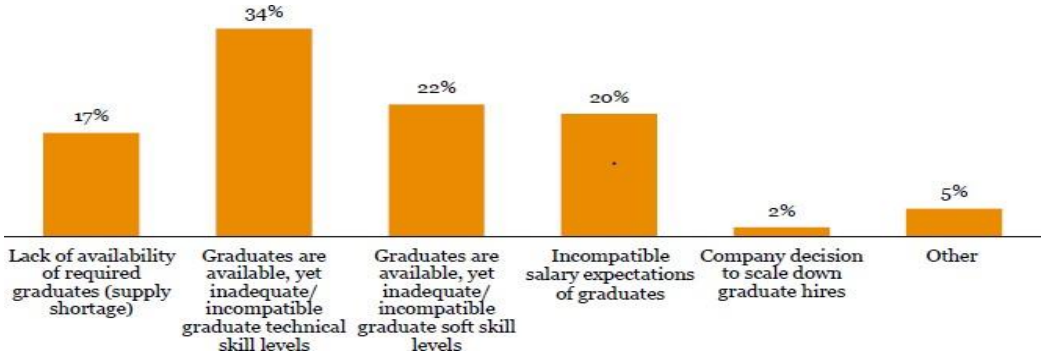

Figure 1 Skill Analysis of Graduands in Sri Lanka

Finding a job in today's competitive market can be challenging, particularly if one lacks the necessary skills or presents a poorly written CV. Although there may be several reasons for this situation, individuals can take steps to enhance their chances of success and progress in their careers. As per Figure 1, [2] the absence of necessary qualifications or experience for the desired position can be a reason for unemployment due to a skills gap

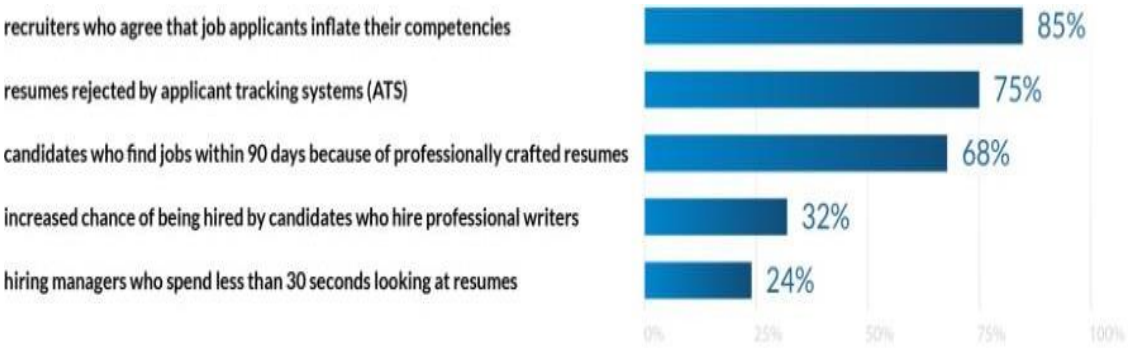

Figure 2 Job Hunting Statistics

CV is an essential tool for any job candidate because it summarizes their qualifications, skills, and work experience. It is often used as a screening tool to determine whether a candidate is a good fit for a job because it is the first impression a potential employer has of a candidate. According [4] to the survey done by 2022, it shows that resume plays a main role in selecting candidate for a job.

Here, matching the job description with resume is a critical step in the job recruitment process. since it [3] demonstrates the suitability for the role, resume increase the chance of getting invited for the interviews.

As a result, this approach aims to develop an automated system that can accurately rank candidate resumes according to the job description, [4] while providing skill analysis based on the resume.

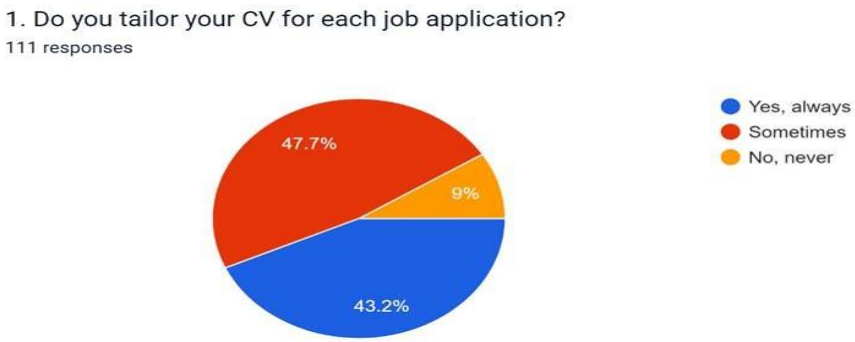

Figure 3 Survey results related to cv tailoring Job description

2.2 Literature Survey

Over time, recruitment methods have evolved from traditional paper applications to digital resumes. As the population continues to grow rapidly, companies advertising job vacancies may receive an overwhelming number of emails from eager candidates daily. To address this challenge, several research studies have been conducted to streamline and simplify the recruitment process.

The process [5] involves extracting pertinent information from a resume and organizing it into segments based on its values. This solution was designed specifically for unstructured CVs, as resumes can vary greatly in their format and structure. To accomplish this task, a machine learning algorithm is used to generate an applicant learning log, which is used to construct a ranking model. It was designed as model can then be used to predict recruitment decisions when a candidate's resume is given.

A different study [6] utilized machine learning techniques to conduct in research. The study aimed to cater to the requirements of recruiters by screening resumes based on their stated criteria. The data used for the study was in the form of a CSV file, with labels assigned to different roles in the IT industry. A stacked classification approach was employed to rank resumes in a systematic manner based on their suitability for various roles. As a result of this research, a clear understanding of the relevance of specific job roles in the IT industry was obtained.

Another research [7] by taking resumes as input and converting them into text format. The extracted texts are then fed into a segmentation model, which identifies different sections.. A sequence labelling model is assigns to each sentence. This research was done to present a summary of information using classification which is done in a Jason format.

The research [8] reveals that several modules are organized to extract a variety of information from job applicants, including personal details, educational background, work experience, and employment history. Here, the system utilizes a filtration module to eliminate irrelevant terms that don't aid in matching. Additionally, a third module categorizes resumes and job posts into occupational categories using a set of skills extracted from both sources.

In this paper, [9] The recruitment search engine matches candidate profiles with job descriptions by using keywords. To identify relevant skills, the engine employs both BERT and Pre-trained MLM techniques by utilizing a combination of CMAP and competency keywords in a knowledge graph, the system has the capability to offer useful recommendations in the area of neighborhood-related subjects.

3. RESEARCH GAP

According to existing research studies, some issues were found when comparing them.

The absence of a well-defined job description structure makes it challenging to accurately rank resumes.

The effectiveness of previous studies that ranked CVs using job descriptions extracted from various sources could be improved by utilizing a well-defined structure to generate job descriptions. Taking a structured approach to creating job descriptions is likely to yield more accurate and relevant results. This approach ensures that all relevant information is included, which can enhance the process of ranking CVs and lead to better outcomes.

There is difficulty achieving high accuracy in resume ranking due to the lack of an established method.

The current approach involves utilizing various machine learning algorithms to sort through resumes. However, many systems have struggled to effectively rank CVs. To address this issue, a stacked model is used where a series of machine earning algorithms are employed in the ranking process. By combining natural language processing techniques for text processing and machine learning for ranking, a more optimal solution can be achieved compared to existing methods.

The unavailability of a suitable approach for providing a summary representation of skill proficiency is an issue.

While earlier studies have emphasized presenting a candidate's CV through knowledge graphs or other graphical formats, a graphical representation may be more effective in comparing a candidate's skills to job requirements. By utilizing a

graphical format for this purpose, it can be easier to comprehend a candidate's skills in relation to the job requirements.

The proposed system primarily aims to rank resumes based on a generated job description, created using inputs from recruiters. Additionally, the system outputs a graphical representation of skill proficiency, enabling companies to gain an overview of candidates' skill level before recruiting them in the future. this research is done to provide a solution to these identified gaps by developing a system with the ability to rank resumes and identify candidate skills to get a best fit for a job opportunity.

When we consider existing implementations in this area:

In Research [10] A, the authors' proposed approach involves using cosine similarity to match a candidate's profile data with a job description, resulting in a shortlist of candidates who closely match the HR job description.

In Research [11] B, the authors of this proposal have suggested a flexible format for candidates to upload their resumes, which can then be analyzed by the system using an algorithm that leverages NLP techniques. The system compares the content of the resumes against the job description to shortlist candidates based on the specific requirements of the company.

In Research C, [6] the authors have proposed a supervised learning approach by using stacking classifiers, which combines different algorithms to yield an acceptable outcome, in order to assist employers in screening candidates based on their specifications and rank them in an orderly fashion.

In Research D, [9] a supervised learning method that utilizes stacking classifiers to combine multiple algorithms and produce a satisfactory result, In order to aid employers in effectively screening job candidates based on their specific requirements and ranking them in a coherent manner.

Features / **Research**	Research A [12]	Research B [13]	Research [8]	ResearchD11]	Proposed System
Generate job description in a proper structure	✗	✗	✗	✗	✓
Summary representation of candidate skills compared to job description	✗	✓	✗	✗	✓
Matching job description with cv	✓	✗	✗	✓	✓
Focus on IT industry job positions	✓	✗	✓	✗	✓

Table 1 Summary of Research Gap of CV Ranking System

4. RESEARCH PROBLEM

The traditional process of manual resume screening can be a tedious and time-consuming task, especially for large organizations that receive a high volume of applications. With the increasing competition in the job market, it is essential [12] for companies to attract and retain top talent quickly and efficiently. This is where a CV ranking system comes in handy.

Recruiters may not be able to create an accurate job description that ensures proper ranking of resumes. Creating a structured job description is crucial to hiring the right candidates. Therefore, it is necessary to develop a feature that allows them to generate a structured job description.

According to a survey conducted by the research team, it was identified that job descriptions are more important in ranking. However, most existing systems focus solely on ranking and do not consider the importance of a proper job description.

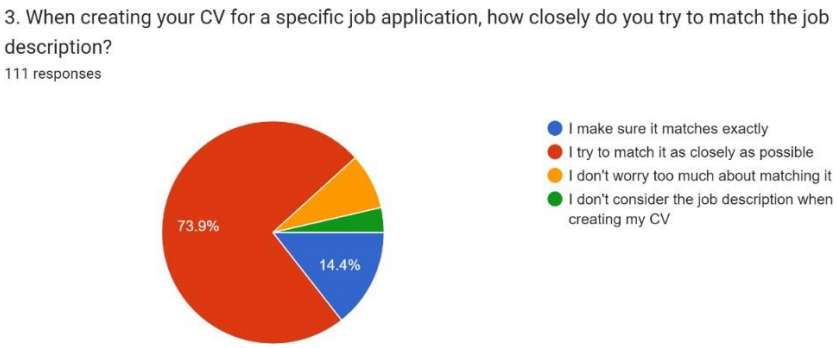

Figure 4 Survey results of CV matching scores

Figure 4 shows that the majority of the responses prefer making resumes according to the job descriptions.

Automated CV [13] ranking systems can help companies reduce time and resources needed for candidate screening while providing a more accurate and efficient selection process. Algorithms match job requirements with candidate qualifications and eliminate human bias from the selection process, ensuring a fair and unbiased assessment of candidates. Therefore, ranking systems should place greater emphasis on the accuracy of ranking algorithms.

Ranking resumes alone is not an effective way to identify a candidate's skills. A more comprehensive overview of skills using graphical methods would provide a better understanding of a candidate's capabilities. Developing this feature gives a better explanation of each candidate’s skills.

By utilizing these two methods, recruiters and HR managers can conveniently compare the proficiency level of several candidates, enabling them to make well-informed decisions as to who is the best fit for the job.

5. OBJECTIVES

5.1 Main Objective

The focus of this study is to create a sophisticated and efficient system that can effectively evaluate, and rank job applicants' resumes based on the requirements outlined in the job description provided by the recruiter. The primary goal of this system is to streamline the hiring process and save time for recruiters and hiring managers by automating the initial screening process. Additionally, the proposed system will provide a comprehensive graphical representation of each candidate's skill proficiency, allowing recruiters to compare candidates' strengths and weaknesses quickly. This feature will enable recruiters to make more informed decisions and select the most suitable candidate for the job.

5.2 Specific Objective

Specific objectives with the research component are:

- **Generate a proper structure for a job description.**

  The proposed chatbot system is designed to streamline the job description creation process by collecting relevant information and data from recruiters to create a consistent and accurate job description format for all job openings. Based on this information, the chatbot will generate a job description in a standardized format, ensuring consistency across all job openings

- **Rank the candidate resume according to the Job description.**

In the proposed system, candidate resumes will be evaluated and ranked based on their relevance to the specific job requirements. By comparing the candidate's qualifications, experience, and skills with the job requirements, the system will assign a score to each candidate, indicating their suitability for the role.

- **Analyze the resume and graph the extracted data of cv and Job Description.**

Once the system has ranked the resumes and generated an overall skill proficiency graph for each candidate, the next step is to compare the job requirements with the candidate's skills and experience using a graphical representation.

6 METHODOLOGIES

The proposed system aims to utilize resumes to rank job candidates and identify the best fit for a particular job vacancy. To accomplish this, we must first create a job description that outlines the specific requirements of the role. Next, we must extract relevant data from the candidate's resume. Once the data from both the job description and the resume have been preprocessed, a machine learning model will be used to rank the candidates. Finally, a graphical representation will be generated to compare the skills of the top candidate.

6.1 System Architecture Diagram

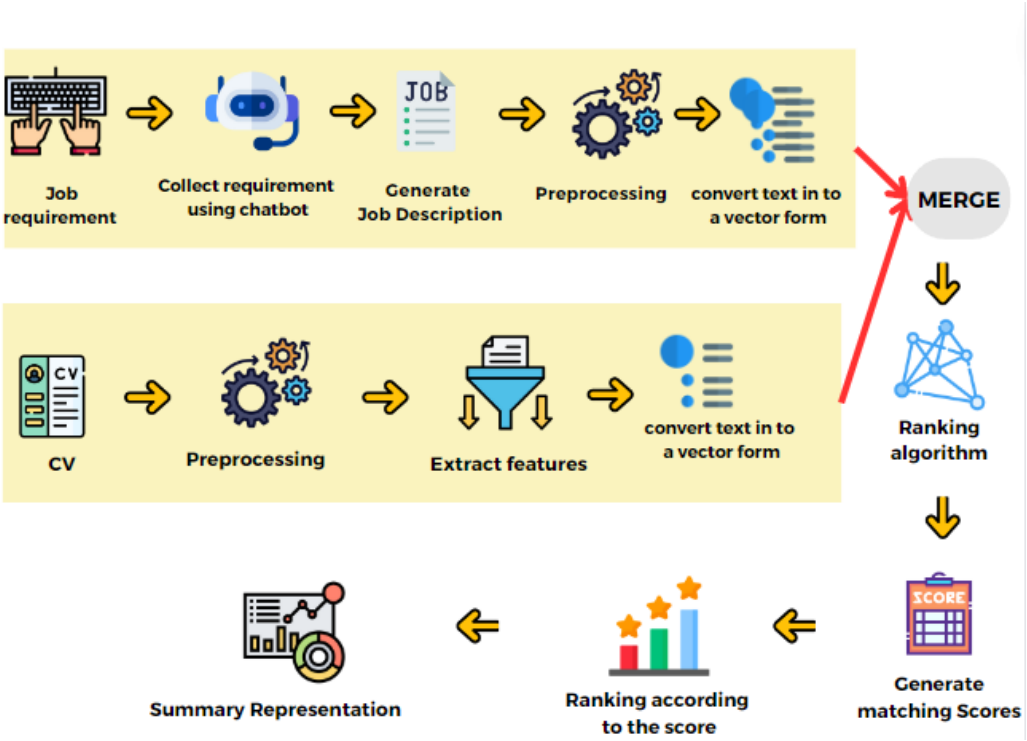

Figure 5 System Architecture diagram of CV Ranking System

6.2 Software Solution

The Software Development Life Cycle (SDLC) [14] is a systematic approach that facilitates the creation of top-notch software with minimal production costs and time. The primary objective of the SDLC is to deliver exceptional software that satisfies all customer requirements and expectations. Agile methodology is a approach we using to develop our proposed system.

Figure 6 Software Devolopment Life Cycle

6.2.1 Requirement Gathering and Analysis.

During the initial phase of software development, the team gathers information about the system and analyzes project ideas and objectives. The primary focus is on identifying the audience, features, and functions that the software is expected to perform. The success of the project largely depends on the accuracy and completeness of the requirements gathered during this phase.

To ensure that all ideas and issues related to CV analysis and job requirements are gathered, we provide a questionnaire through Google Forms as the first step. The questionnaire comprises a set of required questions about automated recruitment, and we pay special attention to the responses we receive. These responses enable us to carry out our research effectively and give more importance to the comments gathered. Additionally, we review existing research and compare them to identify potential areas for improvement to create an effective system. please refer APPENDIX A.

6.2.2 Feasibility Study

6.2.2.1 Schedule Feasibility

To [16] achieve the best possible outcomes from a project, it is essential to create a well-planned timeline that outlines specific deadlines for each task or milestone. A timeline helps to ensure that the project progresses smoothly and efficiently, without delays or disruptions that could negatively impact the outcome.

6.2.2.2 Technical Feasibility

The proposed system should be compatible with existing technologies and Companies should be able to use this without any obstacles. Technologies used in the system should not affect the usability.

6.2.2.3 Operational Feasibility

The proposed solution seeks to simplify and streamline the resume ranking process, while also identifying any gaps or shortcomings in the existing systems that need to be addressed for improved efficiency and effectiveness.

6.2.3 Implementation

Web application development

The result of the project involves a web application that can analyze all output details. Developing the application requires a thorough understanding of web application development and the use of Visual Studio Code as IDE.

Front Web development

The proposed system will use Flask for frontend development. Flask is a web application framework that supports server-side development in Python and can also be combined with HTML, CSS, and JavaScript for full-fledged frontend development. Flask is lightweight and simplifies the creation of user interfaces for Python models, making it a popular choice for data analysis, machine learning, and artificial intelligence applications.

Database handling

Azure Cosmos DB, a database service offered by Microsoft Azure, can store significant amounts of structured, semi-structured, and unstructured data. Cosmos DB is easy for use by creating a container within the database to store resumes. Here, each resume would be saved as a document with specific candidate information as properties

Backend development

The process of creating the server-side components of a web application or software system using the Python programming language is known as backend development. This includes developing APIs, managing database operations, implementing security features, and managing server resources. Python is a popular language for backend development because it is simple to learn, has a large community of developers and resources, and has a diverse set of libraries and frameworks for a variety of tasks.

6.2.3.1 Tools and Technologies

6.2.3.1.1 Tools

- **Visual Studio code** - Visual Studio Code [15] is a powerful and flexible IDE code editor that can be used to develop chatbot due to its open-source nature and it's a free IDE. It also includes features such as a built-in terminal and debugging tools, which can help developers to quickly identify and fix issues in their code.

- **Google Collaboratory** - Google Collaboratory is a web-based workspace that allows users to develop and run machine learning algorithms [16] using powerful computing resources that are available for free. One of the key advantages of Colab is the access to GPU and TPU resources, which can greatly accelerate the processing of complex machine learning tasks that require a lot of computational power.

- **PyCharm** – This IDE provides essential tool for developers as allows developers to write high -quality code which is crucial in the devolopment process. PyCharm's interface uses color-coding to improve code readability and error detection by highlighting keywords, classes, and functions. It autocompletes feature is a time-saving efficiency booster, making it an

essential tool for developers who aim to produce high-quality code while streamlining their coding process.

6.2.3.1.2 Technologies

- **Python** - Python is a popular language for machine learning [17] because it offers several advantages. It is an easy-to-learn language, and it contains a large selection of libraries and frameworks. As it is a flexible language, it can be used for various tasks.

- **Spacy** – One of the popular and widely used Natural Language Processing (NLP) libraries in [17] Python. spacy is an open-source library that is available for free. This library is equipped with various features required in preprocessing and extraction of features.

- **Matplotlib /seaborn /ploy** – libaries plan to use for grphical representation using python.

- **Scikit-learn** – it's a simple and efficient tool for predictive data analysis which is accessible to everybody and reusable in various contexts. It's versatile and integrates well with other Python libraries.

- **NLTK (Natural Language Toolkit)** – NLTK is a open source library for the python programming language. [18] As its containing text processing libraries for tokenization, parsing, classification which is needed for future works of prediction.

- **PDF parsing librarie**s - PyPDF2 – It is a library for Python that helps you do different things with PDF files. You can use it to get information from a PDF document.

- **Model Stacking** –Model Stacking is a technique used to enhance model predictions. [18] It works by combining the results from multiple models and passing them through a meta-learner, which is another machine learning model. By stacking models, you can achieve better results in a convenient and efficient way.

- **Rasa-** Rasa is an open-source framework for building chatbots [19] that can understand and respond to text and voice-based conversations. These chatbots are capable of processing natural language input and maintaining a conversation with users while determining their next course of action.

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It should be noted that the tools, technologies, and algorithms proposed above may be subject to changes based on any challenges or issues that may arise during the development process.

6.2.4 Testing

- **Unit Testing**- For ensuring accuracy, the subcomponents of CV ranking will undergo separate unit testing.

- **Component Testing** – Components will be combined and mapped for accuracy and error testing after the completion of unit testing.

- **Integration testing** – The combined components will undergo integration testing to check for proper integration and the identification of any potential issues.

- **System testing** – The system will be tested as a whole during system testing to assess the functionality and flow of the system.

- **User Acceptance testing** – Users will conduct user acceptance testing to evaluate their satisfaction with the system.

6.2.5 Deployment

Azure – Azure enables seamless movement and a dependable, uniform foundation connecting on-premises and public Cloud. [20] It offers a wider selection of hybrid links, such as virtual private networks (VPNs), caches, content delivery networks (CDNs), and ExpressRoute connections, to enhance user-friendliness and efficiency. The more time it takes for customers to implement an application, the greater the potential loss of business. Azure ensures that the system can be deployed effortlessly and swiftly from any location, while also allowing full authority over which applications are installed on which devices.

7 WORK BREAKDOWN STRUCTURE AND TIMELINE

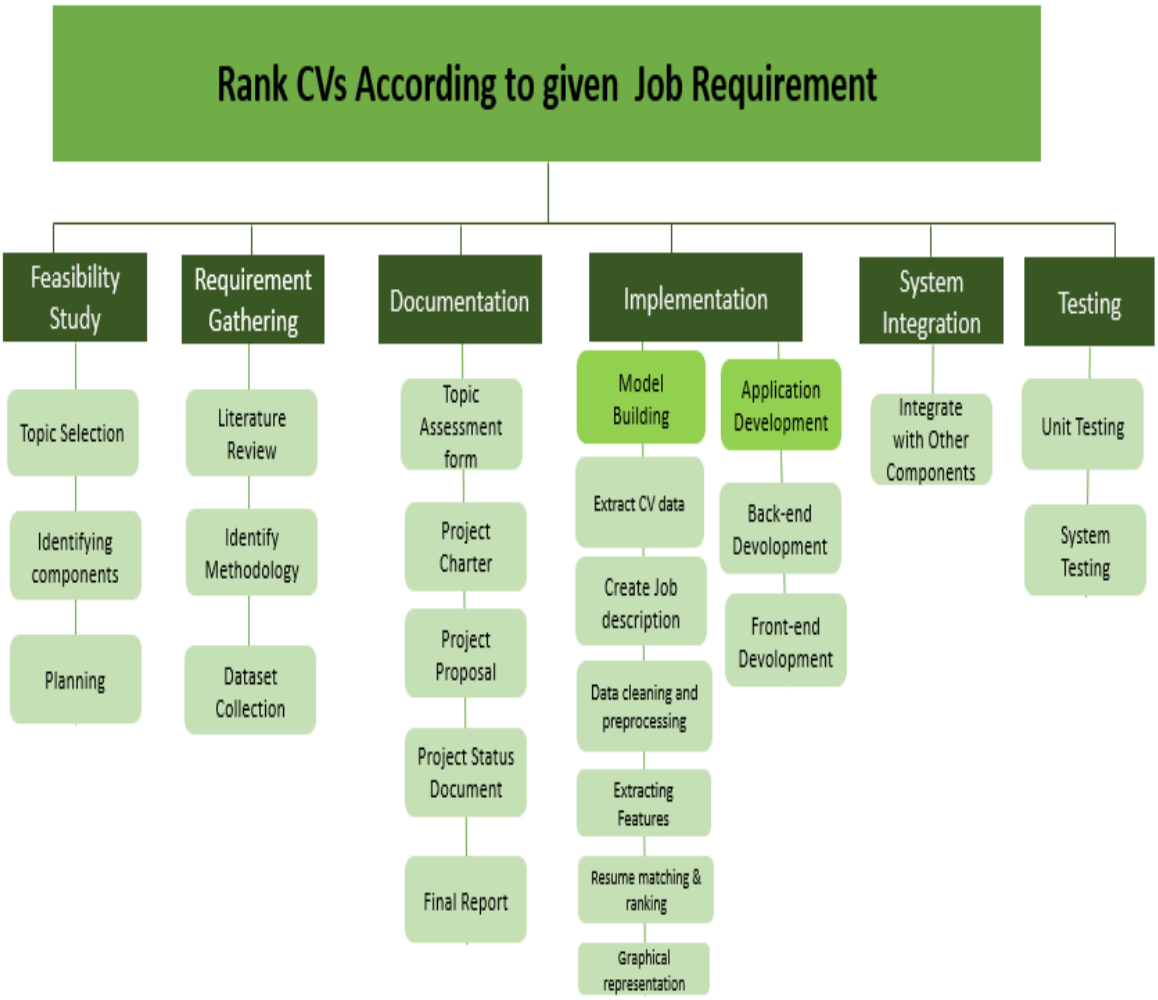

Figure 7 Work Breakdown Structure

8 PROJECT REQUIREMNTS

8.1 Functional Requirements

should be able to generate a job description for all openings by collecting inputs in a proper structure. This will ensure that job descriptions are detailed, accurate, and tailored to the specific requirements of each role.
system should be able to rank the candidates' CVs according to the job description. This will allow recruiters to quickly identify the most suitable candidates for each role and avoid spending valuable time and resources on unsuitable candidates.

system should be able to present each candidate's skill proficiency graphically in an understandable manner. This will enable recruiters to easily compare the skills of different candidates and make informed decisions.

8.2 Non-Functional Requirement

- Accuracy - The system should provide accurate and relevant rankings of CVs and provide a summary representation.
- Usability - The system should be user-friendly, with clear and intuitive interfaces that are easy to navigate.
- Performance -The system should be able to process many resumes quickly and efficiently.
- Reliability - The system must be highly available and reliable, with minimal downtime or data loss.

8.3 User Requirements

- The user should be able to define the requirements of specific job openings.
- The user should be able to understand grphical representation of skill proficiency.

9 GANNT CHART

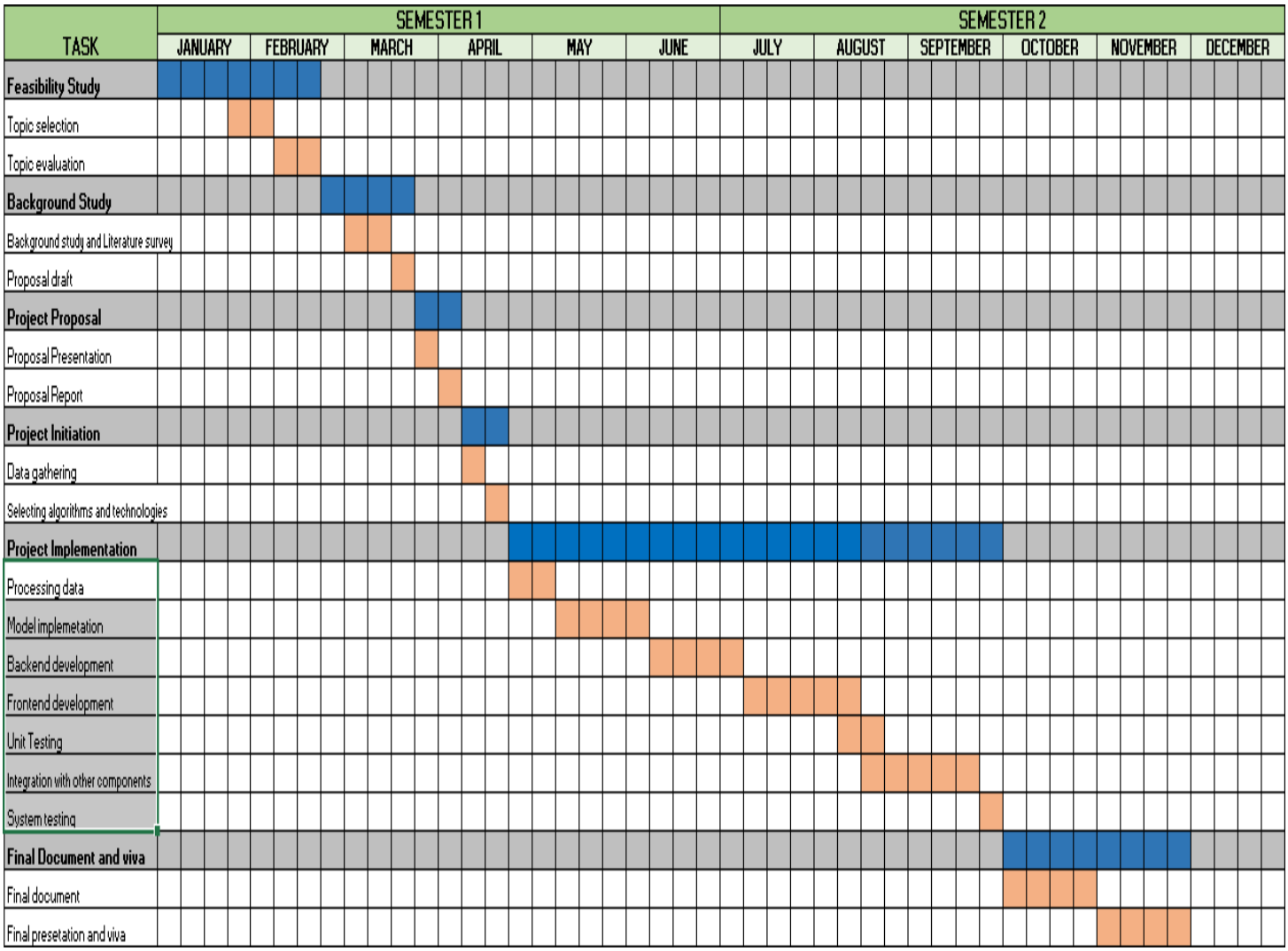

Figure 8 Gannt Chart of the System

10 COMMERCIALIZATION

Intellihire is a software solution developed by SMMS Software Solutions to streamline the recruitment process for IT companies, which will be developed as a web application, and can also be expanded to include mobile and desktop versions. By introducing this application “Intellhire”, companies can save significant amounts of time in the recruitment of candidates. Compared to existing applications in the market, this application offers new and advanced features to the recruiting people, which will enable them to get the maximum usage of automated recruiting processes. Also, this product includes a free version with basic features and a paid version with advance features.

This application will allow companies to find the right candidates without facing the loss of resources. With the ability to effectively rank candidates based on job descriptions and a thorough analysis of their CVs, companies can streamline their recruitment process and quickly identify the most suitable candidates for their open positions. Additionally, by automating the recruitment process, recruiters can focus on other essential tasks, such as conducting interviews and onboarding new hires, thus improving overall productivity. This product focus mainly of HR professionals of the company. Ultimately, an automated recruiting application can provide companies with a competitive advantage, allowing them to attract and retain top talent while also saving time and resource es.

Figure 10 Logo of the System

Figure 9 Logo of SMMS Solution

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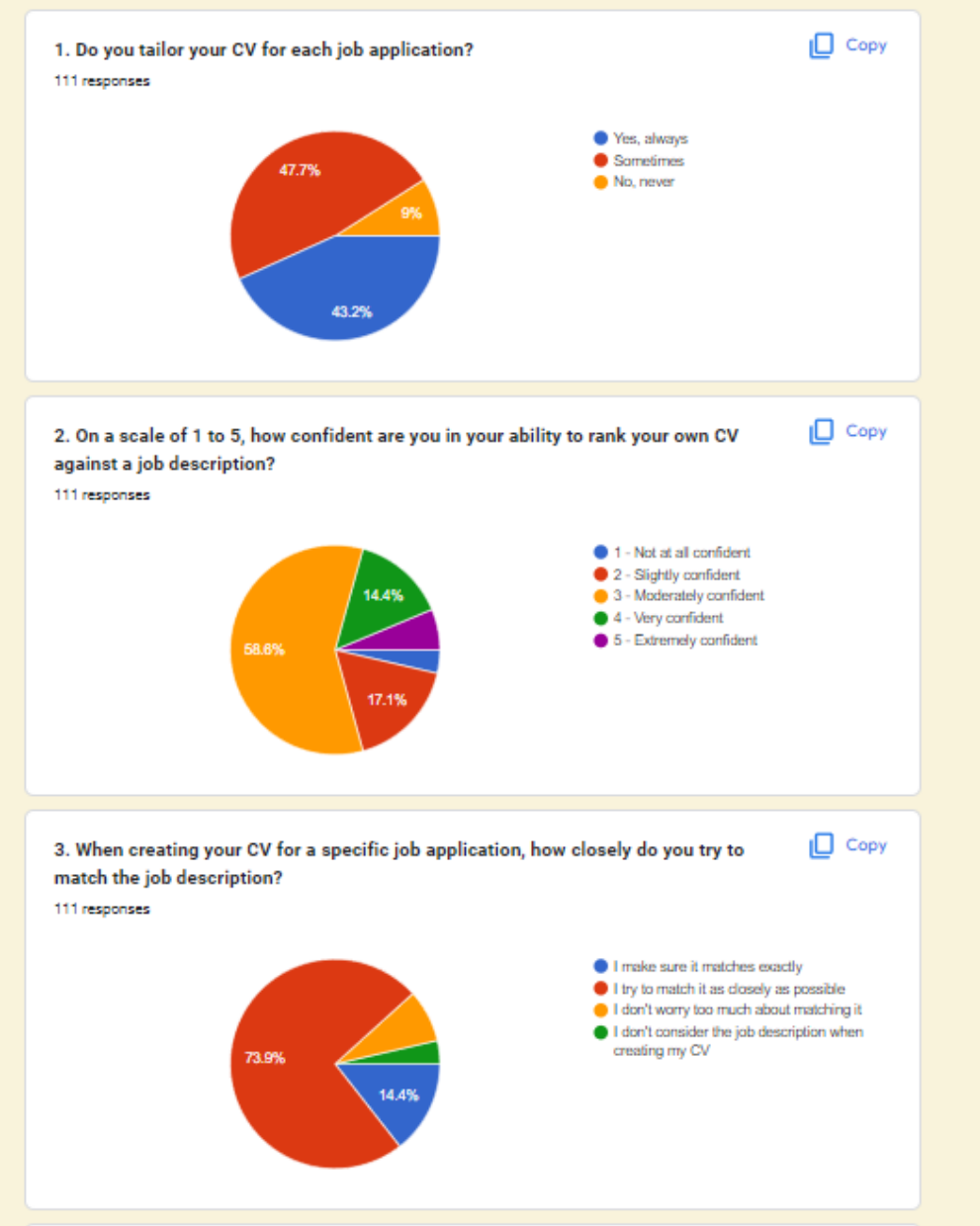
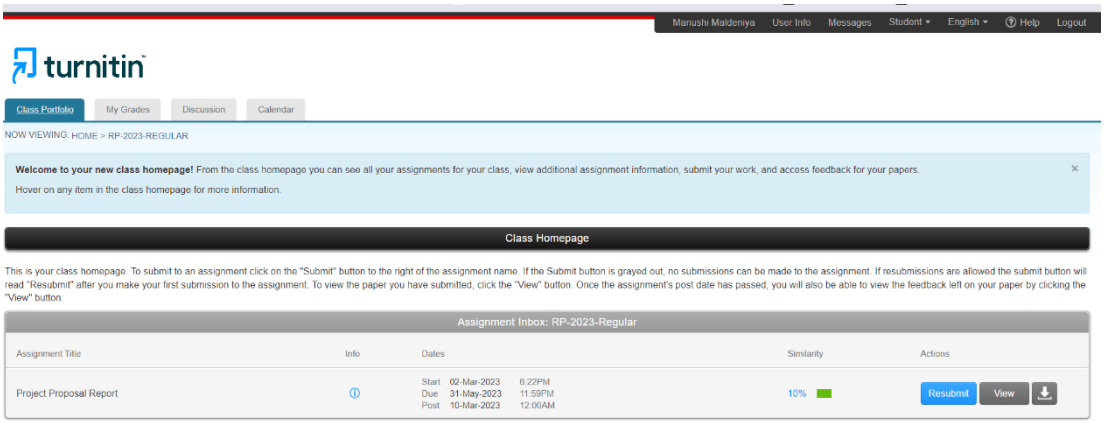
11 APPENDICES

Appendix A



Appendix 1 Survey Questionnaire

Appendix B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