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Artificial Intelligence-Powered Personalised Career Guidance System

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Abstract

Career guidance is the practice of providing individuals with information, advice, and support to help them make informed decisions with respect to their education, training, skills development and subsequent career paths. Thus, supporting individuals to navigate the process of making education and skills development choices and by extension career paths. Personalised career guidance further refines this process by tailoring recommendations to individual profiles and aspirations. With growing availability of digital data, this presents a vast amount of data that traditional methods of personalised career guidance are incapable of handling. However, AI tools have shown promising capability to sieve through huge volume of data to generate highly accurate and relevant recommendations for each individual, thus, this paper presents a personalised AI-based career guidance tool to overcome the limitations of the traditional approaches. In the methodology, the structured waterfall was adopted; ensuring systematic design, implementation, and testing phases. System modelling was accomplished through use-case, activity, class, and entity-relationship diagrams, providing a comprehensive framework for the system's implementation and functionality. The implementation utilised Supabase for a real-time database, authentication, and backend services, facilitating seamless integration with the AI layer. Rigorous testing, including functional, unit, and API tests validated the platform's performance, achieving efficient execution times and accurate recommendations. User acceptance testing engaged target users, whose feedbacks were used to further refine the system, improving its practicality and user-centric design. The recommendations engine demonstrated its adaptability by generating tailored career suggestions for diverse user profiles. This article demonstrates the potentials of AI in personalised career guidance while highlighting the importance of structured development and iterative user feedback.

Keywords: artificial intelligence, career, guidance, personalised, AI-Powered

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INTRODUCTION

Career guidance is the practice of providing individuals with information, advice, and support to help them make informed decisions about their education, training, skills development and subsequent career paths. It supports individual navigate the process of making education and skills development choices and by extension the job market by making information organised, and and readily available (Roy, 2020). The process encompasses a range of activities aimed at assisting individuals in making informed decisions about their education, training, and future career paths, thus: Self-assessment - identifying skills, aptitudes, and personality traits to understand personal strengths and weaknesses; exploration - gaining insights into diverse career options, educational pathways, and industry trends; decision-making - making informed choices based on factors like personal interests, job market demands, and skill alignment; and skills development - enhancing essential skills like decision-making, problem-solving, and self-efficacy for career success.

In Personalised career guidance, these steps are further refined by tailoring recommendations to individual profiles and aspirations. Achieving this requires an analyses vast amounts of data relating to an individual, this may include; skills and abilities - identified through assessments of soft and technical skills; interests and preferences - knowing activities and areas that interest individuals; and career goals and aspirations -defined by the individual's desired lifestyle, income, and long-term ambitions. With the growing availability of digital data, AI becomes the fit-for-purpose tool as it is capable sieving through the huge volume of data to generate highly accurate and relevant recommendations for each individual even with additional factors like: Job market trends - matching skills and interests with in-demand professions and emerging career opportunities; educational pathways -recommending suitable academic courses to develop necessary skills; salary potential and career growth - providing insights into financial prospects and advancement possibilities within different career paths; personality and work environment- suggesting jobs that align with individual preferences for work culture, pace, and collaboration; accessibility and scalability - AI systems can reach a wider audience, guiding individuals who may not have access to traditional counselling services; and constant learning and adaptation: AI algorithms can learn and improve over time, ensuring that recommendations remain up-to-date and reflect the ever-changing job market landscape.

Based on the foregoing, making career choices increasingly present a complex array of variables that makes the task challenging. For instance, it is crucial that individuals to be guided know themselves in terms of attitudes, skills, interests, values, and the resources available to them. Secondly, it is helpful to understand what different careers require, the conditions for success, priorities, drawbacks, and the opportunities they offer. Again, one must consider how these two sets of facts integrate or connect for choice making (Mulhall, 2014). The complexity of choosing a career is further compounded by the sheer diversity of career options available in today's technology-driven workplace. Young people in high school and at undergraduate levels often struggle to decide on the right educational and career path due to overwhelming choices and a lack of personalised guidance. One emerging concern in the realm of career guidance is the need for a more personalised and inclusive approach. However, traditional methods of career guidance have proven insufficient in providing tailored recommendations, leaving people overwhelmed by the vast array of career options, thus, creating uncertainty about which path to pursue. AI-technology has shown potentials in providing individuals with tailored recommendations based on their unique skills, interests, and aspirations.

Numerous studies, including Tuhame et al (2022) have addressed the complexities of career prediction and subject selection. These studies highlight the importance of considering factors such as student interest, ability, and the relevance of subjects to career aspirations. While these theories provide valuable insights, practical implementation has been challenging, especially in the developing world. Several other attempts have been made at delivering digitized career guidance. For instance, Hendahewa et al (2018), designed and developed a Career Advisory expert system, as a tool that provided effective guidance in choosing appropriate career paths and elective subjects. This innovative system paved the way for undergraduates to get customised advice on their desired career paths. For students lacking a clear vision, this platform offered a range of potential paths based on their past academic records. Using past exams and user psychology led a good number of students to believe the system overestimated their skills. It lacked personalisation using the users' interests or innate abilities but their academic performances only. In Kiselev et al (2020) the authors demonstrated that social networks data where people build values and identities can be used by AI to help individuals find careers that matche their values.

Tuhame et al (2022) built a model that predicts students' subjects and career choices based on several factors: namely; personality, environment, confidence, goals, and career options. It takes inspiration from different theories and includes new ideas like tracking interest changes and considering job growth trends. The model predicts choices as a process, not a one-time event. It also examines how these factors influence each other. For example, confidence affects goals, and goals affect career decisions. Key features were Personality (Uses Holland's RIASEC model to track interest changes over time), Career Decision Process (explains what makes good career prediction), job projections (Considers future job growth, unlike current systems), hypotheses (Tests how these factors influence each other). However, even though this suggested model is a very good prediction theoretical model, it lacks any implementation. Westman et al. (2021) highlighted failed applications of AI as emphasised the requirements for AI in Career Guidance, even though these requirements were presented, no AI software was made to test these requirements. In Asma & Abeeda (2017), the authors conducted a survey to determine the factors that influenced students the most. The outlined factors included: peer pressure, gender, counsellor, parents, media and personal interest. The study proved that students were more highly influenced by personal interests than counsellors. This study proved that traditional methods of career guidance fall short of personalised recommendations but did not provide any solution. Investigating factors affecting students' subject selection at the secondary school level by Javed (2018), the study used different data collection methods to know what influenced students' choice of subject in high school, it proved that students also were highly influenced by personal interest rather than other factors. It proved again that personal interest for students was very important but there was not a guidance system for personalised guidance.

Theoretically, two theoretical foundations underpin this article, namely; the Holland's Vocational Theory (HVC) and Social Cognitive Theory (SCT). HVC developed by psychologist John Holland in the 1950s has become a cornerstone in understanding the relationship between personality and career choices. It postulates that both individuals and work environments can be categorized into six types based on core interests and skills referred to as RIASEC: (i) Realistic (R): Individuals with strong mechanical and physical abilities, attracted to hands-on work involving tools and machines; (ii) Investigative (I): Analytical and curious, drawn to research, problem-solving, and scientific exploration; (iii) Artistic (A): Imaginative and creative, thriving in expressive fields like music, design, and writing; (iv) Social (S): Service-oriented and empathetic, excelling in interpersonal communication and helping others; (v) Enterprising (E): Persuasive and ambitious, adept at leadership, risk-

taking, and organizational skills; and (vi) Conventional (C): Detail-oriented and organized, drawn to structured tasks and data analysis. Career guidance tools often adopt HVC to assess individuals and suggest suitable career options. However, it's important to note that it's not a deterministic model. Other factors like personality traits, values, and external circumstances also play a crucial role in career choice.

Social Cognitive Theory (SCT) on the other hand offers a much more reliable guide. Developed by Albert Bandura, SCT posits that our career choices are shaped by three key factors: (i) Self-efficacy: Our belief in our ability to succeed in specific careers; (ii) Outcome expectations: Our anticipation of the rewards and challenges associated with different career paths; and (iii) Social Learning: Observing and mimicking the career choices of others, especially those we admire or identify with. For instance, a high school student with an interest in coding and a passionate mentor working in the tech industry. Their mentor's success and enthusiasm (social learning) can boost the student's self-efficacy in pursuing a career in tech. If they then witness the mentor overcoming challenges and reaping the rewards of their work (outcome expectations), the students is more likely to believe they can follow a similar path. Figure 1 presents the SCT framework showing its various components and how they interrelate.

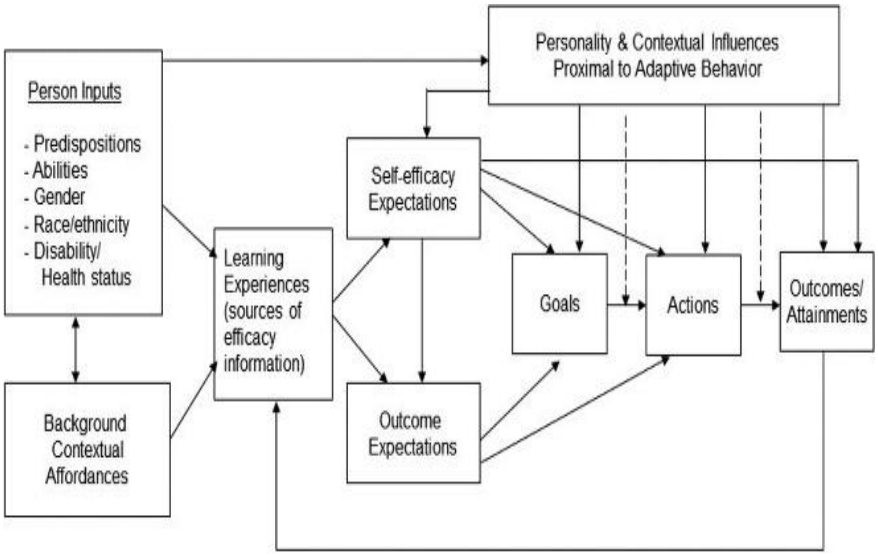

Figure 1: The SCT Framework ***(Adapted from (Lent & Brown, 2019)).***

SCT goes beyond simply mirroring others. It emphasises personal agency, where individuals actively interpret and apply what they observe to their career aspirations. For example, a student inspired by a nurse might not aspire to become a nurse themselves, but instead, their experience could fuel their interest in pursuing a career in healthcare research. However, to maximise the outcome of the AI implementation of these theories, this paper proposed a merger of the Holland's Vocational theory and Social Cognitive Theory as presented in the following section.

i. Personality-driven assessment: HVT provides AI with a starting point to understand the user's personality type and related career interests.
ii. Dynamic adaptation: SCT's focus on self-efficacy and goals allows AI to consider individual experiences, skills, and evolving aspirations.
iii. Predictive insights: By analysing past user interactions and performance in tasks aligned with their HVT type, AI can predict potential success in specific careers.
iv. Adaptive guidance: SCT's emphasis on outcome expectations enables AI to tailor recommendations based on the user's perceived likelihood of success and satisfaction in different career paths.

v. Continuous learning: AI can continuously update its knowledge base of career options and their requirements, adapting to emerging trends and job markets.

The novelty comes from the solid theoretical foundation based on HVC and SCT theories. This underpins the creation of an AI-driven career guidance system with two integrated layers: one collects user profiles, and the second uses AI to process this data, providing accurate and timely recommendationsThe rest of the paper presents section 2 which addresses the methodology, section 3 presents the results and finding while section 4 concludes the paper.

METHODOLOGY

The methodology followed the structured waterfall (Adenowo, 2020) variant of the software development life-circle, thus, ensuring a clear sequence of well-defined phases and comprehensive documentation. This approach emphasises careful planning and thorough execution to minimize risks and deliver a high-quality outcome. This is also important as the system is driven by a set of theoretical frameworks earlier discussed in the introduction section and will be underpinned by an AI layer. The modelling of the system is demonstrated with use-case, activity, class and entity relationship diagrams as elaborated in the proceedings sections.

Use Case Diagrams

The use case diagram as presented in Figure 2 shows the web of interactions between various actors - be they users or other sub-systems, and the system under consideration. This diagram provides a comprehensive overview, illustrating the flow of actions and functionalities, thereby aiding the understanding of how different entities interact with the system to accomplish specific tasks or objectives.

Figure 2: ***Use Case Diagram***

Activity Diagram

The activity diagram presented in Figure 3 visualises the flow of activities and actions within a system, showing the sequence of various processes with clarity and precision. Providing a structured depiction of activities, transitions, and decision points.

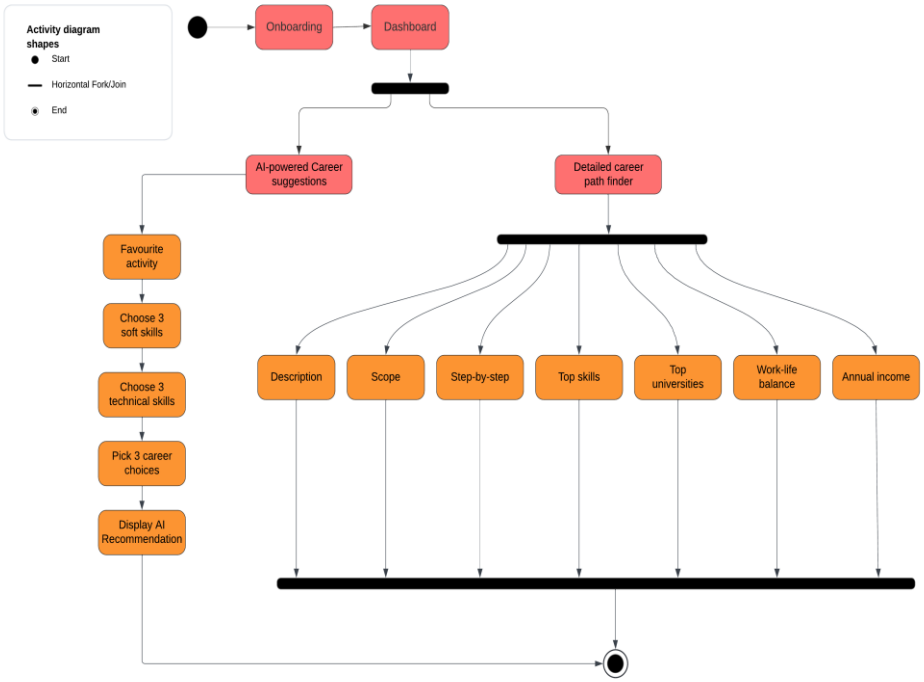

Figure 3: Activity Diagram

Class Diagram

The class diagram presented in Figure 4 provides a comprehensive visual illustration of how various classes interact, communicate, and collaborate, it functions as a schematic blueprint for the new system to be developed.

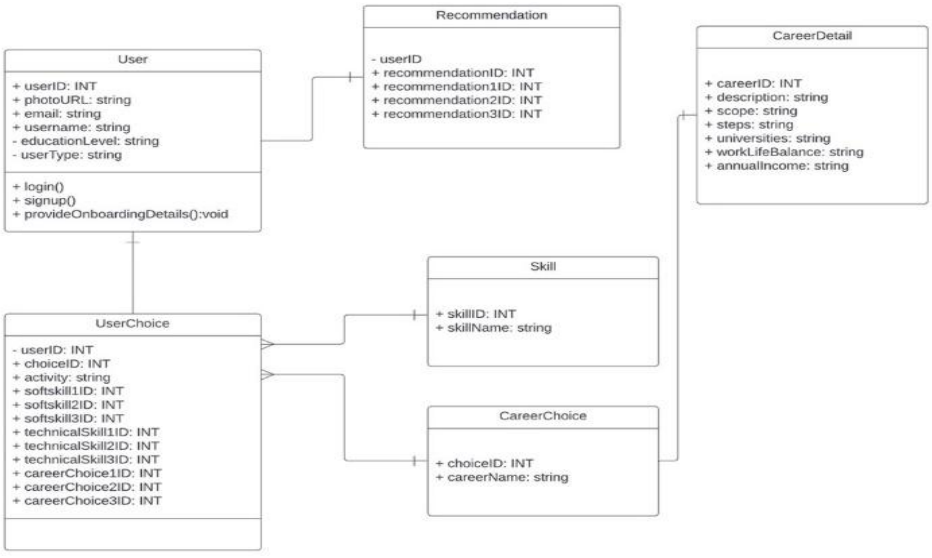

Figure 4: *Class Diagram*

Entity Relationship Diagram

Figure 5 presents the entity Relationship Diagram (ERD) that illustrates the various entities and how they interact, interrelate, and depend on each other within the ecosystem.

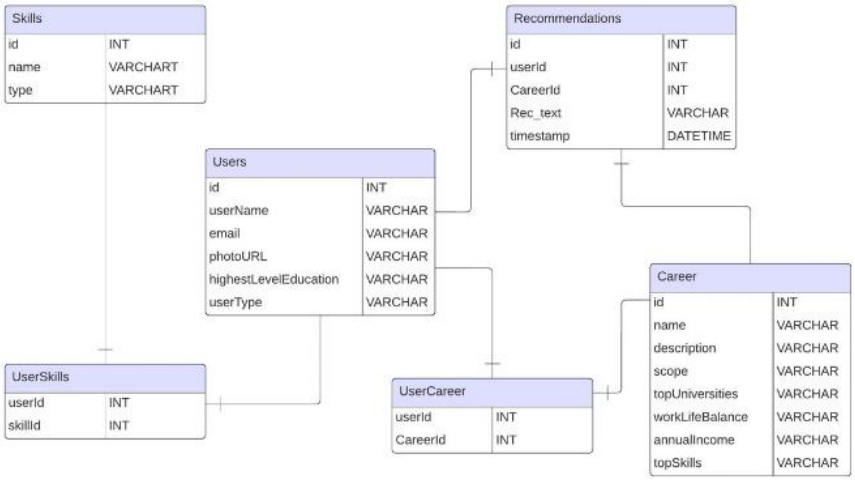

Figure 5: ***Entity Relationship***

RESULTS AND DISCUSSION

The results of the new system are presented in the implementation and testing of the system as described in the following sub-sections:

Results

Implementation

The implementation phase of the AI-powered career guidance platform involved translating the design specifications into a functional system. It involved designing the front end of the web application, designing the user interfaces and features to improve user experience starting from the landing page presented in Figure 6 and other pages in the project on one hand and on the hand the development of the backend infrastructure and database system necessary for the AI-powered career guidance platform to function. Supabase, a cloud-based platform, was utilised to create a real-time database, authentication system, and backend services. This decision was made to simplify backend development, ensuring rapid development and efficient scaling.

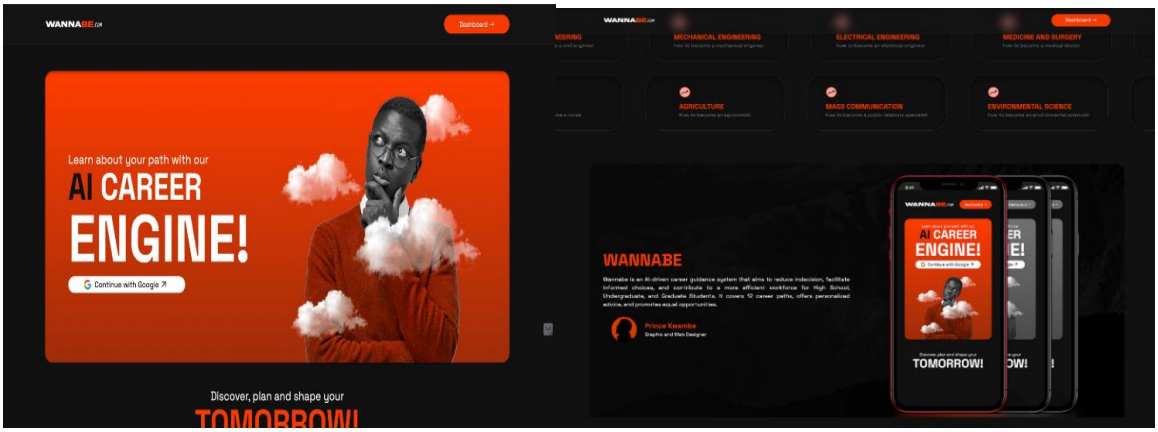

Figure 6: ***Landing Page***

The Database implementation presented in Figure 7 involved deploying the earlier designed ERD in the supabase database management system to store user profiles, user inputs, career recommendations, and other relevant information. Implementing authentication mechanisms to secure user data and ensure compliance with privacy law and regulations. Integrating

Supabase services with the frontend and backend components of the platform to enable seamless data exchange and real-time updates.

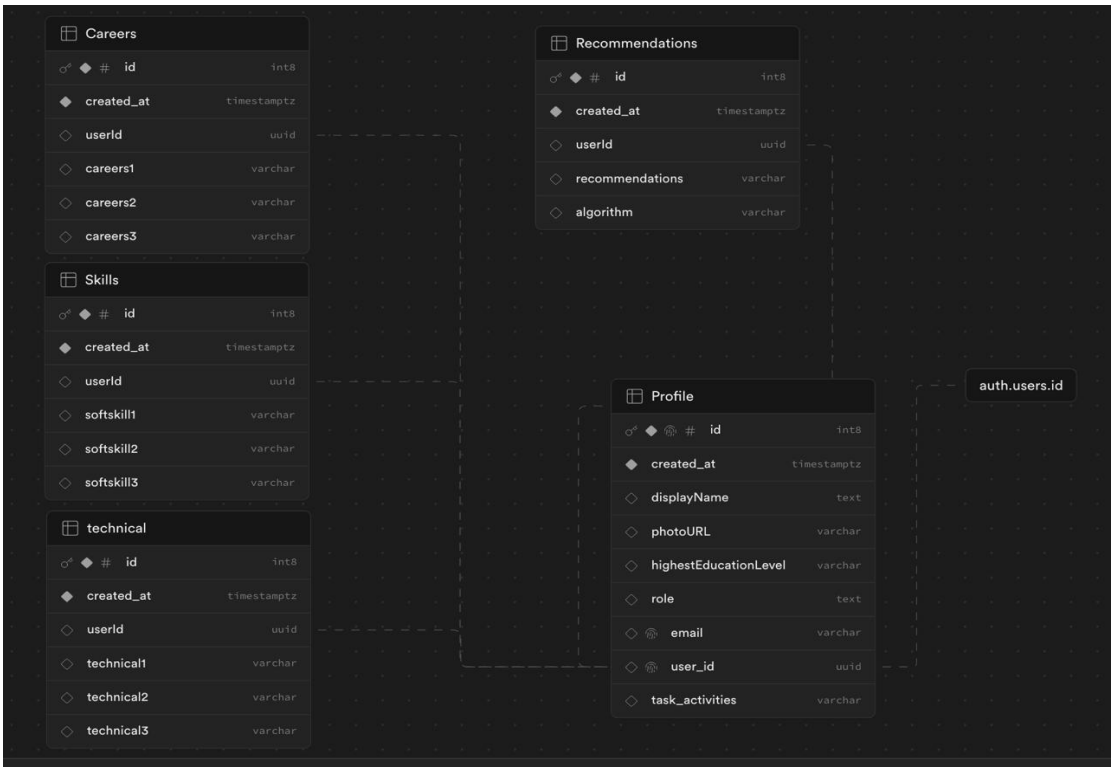

Figure 7 Database Schema

Testing

The testing phase aimed to validate the functionality, usability, and performance of the AI-powered career guidance platform. Various testing methodologies were deployed to identify and address any issues or bugs before deployment to ensure a smooth user experience.

Functional and Unit Testing

The functional testing focused on verifying that all features and functionalities of the platform were working as intended. Test cases were created to validate user registration, login, profile management, questionnaire completion, recommendation generation, and other core functionalities. Automated testing tools, such as Postman, were used to execute test cases and identify any deviations from expected system behaviour. The unit tests on the other hand are were designed to test individual units of code in isolation. The unit testing results was successful using Playwright. All tests passed for all pages across the three browsers tested (Chromium, Firefox and Webkit). The test execution time varied between pages and browsers but all tests were completed in under 4 seconds as presented in Figure 8.

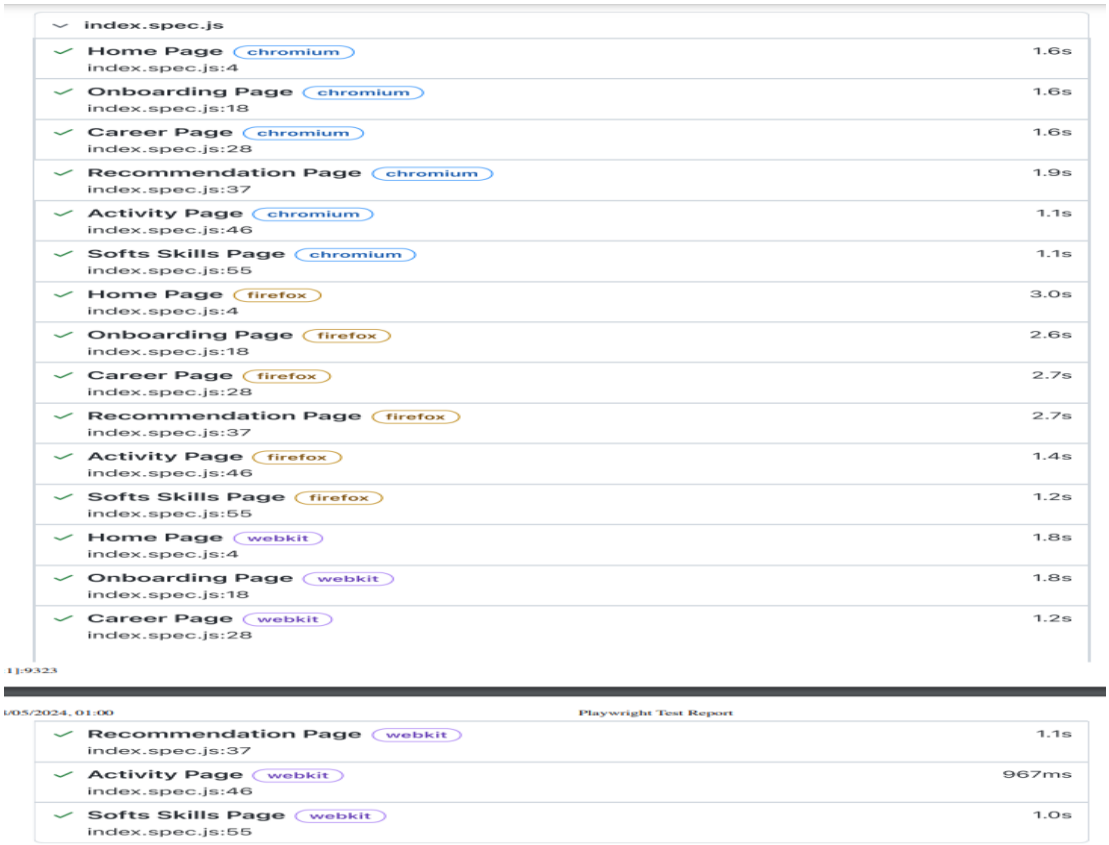

Figure 8: ***Unit Testing Result***

Llama API Testing

The Llama API testing result was successful overall. The runner was able to complete all 10 iterations of the test in 1 minute and 25 seconds, with an average response time of 8464 milliseconds as presented in Figure 9.

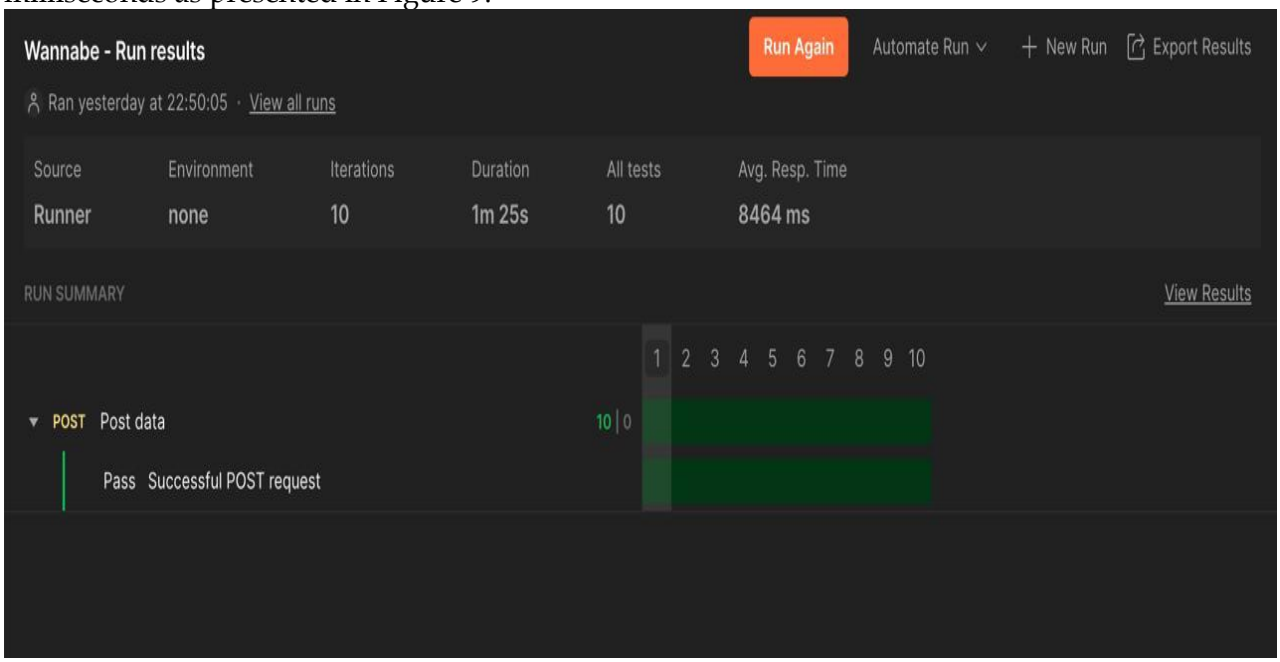

Figure 9: ***Llama API Testing Result***

API Recommendation Testing
To evaluate the effectiveness of the recommendation system, three scenarios were simulated with distinct user profiles and each user profile generated recommendations that were unique to the users with respected to the inputs provided. The input parameters and corresponding recommendations for each user are presented in the following section.

User One
Activity: Enjoys puzzles and problem-solving
Soft skills: Creativity, Negotiation, Problem-Solving
Technical skills: Video Editing, Web Development, Social Media Management
Career choices: Computer Science, Engineering, Pharmacy

User One Recommendations
Based on your preferences and skills, the following courses are recommended:
Computer Science: This aligns with your interest in puzzles and figuring out stuff, and your technical skills in video editing, web development, and social media management. Computer Science will challenge you to solve complex problems and develop innovative solutions.
Electrical Engineering: This course combines problem-solving with creativity, which suits your soft skills. Your technical skills in video editing and web development will also be useful in electrical engineering's focus on digital systems and electronics.
Information Technology: This course is a great fit for your technical skills in web development and social media management. IT also requires problem-solving and critical thinking, which aligns with your soft skills.

User Two
Activity: Enjoys fixing things with care
Soft skills: Critical Thinking, Emotional Intelligence, Attention to Safety
Technical skills: Clinical Skills, Auditing, Data Analytics
Career choices: Nursing and Nursing Science, Computer Science, Medicine

User Two Recommendations
Based on your preferences and skills, the following courses are recommended:
Nursing and Nursing Science: Your technical skills are clinical skills and attention to safety make nursing science and the care giving courses fit for you. Your emotional intelligence and critical thinking will also serve you well in this caring profession.
Medicine and Surgery: Your technical skills in clinical skills and data analytics, combined with your attention to safety, make medicine a suitable choice. Your critical thinking and emotional intelligence will also be valuable assets.
Pharmacy: Your attention to safety and critical thinking skills aligns with the precision required in pharmacy. Your technical skills in clinical skills and data analytics will also be useful in this field.

User Three
Activity: Enjoys building and designing spaces
Soft skills: Critical Thinking, Conflict Resolution, Public Speaking
Technical skills: Web Development, Social Media Management, Writing and Editing
Career choices: Law, Education, Mass Communication

User Three Recommendations
Based on your preferences and skills, here are the top three most suitable courses for you:

Civil Engineering: Your love for building cool things and making spaces work, combined with your critical thinking and public speaking skills, make civil engineering a great fit. You will design and develop innovative structures and solutions.
Mechanical Engineering: This course combines problem-solving with creativity, which suits your soft skills. Your technical skills in web development and writing/editing will also be useful in mechanical engineering's focus on design and development.
Architecture: Your passion for building and making spaces work, combined with your critical thinking and public speaking skills, make architecture a suitable choice. You'll design and develop functional and aesthetically pleasing spaces.

User Acceptance Testing (UAT)
User acceptance testing involved engaging real users, including high school students and undergraduates, to interact with the platform and provide feedback. Test scenarios were designed to cover various user journeys, from registration and profile creation to receiving career recommendations. Feedbacks from UAT sessions were collected through surveys, interviews, and direct observation, allowing for a comprehensive evaluation of the platform's performance and user experience.

DISCUSSION

This paper set out to demonstrate the potentials of AI in navigating the difficult terrain of career choices, especially for college students who are about the enter the university. Although, there has been consensus among authors that the complexity of factors and the vast amount of data required in accurately making recommendations for young is increasing (Egbaria, 2023; Tuhame et al 2022). This is further exacerbated by the increased availability of digital data which again, authors agree can only be processed by AI, (Kiselev et al, 2020; Hendahewa et al, 2018), consequently, the article leverages the ability of AI to sieve through huge piles of data to make decision with high level of accuracy. Theoretically, the system is built on a merger of two important underpinning theories, namely: Holland's Vocational Theory (VCT) and Social Cognitive Theory (SCT) as opposed to existing systems in (Jawhar, et al, 2024; Babu, 2024; and Monreal and Palaoag, 2024; and Westman et al, 2021) which were either built on one of these theories or built on no theory at all. The methodology employed in this study highlights the effectiveness of using a structured waterfall approach in developing an AI-powered career guidance platform. By meticulously following well-defined phases, a systematic design and implementation process, reducing risks and achieving clarity in system modelling through diagrams such as use-case, activity, class, and entity-relationship diagrams. These visual aids facilitated a deeper understanding of the system's functionalities and interactions. The integration of the Llama API played a critical role in enabling advanced AI capabilities, while Supabase simplified backend development with its robust database and real-time functionalities. Testing results underscore the system's reliability, with unit and functional tests demonstrating cross-browser compatibility and efficient performance. Additionally, the API recommendation testing confirmed the platform's ability to generate accurate, user-tailored recommendations. The user acceptance testing is another layer that further validated the system's practical utility through refinements, garnering positive feedback from real users. These outcomes collectively emphasize the potential of AI-driven solutions in transforming career guidance while highlighting areas for iterative improvement.

CONCLUSION

This research successfully developed and evaluated an AI-powered career guidance platform, leveraging a structured waterfall approach to ensure clarity and precision in the development process. The methodology provided a robust framework for modelling and implementing key system components, as demonstrated through use case, activity, class, and entity relationship

diagrams. The platform's implementation included a user-friendly frontend design, a real-time database using Supabase, and seamless integration between backend services and AI capabilities. Comprehensive testing validated the platform's functionality and performance, with unit and functional tests confirming its reliability across different browsers. The Llama API and recommendation system effectively delivered personalised career guidance tailored to individual user profiles, showcasing the system's accuracy and responsiveness. User acceptance testing further affirmed the platform's usability and relevance to target users. Overall, this study demonstrates the potential of AI in transforming career guidance, offering a scalable and efficient solution to support users in making informed career choices. The system can further be refined with continuous improvement and updates arising from user feedbacks and collaboration with educational institutions where the bulk of the people who require these services are found.

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