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Development of a PKM Website Prototype for UMM Students Using User-Centered Design

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Abstract: *Personal Knowledge Management (PKM) is very crucial for students to manage their own knowledge and activities in learning. However, previous PKM system development in academia lacks user involvement during development, resulting in the final system design not aligning with student's actual workflow and causing low usability. In this study, the prototype of the web-based PKM system will be designed with iterative User-Centered Design (UCD) that centers on the students for the design of the system solutions. The research adopts four phases of UCD: user and context identification, specification of user requirements, design of the solutions and usability evaluation. User Personas were created through literature review and contextual observations. The prototype was designed with Figma and tested with the System Usability Scale (SUS), initially involving 16 students from UMM in their fifth semester and above, with 15 valid responses analyzed after excluding one extreme outlier. A SUS score of 71.17 ± 14.59, with a 95% confidence interval of [63.09–79.25], places the system in the "Acceptable" (Grade C) category. This shows that the UCD approach can successfully develop a moderately usable PKM system, which still needs further improvement in learnability to better address students' problems in the document management process.*

Keywords: *Personal Knowledge Management, User-Centered Design, System Usability Scale, Prototyping, Academic Systems.*

1. Introduction

People these days are facing more challenges in managing their complex and huge personal information. Thus, managing personal knowledge is very important. One can use Personal Knowledge Management (PKM) to acquire, create, and share knowledge on one's own without any organization. The main aim of this is to assist people with information overload for personal effectiveness [1]. The purpose of Personal Knowledge Management (PKM) is to allow people in any profession to manage their knowledge and information optimally. In other words, the goal is to organize personal assets so that they become better organized and efficient. And it makes required information easy to access whenever needed [2]. The effective implementation of PKM can help individuals become more competent and competitive in the workplace as well as grow and learn [3].

According to [4], students who possess knowledge and PKM competencies have a better developed skillset. Even though it is really helpful, PKM implementation does have challenges when it comes to practice. After having personally observed this informally, it was found that one issue, that of the large amount of academic paper created mostly by the upper year informatics majors. Unfortunately, many documents end up disordered in local drives, all over cloud drives, or in old chats. Having no central management creates many inconveniences for students who tend to lose data and face delays in preparing a professional portfolio.

Information technology usage will generally give better control over user accessibility and their activities [5]. However, in the academic field the prior developments of PKM systems have been entirely based on R&D [6]. These approaches tend to be more focused towards developers, rather than students' actual workflows. A useful program with low usability because the systems developed often do not match real user workflows and thus are not practical [7].

Changing our focus from one based around the technology to one based on the user will help us address this gap. The integrated user-centered design (UCD) techniques in a personal knowledge management (PKM) systems development. UCD integrates end-users into the design cycle continuously [8]. Research shows that doing so increases utility and satisfaction with the product [9]. With the use of UCD's participatory method, it is expected that the system fits with the academic workflow and preferences of students [10], and this is more user-driven compared to earlier PKM methods. This research seeks to answer the questions: (1) How to identify PKM user requirements in academia? and (2) How to identify PKM's user requirements from UMM students? How can UCD design a PKM system to meet the document management needs of UMM students?

2. Literature Review

Previous studies on PKM in academia, primarily focusing on its critical role for university students, have been compiled in this review. Nuryasin [6] highlighted that PKM is highly recommended for undergraduates to support self-directed learning and the management of academic documents. In addition, students equipped with PKM skills demonstrate superior analytical abilities and higher technological literacy [4]. On the other hand, a lack of effective personal knowledge management can decrease student performance and hinder academic progress, as they struggle with unorganized data and communication barriers [11]

Studies on UCD have also been widely explored to demonstrate the effectiveness of integrating user involvement in the development process. In the study on the development of mobile applications for underserved populations with low health literacy, the UCD method helps designers understand user needs, limitation, mental models, and expectations [10]. Furthermore, UCD combined with System Usability Scale (SUS) was also used to design a health consultation app, earning a SUS score of 73.5, which indicates that user needs are well met [12]. A similar approach in disaster management sector used UCD for a disaster-resilient church dashboard, achieving a SUS score of 80.5 for users and 81.25 for admins[13]. These studies reveal that UCD yields the best results when the target user group is well-defined and involved iteratively, rather than only at the end.

Even after knowing this, UCD has not been used in academic PKM systems. The most comparable prior work is a PKM prototype created by Nuryasin's [6] for academic, which uses an R&D (research & development) approach based on developer assumptions, not systematic user involvement. The team did not test usability with actual users and did not observe user workflows with students. The model addressed theoretical functions of a PKM system, but seems not to have been validated against actual student behaviour. The gap this study will fill. The research redefines the development process using PKM concepts through a participatory UCD model and usability testing. The research project focuses on creating a usable system that meets students' document management practices.

3. Methods

The study was conducted using iterative prototyping based on User-Centered Design. This approach is chosen because it involves the end-user during the complete development cycle to make sure the system built fulfills their requirements [14] [15]. The design medium chosen for the project was prototyping, which allows users to interact with the system before its full implementation [16] [17]. The UCD method has four stages as shown in figure 1 [13].

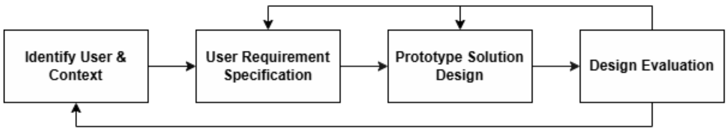

Figure 1. Flow User-Centered Design

To ensure clarity and methodological rigour, the four stages of the UCD framework were executed through distinct research procedures: (1) Literature Review and Observation to identify the user and context, (2) Requirement Analysis to specify user needs, (3) Prototyping to design the solution, and (4) Usability Testing to evaluate the design.

A. User and Context Identification

Two approaches were used to identify the qualities, needs and behavior of future users in this phase. Initially, the study conducted a review of literature through past studies on PKM issues in academia and benchmarked the effectiveness of UCD methodologies to find gaps between PKM system and previous developer-centric systems. In the second approach, we observed five students of Informatics UMM (semester 5 or above) with the Contextual Inquiry method while performing their academic documentation on their personal device without any PKM system. After observing their natural behavior, the results from both (the techniques) were documented and helped reveal common patterns and prioritize user pain points for requirements.

B. User Requirement Specifications

Following the data collection, a requirements analysis was conducted to recognize users' needs and prioritize features. This stage combined the gaps in the literature review with the pain points collected through observations in the context. At this point, the User Personas were created to stay aligned with users' use cases. User Persona is a fictional representation of an ideal user based on their characteristics, goals and pain points which are recorded in the use data [18]. Through the persona as a design proxy, the goals and pain points identified were mapped to functional requirements (meaning, each requirement responds to a specific observed user need rather than assumed technical need).

C. Prototype Solution Design

The goal of this phase is to convert requirements into visual forms and interactions for direct testing. The prototype was created using Figma to create a high-fidelity interactive medium in order to provide the user with an experience close to the final system [19]. The design process kicks off by determining the information architecture as well as user flow. We map out the main journey from login and dashboard access to managing activity documents and creating structured portfolios. The diagram (in Figure 2) is a way to create a user flow that serves as a guide for the page structure and connection of features. Scope of the prototype is limited to the interface components such as authentication, document management, document classification, and generation of portfolio.

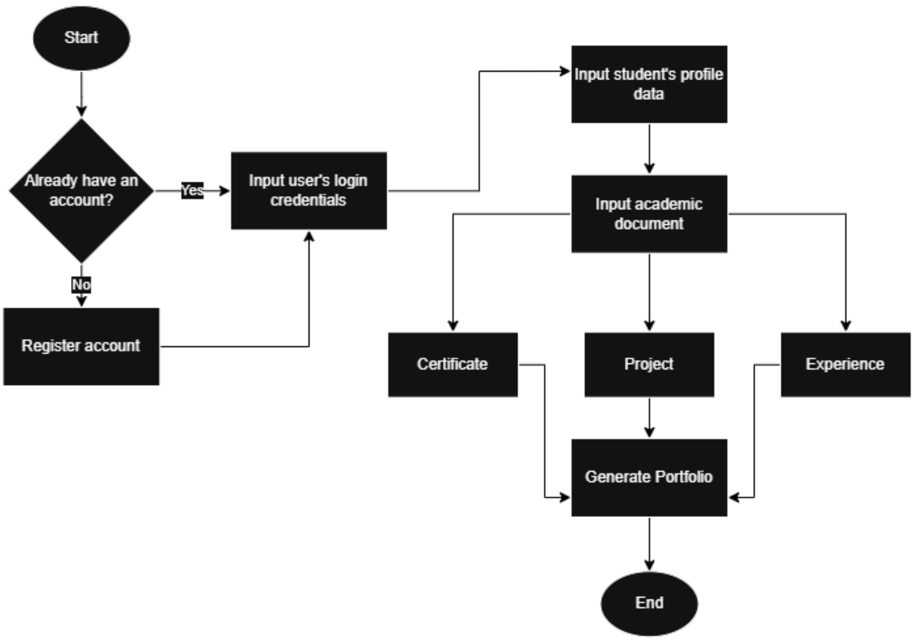

Figure 2. User Flow

D. Design Evaluation

To assess usability of prototype and scope for improvements. Thus, evaluating the design process was used in this case. The evaluation was conducted through user testing. These users were selected through purposive sampling, namely informatics UMM students in the fifth semester or above who had experience in managing academic documents. Those taking part in the study were to manipulate the prototype and use it as intended. Through interactive testing, we gain feedback on whether the user interaction with the system is smooth and the flow is as expected. The SUS is a standardized instrument used for measuring the usability of software from the user's perspective [20]. Through a clickable Figma prototype to provide a near-real-world experience, the users interacted with the system. According to the table, instrument contains 10 valid items which are 1-5 point likert scale.

Table 1. System Usability Scale's Questionnaire

	Question
Q1	I would be interested in using this system once it becomes available.
Q2	I find the information presented in the prototype to be clear.
Q3	I find the interaction flow within the prototype easy to follow.
Q4	I would require a guidebook to understand the features provided.
Q5	I feel that the features provided align well with the system's objectives.
Q6	I found the design to be consistent across pages.
Q7	I found it difficult to locate the features I needed within the prototype.
Q8	I believe most other students would learn to use this prototype very quickly.
Q9	I would need to spend a significant amount of time familiarizing myself with the system to understand how it works.
Q10	I am confident that this system can assist students in managing their academic documents.

The collected data were analysed according to the SUS scoring rules which involved normalisation of the positive and negative items and conversion to an overall score in the range of 0-100. An analysis of user comments qualitative feedback was done for design barriers This two-pronged approach sheds light on both design quality and the development priorities for future iterations.

4. Results and Discussion

A. User and Context Identification

The study's target audience was determined using purposive sampling, which seeks subjects who meet specific requirements related to the research parameters and contexts used in the data collection [21]. Fifth semester students were selected for the study because they can handle different types of knowledge and learning experiences in a systematic and self-directed manner at this level. To further confirm literature findings, field observations using the Contextual Inquiry method, were conducted with five UMM students (5th semester and above) The observation simulates internal processing of knowledge without involving any PKM system on their device In Table 2, patterns of problems among the five participants are identified in the results of observation.

Table 2. Observation Review

Student's Management Problem	Pattern	Pain Point	Priority
Storing files in the "Downloads" folder or course-specific folders that frequently become disorganized/cluttered.	Unstructured local storage as default management method	Document Disorganization	High
Leaving project files piled up on hard drives without descriptive documentation or information.	No habit of adding context to saved files	Metadata absence	Medium
Manually sifting through piles of old folders, chat histories, and a storage drive scattered across various locations.	Retrieval relies entirely on memory and manual search	Retrieval Difficulty	High
Manually re-collecting files and assembling a portfolio from scratch using Canva/Word	Portfolio creation is entirely manual and repeated every update	High-effort manual process	High

Five participants exhibited two main types of behaviours: 1) they predominantly made use of unstructured local storage, such as Downloads and loose folders created for each course, resulting in fragmented collections of files and difficulties in retrieving them; 2) building portfolios was a manual process which involved time-consuming re-collections of files and reformatting. The major pain point for productivity at the academic level was the manual nature of the process. Other pain points were disorganized documents and poor metadata practices. The results were synthesized into a User Persona representing the typical user with key behaviours, goals, pain points as shown in Figure 3.

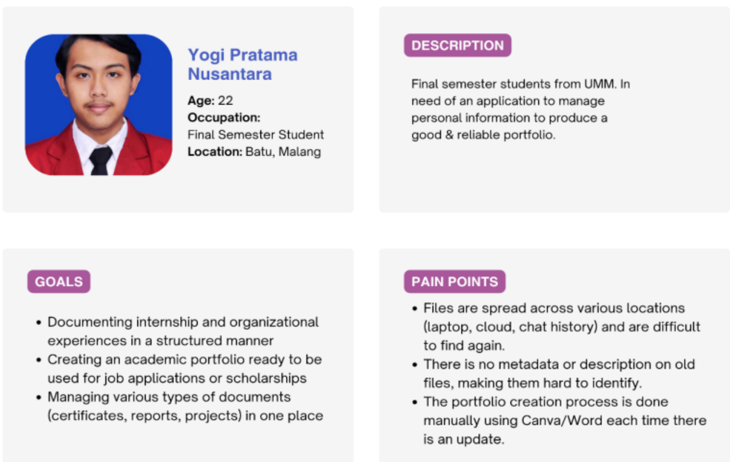

Figure 3. User Persona

B. User Requirement Specifications

After determining who will use it and in what context, we went on to create user requirements for the prototype. The synthesized findings from user contextual observations and user persona analysis determined feature priorities. Below in Table 3, the user requirements are designed.

Table 3. User Requirement Table

Code	User Requirement	Description
FR1	Registration	Students can create an account by providing their personal data
FR2	Login	Students can log in to the system using a registered account.
FR3	Document Upload	Students can upload documents related to academic activities (e.g., certificates, projects, internships).
FR4	View Document List	Students can view a list of their academic documents.
FR5	Edit Document	Students can edit information or replace files in existing documents.
FR6	Delete Document	Students can delete specific documents from the system.
FR7	Document Classification	The system categorizes documents by type (project, certificate, research, etc.).
FR8	Generate Portfolio Document	The system generates a structured portfolio document from all stored academic activities.
FR9	Print Portfolio Document	Students can print the portfolio document as a PDF or a hard copy.

The observed findings and user persona were synthesized to develop the functional requirements. The main pain point highlighted in Table 2, the lengthy manual portfolio assembly process (Observation 4) identified FR8 (Generate Portfolio Document) and FR9 (Print Portfolio Document) as top priority system requirements. Additional pain points of cluttered documents and difficult retrieval of files corresponded directly to the ‘core’ document management functions as per the system. Namely, FR3–Document Upload, FR4–View Document List, FR5– Edit Document and FR7– document Classification. FR1 (Registration) and FR2 (Login) were added as system access technical preconditions without direct responses to observed pain points.

Additionally, non-functional requirements (NFRs) were considered to define the quality attributes. Considering that the current deliverable is a Figma prototype and not a full system, the implementation phase focuses on the following: Usability (NFR1), Consistency (NFR2), Accessibility (NFR3). These are all subcharacteristics that affect usability and are measurable through the SUS instrument. Requirements like Security (NFR4), Scalability (NFR5) and Data Privacy (NFR6) will be post implementation.

C. Prototype Solution Design

The design of the PKM system interface examines the prototype in Figma application software. The resulting prototype is an interactive simulation where one can access functionalities of the system and all features that are integrated. The user flow identified in Section 3C as well as the pain points from the persona and contextual observation dictated the prototype design. The design of every interface component was guided by some functional requirement. The UI/UX design approach was primarily kept simple and consistent to minimize the learning curve for students moving from an unstructured local storage on their local machines to a structured PKM system [22].

The system entry, according to FR1 and FR2, is the login page in Figure 4. As an additional authentication for new users, a Google login was added. The registration link was added to ensure that users are not stuck on the login page and improve usability for new users (NFR1). The prototype is implemented as a web-based solution, ensuring that the system is accessible through any standard web browser and requires no additional software, which aligns with NFR3.

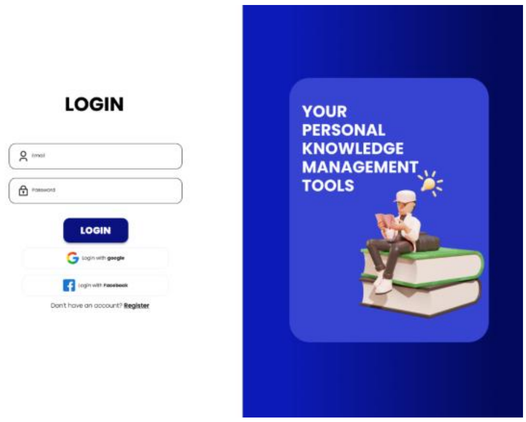

Figure 4. Login Page

As shown in Figure 5, crucial information on the profile page includes name, email, and home intitution. The information on this page is used to automatically generate the portfolio in FR8. This means there's no need to re-enter your information yourself whenever a portfolio is generated. This feature is discussed in a pain point in Observation 4. The project page in Figure 6 and the data entry form in Figure 7 implement FR3, FR5, FR6, and FR7. The structured input form requires filling out the project name, URL, and date. Due to the behaviour highlighted in Observation 2, the design is aimed at enforcing metadata documentation practices. The list view on the project page implements FR4 and FR7 at once by presenting documents in a scannable categorized fashion, replacing the manual folder sifting behaviour documented in Observation 3. The certificate and experience pages use the same design pattern to ensure consistency across document types (NFR2), while also using different modules to solve the unstructured local storage behaviour documented in Observation 1.

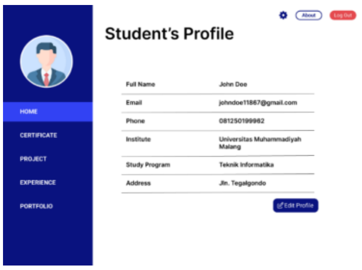

Figure 5. Profile Page

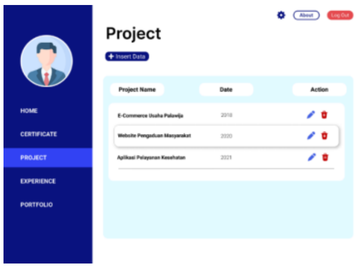

Figure 6. Project Page

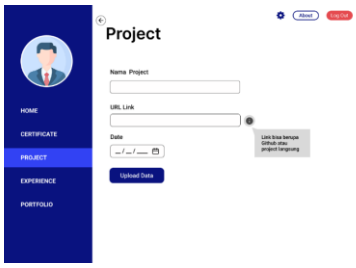

Figure 7. Insert Data Project

The portfolio page in Figure 8 and the portfolio generation result in Figure 9 are the highest priority feature of the system, implementing FR8 and FR9. They combine data from profiles, certificates, projects and experiences and fix the manual re-collection issue observed in Observation 4. The automated generation creates a portfolio ready for PDF download which replaces the repetitive Canva/Word flow of the participants. The aesthetic of this page as one single big dashboard also serves the persona's main goal of making a portfolio for professional and scholarship applications without any additional formatting.

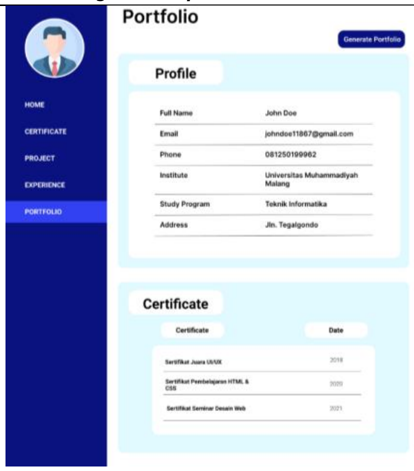

Figure 8. Portfolio Page

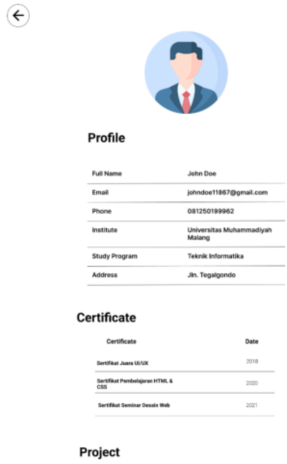

Figure 9. Generate Portfolio

D. Design Evaluation

User Testing was deployed at the prototype design evaluation stage to obtain complete feedback and evaluation on the PKM System Prototype. 16 students of UMM who are active in campus activities (semester 5 and above). Selection of this subject was done by purposive sampling method with the following criteria.

1. Experience in managing academic documents,
2. Prior use of digital systems for academic purposes,
3. Willingness to participate in the testing process until completion.

The number of respondents was deemed sufficient for measuring perceived usability using the SUS [23]. Before analysis, data screening was performed to identify extreme outliers that could bias the interpretation of results. Z-score Outlier Detection was utilized using Formula (1) below:

$$Z = (x - \mu) / \sigma \qquad (1)$$

Based on Table 4, Respondent 13 (R13) was identified in question Q5 with a Z-Score of -3.15. This was classified as an extreme outlier as it fell below the negative threshold of -3 and the overall Z-score pattern R13 in Table 4 shows negative extreme values in 6 out of 10 items (Q1, Q2, Q3, Q5, Q6, Q8, Q10 all below -2). Consequently, the final analysis was conducted on 15 valid respondents.

Table 4. Outlier Z-Score Result

Res	Q1	Q2	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9*	Q10
R1	0.05	0.08	0.98	-1.23	-0.13	-0.17	-0.48	1.13	-0.85	-0.08
R2	0.89	1.29	0.06	0.28	-0.13	-0.17	1.23	1.13	1.55	1.13
R3	0.05	0.08	0.06	1.04	-0.13	0.76	2.08	1.13	0.75	1.13
R4	0.05	0.08	0.98	-1.23	-0.13	0.76	-0.48	1.13	-0.05	-0.08
R5	0.05	0.08	0.06	0.28	-0.13	-0.17	0.37	-0.08	0.75	-0.08
R6	-2.45	-1.13	-2.7	0.28	-1.13	-2.04	0.37	-1.29	0.75	-1.29
R7	0.05	0.08	0.06	1.04	0.88	0.76	-0.48	-0.08	-0.05	-0.08
R8	0.89	0.08	0.98	-1.23	-0.13	0.76	-1.33	-0.08	-0.85	-0.08
R9	0.05	0.08	0.98	1.04	0.88	0.76	-1.33	1.13	-1.65	-0.08
R10	0.05	-1.13	0.06	1.04	0.88	0.76	-0.48	-1.29	1.55	1.13
R11	0.89	-1.13	0.06	1.04	0.88	-1.11	-0.48	-0.08	-0.85	1.13
R12	0.89	0.08	0.98	-1.99	-0.13	0.76	-0.48	-0.08	-0.85	-0.08
R13	**-2.45**	**-2.34**	**-1.78**	**-0.47**	**-3.15**	**-2.04**	**2.08**	**-2.49**	**0.75**	**-2.49**
R14	0.05	1.29	0.06	-0.47	-0.13	-1.11	-0.48	-0.08	-1.65	-1.29
R15	0.89	1.29	0.06	-0.47	0.88	0.76	0.37	-0.08	0.75	-0.08
R16	0.05	1.29	-0.86	1.04	0.88	0.76	-0.48	-0.08	-0.05	1.13

As per Formula (2), the calculation of SUS scores involves analyzing positive and negative items. For the first group of positive items (Q1, Q2, Q3, Q5, Q6, Q8, Q10), we calculate the score as (response value – 1), but for the negative items (Q4, Q7, Q9), we calculate them using (5 - response value). The sum of all scores is multiplied by 2.5 for the final SUS score.

$$SUS = 2.5 \times \left(\sum_{i\in P}(Q_i - 1) + \sum_{j\in N}(5 - Q_j)\right) \quad (2)$$

Table 5 shows that 15 respondents gave average SUS score of 71.17 ± 14.59. Moreover, 95% confidence intervals were computed using the t-distribution (N < 30): [63.09–79.25]. The usability level is classified as “Acceptable” using the “Grade C” score. This indicates that the proposed PKM system is moderately usable. This indicates that while the prototype works fine, it is not sufficiently usable that it could be adopted as is without any further upgrades.

Table 5. Questionnaire Evaluation Result

Resp.	Q1	Q2	Q3	Q4*	Q5	Q6	Q7*	Q8	Q9*	Q10	SUS Score
R1	4	4	5	2	4	4	2	5	2	4	80.0
R2	5	5	4	4	4	4	4	5	5	5	67.5
R3	4	4	4	5	4	5	5	5	4	5	62.5
R4	4	4	5	2	4	5	2	5	3	4	80.0
R5	4	4	4	4	4	4	3	4	4	4	62.5
R6	1	3	1	4	3	2	3	3	4	3	32.5
R7	4	4	4	5	5	5	2	4	3	4	70.0
R8	5	4	5	2	4	5	1	4	2	4	85.0
R9	4	4	5	5	5	5	1	5	1	4	82.5
R10	4	3	4	5	5	5	2	3	5	5	62.5
R11	5	3	4	5	5	3	2	4	2	5	70.0
R12	5	4	5	1	4	5	2	4	2	4	85.0
R13	4	5	4	3	4	3	2	4	1	3	72.5
R14	5	5	4	3	5	5	3	4	4	4	75.0
R15	4	5	3	5	5	5	2	1	3	5	67.5
Mean	4.00	4.00	4.07	3.60	4.20	4.27	2.40	4.07	2.87	4.07	

The standard deviation of 14.59 is quite large, suggesting variability in the data. The SUS scores ranged from 32.5 (R6) to 85.0 (R8 and R12). This variation suggests that not all users were able to interact with the prototype system. Some users found it very intuitive, while others struggled with the system. A more in-depth look reveals two clusters. The items scoring high-value such as Q6 (M=4.27), Q5 (M=4.20), Q3 (M=4.07), Q8 (M=4.07), and Q10 (M=4.07). A high score shows that the prototype generates visual consistency, relevant features, and intuitive interaction flow.

The items Q7 (M=2.40), Q9 (M=2.87), and Q4 (M=3.60) are consistently unlearnable. Many users tried to find features due to the low score for Q7. This suggests that the information architecture is not yet intuitive for first-time users. According to Q9 and Q4, it is anticipated that respondents would need time and assistance. This gap is considerable as the users in the target audience are senior students who are relatively tech-savvy. This implies that it would be an even greater challenge for people who have less technical knowledge.

Qualitative feedback from respondents supplemented the quantitative indication of learnability. In line with the low score for Q4 and Q9, three respondents wanted a user guide or onboarding tutorial. Also, two respondents noted that some UI elements, especially in the portfolio generation workflow, were not self-explanatory. The portfolio entry to output flow needs visual signalling to signify transitions through different pages. The prototype has enjoyable core functionality, but the discoverability of the overall system needs work.

Evaluation results serve as a realistic benchmark for prototype solution. SUS score is moderate with a large standard deviation and consistently low learnability across a number of items. This indicates that the prototype requires some extensive tweaking before it can be put to use. In subsequent versions, it would be beneficial to work on an onboarding handbook, a better in-product discoverability of features, and conducting larger usability tests with more diverse samples to reduce the confidence interval of our claims.

5. Conclusions

Based on the implementation of UCD and iterative prototyping, This research demonstrated the potential to produce a reasonably responsive prototype for the needs of UMM senior informatics students. The study indicates that user involvement in developing interface systems during the four stages of identification of users and context, specification of requirement, design of prototype and usability evaluation lead to a better system than the developer-oriented. The study also proved that a student-oriented system can be better designed by students themselves when designers get involved. The prototype fulfilled nine of the functional requirements based on observations and personas, with automated generation of portfolios as its key feature addressing key user pain points.

The usability evaluation yielded an average SUS score, or System Usability Scale score, of 71.17 (± 14.59) with a 95% confidence interval of [63.09–79.25]. This classified the system as "Acceptable" (Grade C). This suggests that the UCD approach has been successful in bringing core features of the system in line with user needs. However, learnability and feature discoverability require further improvement to make it comparatively more usable across different user backgrounds. The above findings should be seen the limitations of this thesis. The small sample size n=15 and that the product is a Figma based clickable prototype and not a fully functioning system hence the usability claims cannot be generalized.

The future development would be centered around: Making an onboarding guidebook to fill the learnability gap situations, Modifying the portfolio generate workflow based on qualitative user feedback and Have the prototype made more fully functional and coded so that usability will be more comprehensibly assessed. There is a suggestion to perform testing with a large group for more usability findings, as well as assessing whether it is ready for academia.

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